



Boiler Book 2011

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Model CBEX Elite

100-800 HP



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FEATURES AND BENEFITS

The CBEX Elite 100-800 HP Firtube boiler is designed, manufactured, and packaged by Cleaver-Brooks. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firtube boilers, the following features apply to the CBEX.

Two Pass Design:

- The packaged boiler offers high efficiency, flexibility, reliability, safety and ease of operation.

Front and Rear Access:

- Provides access to front tube sheet and furnace.
- Large rear access plug for turnaround and furnace access.

Natural Gas, No. 2 Oil, or Combination Burners Available:

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.

PRODUCT OFFERING

Burners are available to fire natural gas, No. 2 oil, or a combination of oil and gas. Standard product offering for 100-800 HP CBEX boilers is:

- Two pass wetback design.
- 150, 200, or 250 psig steam
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks authorized representative for option details).

- Boiler Options:
 - Additional screwed or flanged tapings.
 - Blowdown valves.
 - Non-return valves.
 - Feedwater valves and regulators.
 - Surface blowdown systems.
 - Surge load baffles.
 - Seismic design.
- Burner/Control Options:
 - Flame safeguard controllers.
 - Lead/lag system.
 - Special insurance and code requirements (e.g., IRI, FM, NFPA8501).
 - Alarm bell/silence switch.
 - Special motor requirements (TEFC, high efficiency).
 - Special indicating lights.
 - Main disconnect.
 - Elapsed time meter.
 - NEMA enclosures.

Remote emergency shut-off (115V).

Circuit breakers.

Day/night controls.

Special power requirements.

Low NOx Equipment.

- Fuel Options:

Gas strainer.

Gas pressure gauge.

Future gas conversion.

Oversized/undersized gas trains.

Optional Oil Pumps.

DIMENSIONS AND RATINGS

Dimensions and ratings are shown in the following tables and illustrations.

NOTE: The following information is subject to change without notice.

Table 1 - CBEX steam boiler ratings

Table 2 - CBEX hot water boiler ratings

Figure 1 / Table 3 - CBEX steam boiler dimensions

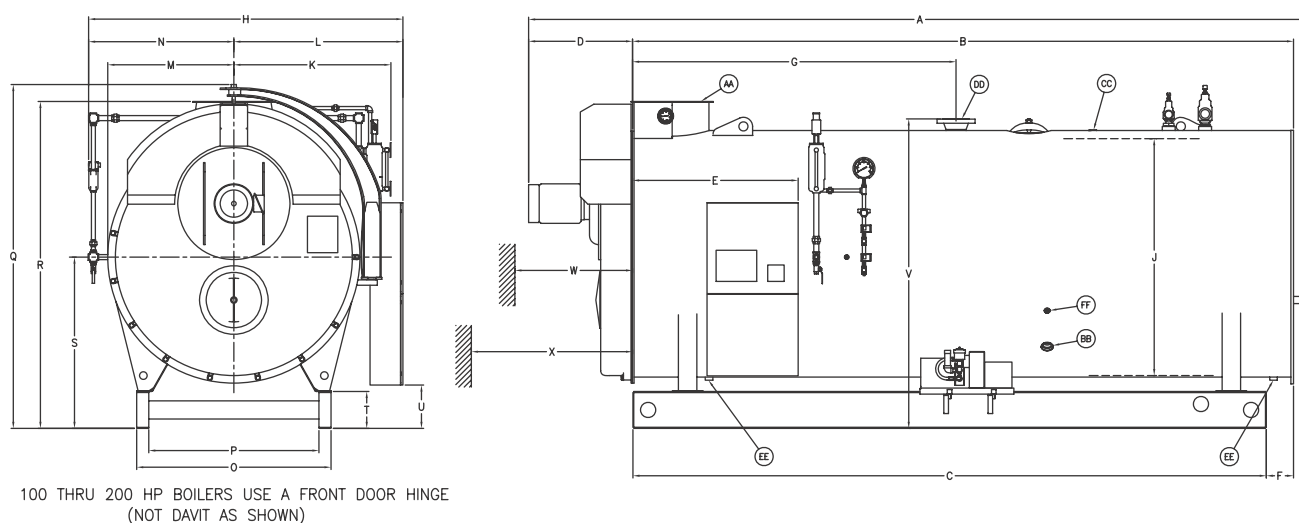
Figure 2 / Table 4 - CBEX hot water boiler dimensions

Table 1. CBEX Steam Boiler Ratings

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
RATINGS - SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr from and at 212 °F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.0	116.6	145.8	174.9	204.1	233.3
Gas CFH (1000 Btu)	4082	5102	6123	8164	10205	12246	14287	16328	20410	24492	28574	32656
Gas (Therm/hr)	40.8	51.0	61.2	81.6	102.0	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp (60 ppm)A	2	7-1/2	7-1/2	10	10	20	15	15	15	25	40	50
Blower Motor hp (30 ppm)A	3	7-1/2	7-1/2	15	15	20	20	20	30	40	50	75
Blower Motor hp (9 ppm)A	3	7-1/2	7-1/2	15	15	20	20	25	30	50	75	n/a
Oil Pump Motor, No. 2 Oil	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Air Compressor Motor hp (No. 2 Oil firing Only)	3	3	3	3	5	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2
BOILER DATA												
Heating Surface sq-ft. (Fireside)	390	452	526	697	820	860	1122	1412	1642	1769	2230	2301
NOTES: A. Blower motor size for boiler operating pressures 125 psig and less, contact your local Cleaver-Brooks authorized representative for higher pressures and altitude.												

Table 2. CBEX Hot Water Boiler Ratings

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
RATINGS - SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 85% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	28.1	35.2	42.2	56.3	70.3	84.4	98.4	112.5	140.6	168.8	196.9	225.0
Gas CFH (1000 Btu)	3938	4922	5907	7876	9845	11814	13783	15752	19689	23627	27565	31503
Gas (Therm/hr)	39.4	49.2	59.1	78.8	98.4	118.1	137.8	157.5	196.9	236.3	275.7	315.0
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp (60 ppm)	2	7-1/2	7-1/2	10	10	20	15	15	15	25	40	50
Blower Motor hp (30 ppm)	3	7-1/2	7-1/2	15	15	20	20	20	30	40	50	75
Blower Motor hp (9 ppm)	3	7-1/2	7-1/2	15	15	20	20	25	30	50	75	n/a
Oil Pump Motor, No. 2 Oil	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Air Compressor Motor hp (No. 2 Oil firing Only)	3	3	3	3	5	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2
BOILER DATA												
Heating Surface sq-ft. (Fireside)	390	452	526	697	820	860	1122	1412	1642	1769	2230	2301

Figure 1. CBEX Elite Steam Boiler Dimensions, 100-800 HP**Table 3. CBEX Elite Steam Boiler Dimensions 100-800 HP**

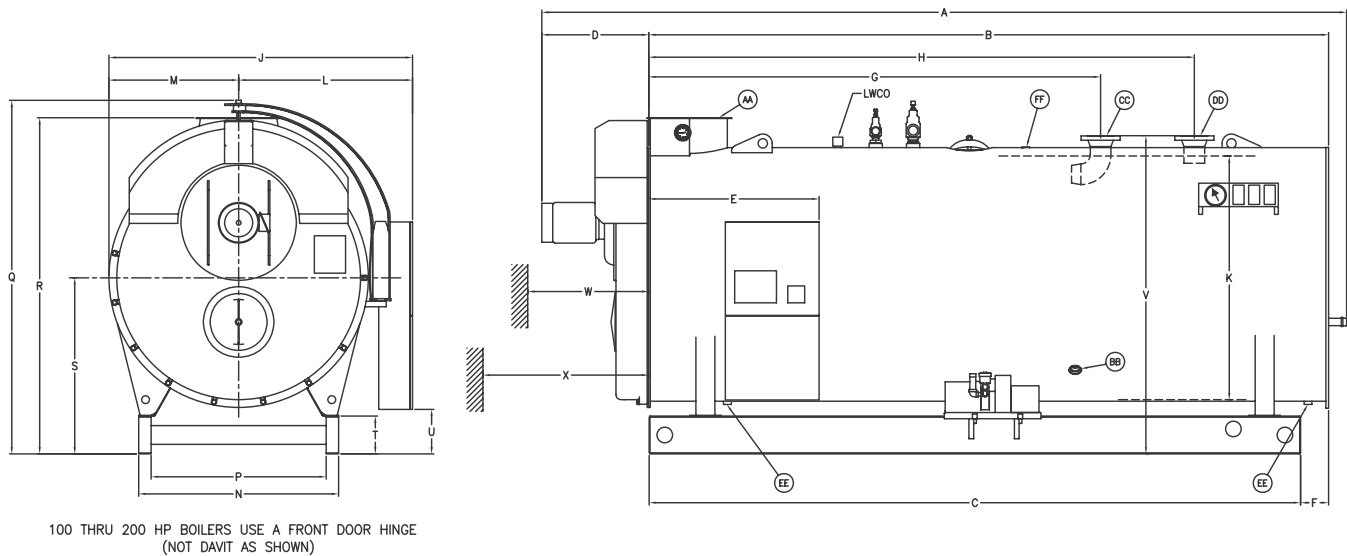
BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
LENGTHS													
Overall Length (60 PPM system)	A	165	172	176.5	201.5	231.5	242.5	249	265	260.5	282.5	291	299
Overall Length (30 PPM system)	A	167	176	180.5	203.5	233.5	243.5	255	268	271.5	287.5	298	307
Overall Length (9 PPM system)	A	167	176	182.5	205.5	233.5	243.5	255	270	271.5	288.5	300	n/a
Shell	B	137.5	144.5	149	168	196	204	217.5	226.5	229	244	253	260
Base Frame	C	130.5	137.5	140	159	186	194	208.5	217.5	219.5	234.5	243.5	250.5
Front Head Extension (60 PPM system)	D	21.5	21.5	21.5	27.5	29.5	32.5	25.5	32.5	25.5	32.5	32	33
Front Head Extension (30 PPM system)	D	23.5	25.5	25.5	29.5	31.5	33.5	31.5	35.5	36.5	37.5	39	41
Front Head Extension (9 PPM system)	D	23.5	25.5	27.5	31.5	31.5	33.5	31.5	37.5	36.5	38.5	41	n/a
Front Ring Flange to Panel	E	46	46	48	48	47	47	57	57	52	52	52	52
Rear Ring Flange to Base	F	7	7	9	9	10	10	9	9	9.5	9.5	9.5	9.5
Shell Flange to Steam Nozzle	G	62.5	66	73.5	75.5	96.5	100.5	106.5	111	114.5	122	126.5	130
WIDTHS													
Overall Width	H	81	81	86	86	94	94	105	105	112	112	119	119
I.D. Boiler	J	55	55	60	60	67	67	78	78	85	85	92	92
Center to Water Column	K	42.5	42.5	45	45	48.5	48.5	54	54	57.5	57.5	61	61
Center to Panel	L	44.5	44.5	47	47	50.5	50.5	56	56	59.5	59.5	63	63
Center to Lagging	M	30.5	30.5	33	33	36.5	36.5	42	42	45.5	45.5	49	49
Center to Auxiliary LWCO	N	36.5	36.5	39	39	43.5	43.5	49	49	52.5	52.5	56	56
Base Outside	O	47.5	47.5	52.5	52.5	51	51	64	64	60	60	68	68
Base Inside	P	39.5	39.5	44.5	44.5	43	43	56	56	47	47	55	55
HEIGHTS													
Overall Height	Q	81.5	81.5	87	87	101.5	101.5	113	113	122	122	130	130
Base to Vent Outlet	R	81	81	87	87	94.5	94.5	108	108	114.5	114.5	122.5	122.5
Base to Boiler Centerline	S	41	41	46	46	50	50	56.5	56.5	61	61	65.5	65.5
Height of Base Frame	T	12	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Panel	U	17	17	17	17	20	20	24	24	23	23	23	23
Base to Steam Outlet	V	78.5	78.5	82.5	82.5	90	90	102	102	110	110	118	118

Table 3. CBEX Elite Steam Boiler Dimensions 100-800 HP (Continued)

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
BOILER CONNECTIONS													
Feedwater Inlet (Both Sides)	BB	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Surface Blowoff	CC	1	1	1	1	1	1	1	1	1	1	1	1
Steam Nozzle (300# ANSI Flange)	DD	4	4	4	4	6	6	6	6	8	8	8	8
Blowdown-Front & Rear	EE	1.25	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
Chemical Feed	FF	1	1	1	1	1	1	1	1	1	1	1	1
VENT STACK													
Vent Stack Diameter (Flanged)	AA	16	16	16	16	20	20	24	24	24	24	24	24
MINIMUM CLEARANCES													
Front Door Swing	W	62	62	67	67	78	78	89	89	97	97	104	104
Tube Removal - Front Only	X	89	96	101	120	142	142	160	169	172	187	196	203
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL:													
Thru Window or Door		205.5	212.5	222	241	280	288	312.5	321.5	332	347	363	370
Front of Boiler		232.5	246.5	256	294	344	352	383.5	401.5	407	437	455	469
WEIGHTS IN LBS													
Normal Water Weight		6,550	6,890	8,010	9,060	11,620	12,190	19,340	19,650	20,060	21,620	25,050	25,870
Approx. Shipping Weight - (150psig)		10,650	11,180	12,520	13,900	17,960	18,540	25,960	26,780	31,580	33,320	39,830	40,840

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All connections are threaded unless otherwise indicated.

Figure 2. CBEX Elite Hot Water Boiler Dimensions, 100-800 HP**Table 4. CBEX Elite Hot Water Boiler Dimensions 100-800 HP**

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
LENGTHS													
Overall Length (60 PPM system)	A	165	172	176.5	201.5	231.5	242.5	249	265	260.5	282.5	291	299
Overall Length (30 PPM system)	A	167	176	180.5	203.5	233.5	243.5	255	268	271.5	287.5	298	307
Overall Length (9 PPM system)	A	167	176	182.5	205.5	233.5	243.5	255	270	271.5	288.5	300	n/a
Shell	B	137.5	144.5	149	168	196	204	217.5	226.5	229	244	253	260
Base Frame	C	130.5	137.5	140	159	186	194	208.5	217.5	219.5	234.5	243.5	250.5
Front Head Extension (60 PPM system)	D	21.5	21.5	21.5	27.5	29.5	32.5	25.5	32.5	25.5	32.5	32	33
Front Head Extension (30 PPM system)	D	23.5	25.5	25.5	29.5	31.5	33.5	31.5	35.5	36.5	37.5	39	41
Front Head Extension (9 PPM system)	D	23.5	25.5	27.5	31.5	31.5	33.5	31.5	37.5	36.5	38.5	41	n/a
Front Ring Flange to Panel	E	46	46	48	48	47	47	57	57	52	52	52	52
Rear Ring Flange to Base	F	7	7	9	9	10	10	9	9	9.5	9.5	9.5	9.5
Shell Flange to Water Return	G	84	89	96	108	134	139	148	155	156	166	173	177
Shell Flange to Water Outlet	H	109	114	121	133	160	165	174	181	192	202	209	213
WIDTHS													
Overall Width	J	75	75	80	80	87	87	98	98	105	105	112	112
I.D. Boiler	K	55	55	60	60	67	67	78	78	85	85	92	92
Center to Panel	L	44.5	44.5	47	47	50.5	50.5	56	56	59.5	59.5	63	63
Center to Lagging	M	30.5	30.5	33	33	36.5	36.5	42	42	45.5	45.5	49	49
Base Outside	O	47.5	47.5	52.5	52.5	51	51	64	64	60	60	68	68
Base Inside I	P	39.5	39.5	44.5	44.5	43	43	56	56	47	47	55	55
HEIGHTS													
Overall Height	Q	81.5	81.5	87	87	101.5	101.5	113	113	122	122	130	130
Base to Vent Outlet	R	81	81	87	87	94.5	94.5	108	108	114.5	114.5	122.5	122.5
Base to Boiler Centerline	S	41	41	46	46	50	50	56.5	56.5	61	61	65.5	65.5
Height of Base Frame	T	12	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Panel	U	17	17	17	17	20	20	24	24	23	23	23	23
Base to Water Return & Outlet	V	78.5	78.5	82.5	82.5	90	90	102	102	110	110	118	118

Table 4. CBEX Elite Hot Water Boiler Dimensions 100-800 HP (Continued)

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
BOILER CONNECTIONS													
Water Fill (Both Sides)	BB	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Water return (150# ANSI Flange)	CC	4	6	6	6	8	8	8	10	10	12	12	12
Water outlet (150# ANSI Flange w/Dip)	DD	4	6	6	6	8	8	8	10	10	12	12	12
Drain-Front & Rear	EE	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2
Air Vent	FF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
VENT STACK													
Vent Stack Diameter (Flanged)	AA	16	16	16	16	20	20	24	24	24	24	24	24
MINIMUM CLEARANCES													
Front Door Swing	W	62	62	67	67	78	78	89	89	97	97	104	104
Tube Removal - Front Only	X	89	96	101	120	142	142	160	169	172	187	196	203
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL:													
Thru Window or Door		205.5	212.5	222	241	280	288	312.5	321.5	332	347	363	370
Front of Boiler		232.5	246.5	256	294	344	352	383.5	401.5	407	437	455	469
WEIGHTS IN LBS													
Normal Water Weight		7,270	7,640	9,200	10,400	14,300	14,970	22,950	23,400	25,950	27,880	33,000	34,000
Approx. Shipping Weight - (30 psig)		9,040	9,510	10,630	11,950	14,900	15,670	20,100	21,420	25,100	26,400	31,350	32,130
Approx. Shipping Weight - (125 psig)		9,470	10,100	11,380	12,970	16,430	17,240	23,000	23,320	29,100	30,500	38,050	39,000

PERFORMANCE DATA

Efficiency

Tables 5 and 6 show predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks CBEX firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for CBEX Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7767 for a detailed description of efficiency calculations).

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in the tables listed above) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level. The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:

Natural Gas	No. 2 Oil	No. 6 Oil
Carbon, % (wt) = 69.98	Carbon, % (wt) = 85.8	Carbon, % (wt) = 86.6
Hydrogen, % (wt) = 22.31	Hydrogen, % (wt) = 12.7	Hydrogen, % (wt) = 10.9
Sulfur, % (wt) = 0.0	Sulfur, % (wt) = 0.2	Sulfur, % (wt) = 2.09
Heating value, Btu/lb = 21,830	Heating value, Btu/lb = 19,420	Heating value, Btu/lb = 18,830

2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
3. Efficiencies are based on the following radiation and convection losses. Firing rate of 25% - 1.2%, 50% - 0.6%, 75% - 0.4%, and 100% - 0.3%.

Table 5. CBEX Fuel-to-Steam Efficiencies Natural Gas (with heat recovery)

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
100	84.4	84.8	84.5	84.1
125	84.2	84.7	84.6	84.4
150	84.1	84.6	84.5	84.3
200	83.7	84.4	84.4	84.3
250	84.4	84.8	84.5	84.1
300	84.2	84.6	84.4	84.0
350	84.2	84.7	84.6	84.3
400	85.0	85.1	84.9	84.5
500	84.8	84.9	84.7	84.4
600	84.8	85.0	84.8	84.5
700	84.8	85.0	84.9	84.6
800	84.7	85.0	84.8	84.6

Table 6. CBEX Fuel-to-Steam Efficiencies #2 Oil (with heat recovery)

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
100	87.2	87.6	87.3	86.9
125	87.0	87.6	87.5	87.2
150	86.9	87.5	87.4	87.1
200	86.5	87.2	87.3	87.1
250	87.2	87.6	87.3	86.9
300	87.0	87.4	87.2	86.8
350	87.0	87.5	87.4	87.1
400	87.8	88.0	87.7	87.3
500	87.6	87.7	87.5	87.2
600	87.6	87.8	87.6	87.3
700	87.6	87.8	87.7	87.4
800	87.6	87.8	87.7	87.4

Emissions

Table 6. CBEX Natural Gas Estimated Emission Levels

POLLUTANT	UNITS	60 PPM SYSTEM	30 PPM SYSTEM	9 PPM SYSTEM	7 PPM SYSTEM
CO	ppm ^A	10	10	25	50
	lb/MMBtu	0.0075	0.0075	0.018	0.037
NOx	ppm ^A	60	30	9	7
	lb/MMBtu	0.07	0.035	0.0105	0.0082
SOx	ppm ^A	1	1	1	1
	lb/MMBtu	0.001	0.001	0.001	0.001
HC/VOC5	ppm ^A	8	8	4	4
	lb/MMBtu	0.0032	0.0032	0.0016	0.0016
PM	ppm ^A	-	-	-	-
	lb/MMBtu	0.01	0.01	0.01	0.01

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

Table 7. CBEX #2 Oil Estimated Emission Levels

POLLUTANT	UNITS	60 PPM SYSTEM	30 PPM SYSTEM	9 PPM SYSTEM	7 PPM SYSTEM
CO	ppm ^A	10	10	10	10
	lb/MMBtu	0.008	0.008	0.008	0.008
NOx	ppm ^A	120	90	70	70
	lb/MMBtu	0.16	0.12	0.093	0.093
SOx	ppm ^A	55	55	55	55
	lb/MMBtu	0.1	0.1	0.1	0.1
HC/VOC5	ppm ^A	4	4	4	4
	lb/MMBtu	0.002	0.002	0.002	0.002
PM	ppm ^A	-	-	-	-
	lb/MMBtu	0.025	0.025	0.025	0.025

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

BASED ON THE FOLLOWING CONSTITUENT LEVELS:

Fuel-bound Nitrogen content = 0.015% or less by weight.

Sulfur content = 0.1% by weight.

Ash content = 0.01% by weight.

ENGINEERING DATA

The following engineering information is provided for CBEX Boilers. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

Tables 9 and 10 list quantity and outlet size for safety/relief valves supplied on CBEX boilers.

Table 11 shows steam volume and disengaging area.

Table 12 gives recommended steam nozzle sizes.

Table 13 shows recommended non-return valve sizes.

Table 8. Safety valves steam

VALVE SETTING	150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE	NO. OF VALVES REQ'D	OUTLET SIZE	NO. OF VALVES REQ'D	OUTLET SIZE
100	1	1-1/2"	1	1-1/2"	1	1-1/4"
125	2	1-1/4"	2	(1) 1-1/4" (1) 1"	2	1"
150	2	(1) 1-1/2" (1) 1-1/4"	2	(1) 1-1/4" (1) 1"	2	1"
200	2	1-1/2"	2	(1) 1-1/2" (1) 1-1/4"	2	1-1/4"
250	2	(1) 2" (1) 1-1/2"	2	(1) 1-1/2" (1) 1-1/4"	2	(1) 1-1/2" (1) 1-1/4"
300	2	(1) 2" (1) 1-1/2"	2	1-1/2"	2	(1) 1-1/2" (1) 1-1/4"
350	2	2"	2	(1) 2" (1) 1-1/2"	2	1-1/2"
400	2	(1) 2-1/2" (1) 2"	2	(1) 2" (1) 1-1/2"	2	(1) 2" (1) 1-1/2"
500	2	(1) 2-1/2" (1) 2"	2	(1) 2-1/2" (1) 2"	2	(1) 2" (1) 1-1/2"
600	2	2-1/2"	2	(1) 2-1/2" (1) 2"	2	2"
700	3	(2) 2-1/2" (1) 2"	2	2-1/2"	2	(1) 2-1/2" (1) 2"
800	3	(2) 2-1/2" (1) 2"	2	2-1/2"	2	(1) 2-1/2" (1) 2"

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

Table 9. Relief valves hot water

VALVE SETTING	30 PSIG HW		125 PSIG HW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE	NO. OF VALVES REQ'D	OUTLET SIZE
100	1	2-1/2"	1	1-1/4"
125	2	2"	2	1"
150	2	2"	2	1"
200	2	2"	2	(1) 1-1/4" (1) 1"
250	2	(1) 2-1/2" (1) 2"	2	1-1/4"
300	2	2-1/2"	2	1-1/4"
350	2	2-1/2"	2	2"
400	3	(2) 2-1/2" (1) 1-1/4"	2	2"
500	3	2-1/2"	2	2"
600	4	(3) 2-1/2" (1) 2"	2	2"
700	4	2-1/2"	2	(1) 2-1/2" (1) 2"
800	5	(4) 2-1/2" (1) 2"	2	(1) 2-1/2" (1) 2"

NOTE: Relief valve is Kunkle #537 for 30# & 125#(Section IV) boiler and is Kunkle #927 for 150# HTHW(Section I) boiler.

Table 11. CBEX Elite steam volume and disengaging area

BOILER HP	STEAM VOLUME CU-FT	STEAM RELIEVING AREA SQ-IN
100	10.2	4291
125	10.7	4522
150	17.6	5544
200	20.1	6322
250	34.3	8597
300	35.8	8971
350	50.7	11059
400	53.0	11563
500	78.9	13550
600	84.5	14515
700	107.2	16517
800	110.3	17006

NOTE:

Based on normal water level.

Based on 150 psig design pressure.

Table 12. CBEX Elite recommended steam nozzle size

OPERATING PRESSURE PSIG	BOILER HP											
	100	125	150	200	250	300	350	400	500	600	700	800
15	8	8	8	10	10	12	12	12	12	12	12	12
30	6	6	6	8	8	8	10	10	10	12	12	12
40	6	6	6	6	8	8	8	10	10	10	12	12
50	4	6	6	6	6	8	8	8	8	10	10	12
75	4	4	4	6	6	6	8	8	8	8	10	10
100	4	4	4	6	6	6	6	6	8	8	8	10
125	4	4	4	4	6	6	6	6	8	8	8	8
150	2.5	3	3	4	4	6	6	6	6	6	8	8
200	2.5	2.5	3	4	4	4	4	6	6	6	6	6
250	2	2.5	2.5	3	4	4	4	4	6	6	6	6

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.

Table 13. CBEX Elite recommended Non-Return Valve size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURE (PSIG)							
		50	75	100	125	150	175	200	250
100	3450	3	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2
125	4313	4	3	3	3	3	2-1/2	2-1/2	2-1/2
150	5175	4	4	3	3	3	3	2-1/2	2-1/2
200	6900	4	4	4	3	3	3	3	3
250	8625	4	4	4	4	3	3	3	3
300	10350	6	4	4	4	4	4	4	3
350	12025	6	6	4	4	4	4	4	3
400	13800	6	6	4	4	4	4	4	4
500	17210	6	6	6	6	4	4	4	4
600	20700	8	8	6	6	6	4	4	4
700	24150	8	8	6	6	6	6	6	6
800	27600	8	8	6	6	6	6	6	6

NOTE: Valve sizes (300 psig flanges) given in inches.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table 14 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks CBEX Boilers.

Table 14: Blowdown tank sizing

BOILER HP	WATER (GAL)
100	84
125	89
150	106
200	120
250	161
300	167
350	205
400	214
500	247
600	264
700	300
800	309

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Burner Characteristics

Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures. Also 50 Hz applications and low NOx options should be reviewed by the Cleaver-Brooks authorized representative.

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Gas pressure requirements**Table 14. Model CBEX Elite, Minimum Required Gas Pressure at Entrance to C-B Supplied Regulator/Gas Valve**

BOILER HP	Combination Regulator and Gas Valve Size (in)	PRESSURE REQUIRED ("WC)
100	1.5	12.5
125	1.5	20
150	1.5	27.5
200	1.5	38.5
250	2	41
300	2	55
350	2	75.5
400	2	92
500	2.5	55
600	2.5	79
700	3	80.5
800	3	105

Note: For undersized or oversized gas trains or altitudes above 700 feet, contact your local Cleaver-Brooks representative.

Table 15. CBEX altitude correction for gas

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

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

oz/sq-in x 1.732 = inches WC.

Inches WC x 0.0361 = psig.

oz/sq-in x 0.0625 = psig.

psig x 27.71 = Inches WC.

psig x 16.0 = oz/sq-in.

Boiler Room Information

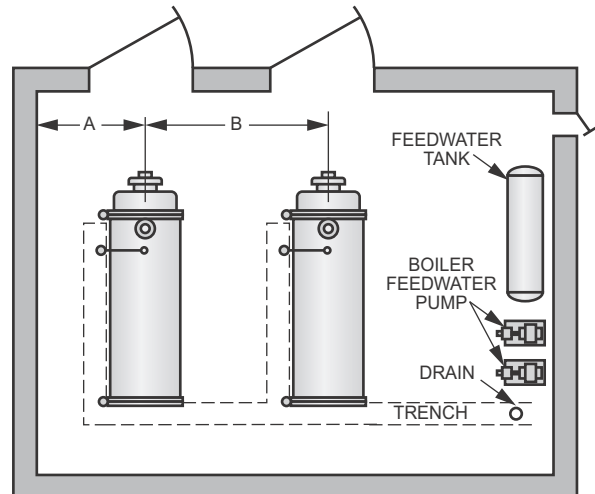
Table 17 shows typical boiler room width requirements.

Table 17. Boiler room width

BOILER HP	100-125	150-200	250-300	350-400	500-600	700-800
DIM. "A"	"86	88	92	98	102	105
DIM. "B"	"120	127	144	151	174	178

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of:
 42" - 100-200 HP
 48" - 250-400 HP
 60" - 500-800 HP
 If space permits, this aisle should be widened.



Stack Support Capabilities

CBEX boilers can support up to 2000 lbs. without additional support.

CBEX boilers can be reinforced to support up to 3000 lbs.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than one (1) square foot.
 - E. Size the openings by using the formula:

$$\text{Area (sq-ft)} = \text{CFM/FPM}$$

2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
 - A. From floor to (7) foot height - 250 fpm.
 - B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 1000 hp boiler at 800 feet altitude.

The air openings are to be 5 feet above floor level.

- Air required: $1000 \times 10 = 10000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm}/\text{fpm} = 10000/250 = 40$ Sq-ft total.
- Area/Opening: $40/2 = 20$ sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the CBEX is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.50''$ W.C. to $+0.50''$ W.C. The maximum pressure variation at any firing rate for the boiler is $0.50''$ W.C.

The low NOx option allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C. The maximum pressure variation at any firing rate for the boiler is $0.25''$ W.C.

Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Table 18. CBEX lifting lugs

BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
100	75.25	21.375	101.75	10	3
125	75.25	21.375	108.75	10	3
150	79.5	21.375	102.5	10	3
200	79.5	21.375	121.5	10	3
250	87.25	27.5	131.25	10	3
300	87.25	27.5	139.25	10	3
350	99.5	36.375	144	10	3
400	99.5	36.375	153	10	3
500	107.625	36.5	162	10	3
600	107.625	36.5	177	10	3
700	115.75	37.75	183.5	10	3
800	115.75	37.75	190.5	10	3

NOTE: Dimensions A, B, and C may vary by 1 inch.

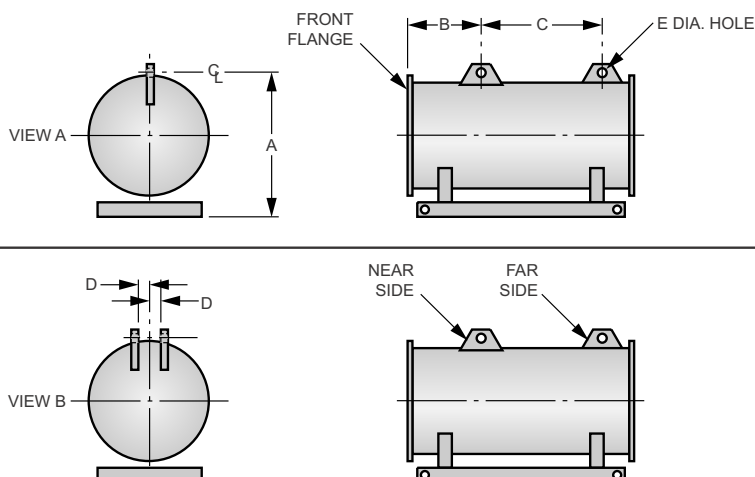
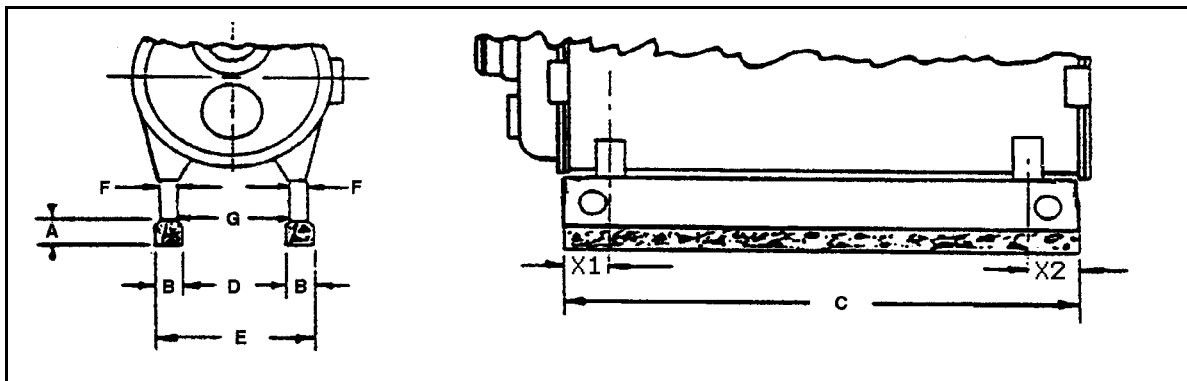


Table 19. CBEX Elite boiler mounting piers

BOILER HP	ALL DIMENSIONS IN INCHES								
	A	B	C	D	E	F	G	X1	X2
100	6	9	130.5	34.5	52.5	4	39.5	15	11.5
125	6	9	137.5	34.5	52.5	4	39.5	15	11.5
150	6	9	140	39.5	57.5	4	44.5	13	11.5
200	6	9	159	39.5	57.5	4	44.5	13	11.5
250	6	9	186.125	38	56	4	43	16	8
300	6	9	194.125	38	56	4	43	16	8
350	6	12	208.5	48	72	4	56	18	11.5
400	6	12	217.5	48	72	4	56	18	11.5
500	6	12	219.5	41.5	65.5	6.5	47	16	11.5
600	6	12	234.5	41.5	65.5	6.5	47	16	11.5
700	6	12	243.5	49.5	73.5	6.5	55	15	12.5
800	6	12	250.5	49.5	73.5	6.5	55	15	12.5

NOTE:

6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the boiler and added height for washing down the area beneath the boiler.



Sample Specifications Steam

Model CBEX Elite 100-800 HP

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SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in meeting y our customer's specific needs and application.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.



PART 1 GENERAL**CBEX Steam Boiler 100-800 HP****1.1 BOILER CHARACTERISTICS (STEAM)**

- A. The Steam Boiler shall be Cleaver-Brooks Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (150, 200, or 250 psig steam). The maximum operating pressure shall be _____ psig and the minimum operating pressure shall be _____ psig (note - minimum allowable operating pressure on the CBEX is 50 psig).
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS12-48 #2 oil and/or natural gas, _____ Btu/cu-ft. Electrical power available shall be _____ Volt _____ Phase _____ Cycle.

PART 2 PRODUCTS**2.1 GENERAL BOILER DESIGN**

- A. Design shall be optimized using CFD modeling verifiable by manufacturer. The boiler shall be a multipass pass horizontal firetube updraft boiler with using extended heating surface optimized to reduce boiler foot print. Boiler shall be mounted on a heavy steel frame with integral forced draft burner and burner controls.
 - 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, fuel, electrical, vent, and blowdown connections.
 - 2. The boiler shall be built to comply with the following insurance and codes (Factory Mutual, XL GAP, ASME, NFPA 8501).
- B. Boiler Shell (Steam)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 - 2. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning. Two lifting lugs must be located on top of the boiler.
 - 3. The front smokebox doors shall be davited and sealed with superwool insulation and fastened tightly using locking lugs on steel studs.
 - 4. The rear door shall be fitted with an access plug for rear fireside inspection.
 - 5. The boiler tubes shall not include turbulators, swirlers, or other add-on appurtenances.
 - 6. The exhaust gas vent shall be located at the front of the boiler and be capable of supporting 2000 lbs. The boiler vent shall contain a stack thermometer.
 - 7. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
 - 8. The boiler insulation shall consist of 2 inch blanket under a sectional pre-formed sheet metal lagging. The insulation must be readily removable and capable of being reinstalled if required.
 - 9. The entire boiler base frame and other components shall be factory painted before shipment, using a hard-finish enamel coating.
 - 10. The boiler shall contain a chemical feed connection.

2.2 STEAM BOILER TRIM

- A. Water Column/low Water Cutoff And Water Level Control System shall be a CB LEVEL MASTER water level control system and shall comprise a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor, and pressure chamber.

The control system shall be designed as follows: The electronic controller shall be mounted in the common control panel and operate in ambient temperatures from 32 degrees F to 125 degrees F. The pressure chamber shall be boiler mounted and operate to pressures of 250 PSIG and the level sensor shall operate to pressures of 250 PSIG and temperatures to 400 degrees F. The pressure-containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase- 60 Hz. All wiring shall be in compliance with the National Electrical Code.

The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/ menu switch and the following features:

- a. Continuous Level Indication
- b. Low Water Cutoff & Alarm
- c. High Water Alarm
- d. Low & High Water Warning
- e. Full Modulating Control of Modulating Feedwater Control Valve
- f. Continuous Monitoring of Float Operation
- g. Column Blowdown Detection and Reminder
- h. Auto or Manual Reset
- i. Real Time Clock
- j. Alarm Annunciation
- k. Alarm History Files with Time Stamp
- l. Water Column Blowdown Record
- m. Auxiliary Low Water Cutoff Check
- n. RS 232 Interface

Maximum Contacts Rating 15 amps Resistive Load

- B. Modulating feedwater Control
The boiler modulating feedwater control and valve shall be included to automatically maintain the boiler water level within normal limits.
- C. Auxiliary Low Water Cut-off
Auxiliary low water cut-off shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.
- D. Steam Pressure Gauge
The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- E. Safety Valves
Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- F. Steam Pressure Controls
The steam pressure control to regulate burner operation shall be mounted near the water column. Controls shall be a high limit (manual reset), operating limit (auto reset), and firing rate control.

2.3 BURNER

- A. Burner shall incorporate Cleaver Brooks “Lean Burn Technology”.
- B. Fuel and air ratio/mixture shall be controlled over the entire operating range, allowing for firing at constant excess air on high turndown burner application.
- C. Burner to be designed specifically for boiler including optimized furnace allowing for low emissions and lean burn combustion.
- D. Mode of Operation
 - 1. Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.
 - 2. A low fire hold temperature control is mounted and wired on the boiler.
- E. Blower
 - 1. Air for combustion shall be supplied by a forced draft blower incorporated into the burner design to eliminate vibration and reduce noise level.
 - 2. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
 - 3. The impeller shall be fabricated aluminum with radial blade, carefully balanced, and directly connected to the blower motor shaft.
- F. Combustion Air Control
Combustion air damper and fuel metering valve shall be operated by individual actuators to regulate the flame according to load demand.

2.4 FUEL SPECIFICATION AND PIPING

Select one of the following fuel types:

- Fuel series 700 - Gas-fired.
- Fuel series 100 - Light oil (No. 2) fired .
- Fuel series 200 - Light oil or gas-fired.

NOTE: Specification writer to select between NOx options of 60 ppm, 30 ppm, 9 ppm or 7 ppm Nox on Natural Gas as required for specific project conditions.

60 PPM Nox Operation Natural Gas

CBEX 100 to 200 Horsepower 60 PPM

- A. Fuel Series 700 - Gas-Fired
 - 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
 - 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).

3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 4. Burner Turndown: Turndown range shall be 4:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
 5. CO on Natural Gas is 10 ppm at 50, 75 and 100 % of firing and 25 ppm at 25% firing rate. Excess air is 15% at 50, 75 and 100% of firing and 30% at 25% firing rate.
- B. Fuel Series 100 - Light Oil-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 4:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.

- b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 4:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO
4. Gas Burner
- a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 4:1 when firing natural gas.
 - c. CO on Natural Gas is 10 ppm at 50, 75 and 100 % of firing and 25 ppm at 25% firing rate. Excess air is 15% at 50, 75 and 100% of firing and 30% at 25% firing rate.

CBEX 250 and 300 Horsepower 60 PPM

A. Fuel Series 700 - Gas-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
- 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
- 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
- 4. Burner Turndown: Turndown range shall be 7:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
- 5. CO on Natural Gas is 10 ppm with excess air at 15%. Turndown of 10:1 on natural gas can be achieved (however, excess air will increase to 40% with CO at 50 ppm).

B. Fuel Series 100 - Light Oil-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
6. Turndown range shall be 7:1 when firing No. 2 oil.
7. Excess air is 25% with 10 ppm CO.

C. Fuel Series 200 - Light Oil or Gas-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 7:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High

and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.

- b. Burner Turndown - Turndown range shall be 7:1 when firing natural gas.
- c. CO on Natural Gas is 10 ppm with excess air at 15%. Turndown of 10:1 on natural gas can be achieved (however, excess air will increase to 40% with CO at 50 ppm).

CBEX 350 to 800 Horsepower 60 PPM

A. Fuel Series 700 - Gas-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
- 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
- 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
- 4. Burner Turndown: Turndown range shall be 10:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
- 5. CO on Natural Gas is 10 ppm with excess air at 15

B. Fuel Series 100 - Light Oil-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
- 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
- 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
- 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.

5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 8:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 8:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 10:1 when firing natural gas.
 - c. CO on Natural Gas is 10 ppm with excess air at 15%.

30 PPM Nox Operation Natural Gas

CBEX 100 to 200 Horsepower 30 PPM

- A. Fuel Series 700 - Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas

fuel.

2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 4. Burner Turndown: Turndown range shall be 4:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
 5. CO on Natural Gas is 25 ppm at 50, 75 and 100 % of firing and 50 ppm at 25% firing rate. Excess air is 15% at 50, 75 and 100% of firing and 30% at 25% firing rate.
- B. Fuel Series 100 - Light Oil-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 4:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.

2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 4:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 4:1 when firing natural gas.
 - c. CO on Natural Gas is 25 ppm at 50, 75 and 100 % of firing and 50 ppm at 25% firing rate. Excess air is 15% at 50, 75 and 100% of firing and 30% at 25% firing rate.

CBEX 250 and 300 Horsepower 30 PPM

- A. Fuel Series 700 - Gas-Fired
 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).

3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 4. Burner Turndown: Turndown range shall be 7:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
 5. CO on Natural Gas is 10 ppm with excess air at 15%. Turndown of 10:1 on natural gas can be achieved (however, excess air will increase to 40% with CO at 50 ppm).
- B. Fuel Series 100 - Light Oil-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 7:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - b. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.

- c. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
- d. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
- e. Burner Turndown - Turndown range shall be 7:1 when firing No. 2 oil.
- f. Excess air is 25% with 10 ppm CO.
- 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 7:1 when firing natural gas.
 - c. CO on Natural Gas is 10 ppm with excess air at 15%. Turndown of 10:1 on natural gas can be achieved (however, excess air will increase to 40% with CO at 50 ppm).

CBEX 350 to 800 Horsepower 30 PPM

- A. Fuel Series 700 - Gas-Fired
 - 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
 - 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 - 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - 4. Burner Turndown: Turndown range shall be 10:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
 - 5. CO on Natural Gas is 10 ppm with excess air at 15%.
- B. Fuel Series 100 - Light Oil-Fired
 - 1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low

- pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 8:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 8:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located

- between the safety shutoff valves. Gas pressure regulator can be offered as an option.
- b. Burner Turndown - Turndown range shall be 10:1 when firing natural gas.
 - c. CO on Natural Gas is 10 ppm with excess air at 15%.

9 PPM Nox Operation Natural Gas

CBEX 100 to 200 Horsepower 9 PPM

A. Fuel Series 700 - Gas-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
4. Burner Turndown: Turndown range shall be 4:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
5. CO on Natural Gas is 25 ppm with excess air at 25%.

B. Fuel Series 100 - Light Oil-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.

6. Turndown range shall be 4:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 4:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 4:1 when firing natural gas.
 - c. CO on Natural Gas is 25 ppm with excess air at 25%.

CBEX 250 to 400 Horsepower 9 PPM

- A. Fuel Series 700 - Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.

2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 4. Burner Turndown: Turndown range shall be 5:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
 5. CO on Natural Gas is 25 ppm with excess air at 25%.
- B. Fuel Series 100 - Light Oil-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 5:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).

3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 5:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 5:1 when firing natural gas.
 - c. CO on Natural Gas is 25 ppm with excess air at 25%.

CBEX 500 and 600 Horsepower 9 PPM

- A. Fuel Series 700 - Gas-Fired
 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.

4. Burner Turndown: Turndown range shall be 6:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
5. CO on Natural Gas is 25 ppm with excess air at 25%.
- B. Fuel Series 100 - Light Oil-Fired
 1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 6:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
 1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 6:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff

valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.

- b. Burner Turndown - Turndown range shall be 6:1 when firing natural gas.
- c. CO on Natural Gas is 25 ppm with excess air at 25%.

CBEX 700 and 800 Horsepower 9 PPM

A. Fuel Series 700 - Gas-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
- 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
- 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
- 4. Burner Turndown: Turndown range shall be 7:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
- 5. CO on Natural Gas is 25 ppm with excess air at 25%.

B. Fuel Series 100 - Light Oil-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
- 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
- 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
- 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering

- controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 7:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 7:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 7:1 when firing natural gas.
 - c. CO on Natural Gas is 25 ppm with excess air at 25%.

7 PPM Nox Operation Natural Gas

CBEX 100 to 200 Horsepower 7 PPM

A. Fuel Series 700 - Gas-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
4. Burner Turndown: Turndown range shall be 3:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
5. CO on Natural Gas is 50 ppm with excess air at 30%.

B. Fuel Series 100 - Light Oil-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
6. Turndown range shall be 3:1 when firing No. 2 oil.
7. Excess air is 25% with 10 ppm CO.

C. Fuel Series 200 - Light Oil or Gas-Fired

1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.

2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, b. and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 3:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 3:1 when firing natural gas.
 - c. CO on Natural Gas is 50 ppm with excess air at 30%.

CBEX 250 to 500 Horsepower 7 PPM

- A. Fuel Series 700 - Gas-Fired
 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).

3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 4. Burner Turndown: Turndown range shall be 4:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
 5. CO on Natural Gas is 50 ppm with excess air at 30%.
- B. Fuel Series 100 - Light Oil-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 4:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.

- b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 4:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
4. Gas Burner
- a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
 - b. Burner Turndown - Turndown range shall be 4:1 when firing natural gas.
 - c. CO on Natural Gas is 50 ppm with excess air at 30%.

CBEX 600 to 800 Horsepower 7 PPM

A. Fuel Series 700 - Gas-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be of high radiant multi-port type gas entry. Burner shall be approved for operation on natural gas fuel.
- 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
- 3. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.
- 4. Burner Turndown: Turndown range shall be 5:1 when firing natural gas (consult with Cleaver-Brooks representative regarding high turndown capability based on available gas pressure).
- 5. CO on Natural Gas is 50 ppm with excess air at 30%.

B. Fuel Series 100 - Light Oil-Fired

- 1. Burner type - The burner shall be mounted at the front of the boiler and shall be a low pressure air atomizing type approved for operation with CS12-48 Commercial No. 2 oil.

2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.
 5. Low Pressure Air Atomizing: separate air compressor module, shipped loose, with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 5:1 when firing No. 2 oil.
 7. Excess air is 25% with 10 ppm CO.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure air atomizing - Separate air compressor module, shipped loose with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 5:1 when firing No. 2 oil.
 - e. Excess air is 25% with 10 ppm CO.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve with plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves. Gas pressure regulator can be offered as an option.

- b. Burner Turndown - Turndown range shall be 5:1 when firing natural gas.
- c. CO on Natural Gas is 50 ppm with excess air at 30%.

2.5 BOILER CONTROLS AND CONTROL PANEL

- A. Control/Entrance Panel - A common enclosure shall house the control panel and the entrance panel. Enclosure shall be NEMA 4/12 rated and shall be mounted at the side of the boiler in a location convenient to the operator. Enclosure shall consist of upper and lower sections divided by a partition with a separate hinged door for each section. Upper section (low voltage) will house boiler controls including flame safeguard and water level system controller. Lower panel section (high voltage) will house entrance panel.
- B. Cleaver Brooks Combustion Control System - Hawk 2000 with parallel positioning with separate actuators for each fuel and combustion air shall be used to provide proper fuel air ratio control.
- C. CB780E Flame Safeguard - Each boiler shall be factory equipped with flame safeguard controller incorporated into the Hawk control.

Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.

Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.6 FLUE GAS HEAT RECOVERY (OPTIONAL SELECTION)

- A. Add Cleaver Brooks economizer selection in this area.
- B. Boiler and economizer to be designed with integral supports allowing for easy economizer installation on boiler eliminating the requirement for separate structure steel support.

2.7 EFFICIENCY GUARANTEE

- A. The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of _____ percent at 100% of rating when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (Contact your local Cleaver-Brooks authorized representative for efficiency details).

PART 3 EXECUTION

3.1 WARRANTY

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up, or 18 months from date of shipment; whichever comes first.

3.2 SHOP TESTS

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.
- B. Start-up Service
 - 1. After boiler installation is completed, the manufacturer shall provide the services of a field

representative for starting the unit and training the operator at no additional costs.

2. A factory-approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

MODEL CBEX ELITE

1300 - 2200 HP
Steam
Wet-back Packaged Burner



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The following information applies to the Cleaver-Brooks Elite Boiler.

FEATURES AND BENEFITS

The Elite 900-2200 HP Firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firetube boilers, the following features apply to the Elite.

Two Pass Design:

- The packaged boiler offers high efficiency, flexibility, reliability, safety and ease of operation.

Front and Rear Doors:

- Davited, front and rear doors, all sizes.
- Provides access to front tube sheet and furnace.
- Large rear access plug for turnaround and furnace access.
- Rear door completely covers and insulates rear tube sheet.

Natural Gas, No. 2 Oil, or Combination Burners Available:

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.

PRODUCT OFFERING

Cleaver-Brooks Elite Boilers are available in 150-250 psig steam designs. Burners are available to fire natural gas, No. 2 oil, or a combination of oil and gas. Standard product offering is:

- 1300 - 2200 hp.
- Two pass wetback design.
- 150-250 psig steam (up to 1600 hp)
150-200 psig steam (1800-2000 hp)
150-190 psig steam (2200 hp)
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks authorized representative for option details).

- Boiler Options:
 - Additional screwed or flanged tappings.
 - Blowdown valves.
 - Non-return valves.
 - Feedwater valves and regulators. Surface blowdown systems. Surge load baffles.
 - Seismic design.

- Burner/Control Options:
 - Flame safeguard controllers.
 - Lead/lag system.
 - Special insurance and code requirements (e.g., IRI, FM, NFPA8501).
 - Alarm bell/silence switch.
 - Special motor requirements (TEFC, high efficiency).
 - Special indicating lights.
 - Main disconnect.
 - Elapsed time meter.
 - NEMA enclosures.
 - Remote emergency shut-off (115V).
 - Circuit breakers.
 - Day/night controls.
 - Special power requirements.
 - Low NOx Equipment.
- Fuel Options:
 - Gas strainer.
 - Gas pressure gauge.
 - Future gas conversion.
 - Oversized/undersized gas trains.
 - Optional Oil Pumps.

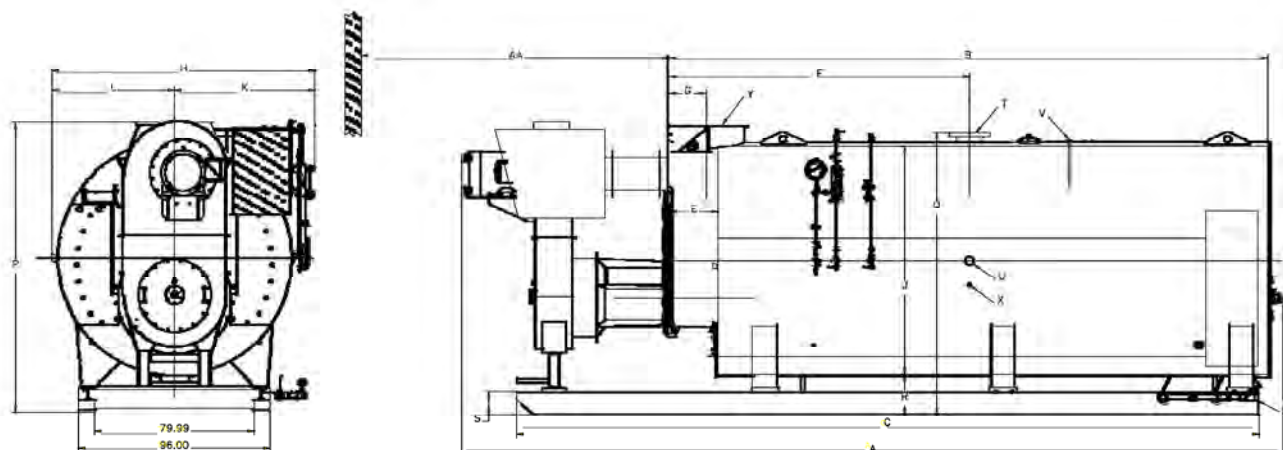
DIMENSIONS AND RATINGS

Dimensions and ratings for the Elite Boilers are shown in the following tables and illustrations. The information is subject to change without notice.

- Table A13-1. Elite Steam Boiler Ratings
- Figure A13-1. Elite Steam Boiler Dimensions 1300-1500 HP
- Figure A13-2. Elite Steam Boiler Dimensions 1600-2200 HP

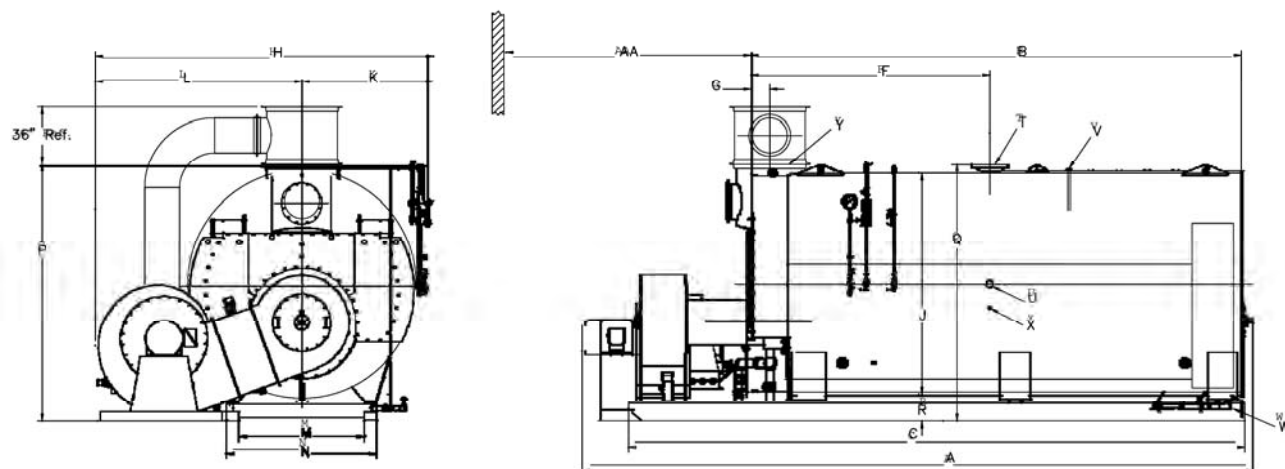
Table A13-1. Steam Boiler Ratings

Boiler H.P.	1300	1400	1500	1600	1800	2000	2200
Ratings							
Rated Capacity - Steam (lbs-steam/hr from & at 212°F)	44,850	48,300	51,750	55,200	62,100	69,000	75,900
Output (1000 Btu/hr)	43,514	46,861	50,208	53,555	60,250	66,944	73,638
Fireside Heating Surface (sq.ft.)	208	258	312	388	388	388	388
Approximate Fuel Consumption At Rated Capacity							
Light Oil Input (gph) - 150# Steam ^C	384	413	443	472	531	590	649
Natural Gas Input (cfh) - 150# Steam ^A	53,720	57,853	61,985	66,118	74,382	82,647	90,912
Power Requirements - 60Hz (Single Phase, 115 VAC)							
Blower Motor Size (HP) ^B	60	75	75	75	75	100	100
Notes: A. Input calculated at nominal 81% efficiency for 1000 Btu gas content B. For altitudes above 700 ft, contact local Cleaver Brooks authorized representative for verification of boiler and blower motor size. C. Input calculated at nominal 81% efficiency based on 140,000 Btu/gal							



Boiler Horsepower	Dim.	1300	1400	1500
Lengths				
Overall	A	385	404	413
Shell	B	281	300	309
Base Frame	C	353	372	381
Over Tubesheets	D	256	275	384
Shell Extension	E	24	24	24
Front To Steam Nozzle	F	142	150	162
Front To Vent Outlet	G	18-1/2	18-1/2	18-1/2
Widths				
Overall	H	131	131	131
Boiler I.D.	J	114	114	114
Center To Water Column	K	71	71	71
Center To Lagging	L	60	60	60
Base Inside	M	80	80	80
Base Outside	N	96	96	96
Heights				
Base To Vent Outlet	P	145-1/2	145-1/2	145-1/2
Base To Steam Outlet	Q	141-1/2	141-1/2	141-1/2
Base To Boiler Bottom	R	20	20	20
Base Rail	S	12	12	12
Connection Sizes				
Steam Nozzle (150 PSIG)	T	10	12	12
Steam Nozzle (200 PSIG)	T			
Feed Water	U	3	3	3
Surface Blowoff	V	1	1	1
Blow Down	W	2	2	2
Chemical Feed	X	3/4	3/4	3/4
Vent Stack Outlet	Y	42	42	42
Minimum Clearances				
Tube Removal (Front Only)	AA	203	222	231
Weight In Lbs.				
Normal Water Capacity		41,320	43,829	45,392
Approx. Ship Weight (150 PSIG)		65,424	69,672	71,435
Approx. Ship Weight (200 PSIG)		72,087	76,810	78,799

Figure A13-1. Elite Steam Boiler Dimensions, 1300-1500 HP



Boiler Horsepower	Dim.	1600	1800	2000	2200
Lengths					
Overall	A	410	424	410	424
Shell	B	296	310	296	310
Base Frame	C	374	388	374	388
Over Tubesheets	D	270	284	270	284
Shell Extension	E	24	24	24	24
Front To Steam Nozzle	F	142	150	142	150
Front To Vent Outlet	G	21-1/4	21-1/4	11-7/8	11-7/8
Widths					
Overall	H	207	207	213	213
Boiler I.D.	J	126	126	138	138
Center To Water Column	K	77	77	83	83
Center To Lagging	L	130	130	130	130
Base Inside	M	80	80	80	80
Base Outside	N	96	96	96	96
Heights					
Base To Vent Outlet	P	158	158	162	162
Base To Steam Outlet	Q	153-5/8	153-5/8	162	162
Base To Boiler Bottom	R	20	20	17-1/2	17-1/2
Base Rail	S	12	12	12	12
Connection Sizes					
Steam Nozzle (150 PSIG)	T	12	12	14	14
Steam Nozzle (200 PSIG)	T				
Feed Water	U	3	3	3	3
Surface Blowoff	V	1	1	1	1
Blow Down	W	2	2	2	2
Chemical Feed	X	3/4	3/4	3/4	3/4
Vent Stack Outlet	Y	42	42	44	44
Minimum Clearances					
Tube Removal (Front Only)	AA	216	230	216	230
Weight In Lbs.					
Normal Water Capacity		52,311	53,797	63,095	63,687
Approx. Ship Weight (150 PSIG)		78,667	83,445	92,706	99,133
Approx. Ship Weight (200 PSIG)		90,060	95,387	104,988	112,016

Figure A13-2. Elite Steam Boiler Dimensions, 1600-2200 HP

PERFORMANCE DATA

Efficiency

Table A13-9 shows predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks Elite Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for Elite Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7767 for a detailed description of efficiency calculations).

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in the tables listed above) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level. The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:
 - Natural Gas
Carbon,% (wt) = 69.98
Hydrogen,% (wt) = 22.31
Sulfur,% (wt) = 0.0
Heating value, Btu/lb = 21,830
 - No. 2 Oil
Carbon,% (wt) = 85.8
Hydrogen,% (wt) = 12.7
Sulfur,% (wt) = 0.2
Heating value, Btu/lb = 19,420
 - No. 6 Oil
Carbon,% (wt) = 86.6
Hydrogen,% (wt) = 10.9
Sulfur,% (wt) = 2.09
Heating value, Btu/lb = 18,830
2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
3. Efficiencies are based on the following radiation and convection losses. Firing rate of 25% - 1.2%, 50% - 0.6%, 75% - 0.4%, and 100% - 0.3%.

ENGINEERING DATA

The following engineering information is provided for Elite Boilers. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

Table A13-3 shows steam volume and disengaging area for Elite boilers.

Table A13-2 lists quantity and outlet size for safety valves supplied on Elite boilers. Table A13-5 gives recommended steam nozzle sizes on Elite Boilers.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table A13-4 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks Elite Boilers.

Burner/Control Information

Burner Characteristics

Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures. Also 50 Hz applications and low NOx options should be reviewed by the Cleaver-Brooks authorized representative.

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations.

Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Boiler Room Information

Table A13-8 shows typical boiler room length and width requirements.

Stack Support Capabilities

Elite Boilers can support up to 2000 lbs. without additional support.

Elite Boilers can be reinforced to support up to 3000 lbs.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than one (1) square foot.
 - E. Size the openings by using the formula:
$$\text{Area (sq-ft)} = \text{CFM/FPM}$$
2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.

3. Acceptable air velocity in Boiler Room (fpm).
 - A. From floor to (7) foot height - 250 fpm.
 - B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 1000 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $1000 \times 10 = 10000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm/fpm} = 10000/250 = 40$ Sq-ft total.
- Area/Opening: $40/2 = 20$ sq-ft/opening (2 required).

Notice: Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Elite is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.50''$ W.C. to $+0.50''$ W.C. The maximum pressure variation at any firing rate for the boiler is $0.50''$ W.C.

The low NOx option allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C. The maximum pressure variation at any firing rate for the boiler is $0.25''$ W.C. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Table A13-2. Elite Steam Boiler Safety Valve Outlet Size

	VALVE SETTING		VALVE SETTING		VALVE SETTING	
	150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
1300	2	(2) @ 4	2	(1) @ 4 (1) @ 3	2	(2) @ 3
1400	2	(2) @ 4	2	(1) @ 4 (1) @ 3	2	(2) @ 3
1500	2	(2) @ 4	2	(2) @ 4	2	(1) @ 4 (1) @ 3
1600	3	(1) @ 4 (2) @ 3	3	(3) @ 3	3	(2) @ 2-1/2 (1) @ 3
1800	3	(2) @ 4 (1) @ 3	3	(1) @ 4 (2) @ 3	3	(1) @ 2-1/2 (2) @ 3
2000	3	(2) @ 4 (1) @ 3	3	(1) @ 4 (2) @ 3	3	(3) @ 3
2200	3	(2) @ 4 (1) @ 3	3	(2) @ 4 (1) @ 3	3	(1) @ 4 (2) @ 3

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

Table A13-3. Elite Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT	STEAM RELIEVING AREA SQ-IN
1300	211.3	161.3
1400	226.9	173.3
1500	234.4	179
1600	290.1	191.2
1800	305.1	201.1
2000	339.7	208.1
2200	375.6	221.8

NOTES:

1. Based on normal water level.
2. Based on 150 psig design pressure.

Table A13-4. Elite Blowdown Tank Sizing

BOILER HP	WATER (GAL)
1300	203
1400	218
1500	225
1600	241
1800	253
2000	265
2200	279

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

Table A13-5. Elite Recommended Steam Nozzle Size

OPERATING PRESSURE PSIG	BOILER HP						
	1300	1400	1500	1600	1800	2000	2200
50	14	16	16	16	16	18	18
75	12	14	14	14	14	16	16
100	12	12	12	12	14	14	14
125	10	10	12	12	12	12	14
150	10	10	10	10	12	12	12
200	8	10	10	10	10	10	10
225	8	8	8	10	10	10	10

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 5000 fpm max. steam velocity.

Table A13-6. Altitude Correction for Gas

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

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

oz/sq-in x 1.732 = inches WC.

Inches WC x 0.0361 = psig.

oz/sq-in x 0.0625 = psig.

psig x 27.71 = Inches WC.

psig x 16.0 = oz/sq-in.

Table A13-7. Elite Natural Gas Estimated Emission Levels

POLLUTANT	UNITS	
CO	ppm*	100
	lb/MMBtu	0.073
NO _x	ppm*	100
	lb/MMBtu	0.117
SO _x	ppm*	1
	lb/MMBtu	0.002
HC/VOC ₅	ppm*	14
	lb/MMBtu	0.006
PM	ppm*	-
	lb/MMBtu	0.01

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

Table A13-8. Boiler Room Size

BOILER HP	1300	1400	1500	1600	1800	2000	2200
LENGTH (Inches) ¹	624	662	680	662	690	662	690
WIDTH (Inches) ²	218	218	218	226	226	234	234

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Length dimension allows for a clear 36" aisle between the boiler rear and the wall. This dimension also includes a tube replacement allowance (front only).

2. Recommended Minimum Width Dimension. Width dimension allows for a clear aisle of 36". If space permits, this aisle dimension should be increased.

Table A13-9. Predicted Fuel-to-Steam Efficiencies - Natural Gas

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
1300	81.8	82.3	82.2	82.0
1400	81.8	82.4	82.3	82.2
1500	81.4	81.6	81.1	80.6
1600	81.6	81.9	81.6	81.3
1800	81.6	81.9	81.6	81.3
2000	81.6	81.9	81.6	81.3
2200	81.6	81.9	81.6	81.3

Table A13-10. Gas Train (Siemens)

Boiler HP	Uncontrolled NOx			30 ppm			9 ppm	
	Gas Train Size, in	Pressure Range PSI		Gas Train Size, in	Pressure Range PSI		Gas Train Size, in	Pressure Range PSI
1300	3 - 4	8.0 - 10.		3 - 4	9.2 - 10		3 - 4	8.3 - 10
	4	5.1 - 8.0		4	6.2 - 9.2		4	5.4 - 8.3
1400	3 - 4	9.5 - 10					3 - 4	9.7 - 10
	4	5.9 - 9.5		4	7.3 - 10		4	6.2 - 9.7
1500	4	6.8 - 10		4	8.4 - 10		4	7.1 - 10
	6	4.9 - 6.8		6	6.6 - 10		6	5.3 - 7.1

Notes:

Table is based on Siemens gas train, which includes a regulating actuator.

Pressures are based on a boiler nominal efficiency of 80%. Incoming pressure is not to exceed 10 psi.

UNDERSIZE

STANDARD

OVERSIZE

Table A13-11. Gas Train (Maxon)

Boiler HP	Gas Flow SCFH	Elite WITH 3" FISHER 1098EGR REGULATOR & 4" MAXON GAS TRAIN					
		Uncontrolled		30 ppm		9 ppm	
		Regulated Pressure (psi)	Supply Pressure (psi)	Regulated Pressure (psi)	Supply Pressure (psi)	Regulated Pressure (psi)	Supply Pressure (psi)
1600	66,950	7.2	10.5 - 15	7.2	10.5 - 15	6.1	9.5 - 15
1800	75,319	10.4	14.5 - 20	10.4	14.5 - 20	6.6	11 - 15
2000	83,688	11.2	16.5 - 20	11.2	16.5 - 20	7.1	12.5 - 15
2200	92,056	13.4	18.5 - 20	13.4	18.5 - 20	7.1	13.5 - 15

Boiler HP	Gas Flow SCFH	Elite WITH 4" FISHER 1098EGR REGULATOR & 4" MAXON GAS TRAIN					
		Uncontrolled		30 ppm		9 ppm	
		Regulated Pressure (psi)	Supply Pressure (psi)	Regulated Pressure (psi)	Supply Pressure (psi)	Regulated Pressure (psi)	Supply Pressure (psi)
1600	66,950	6.9	9 - 15	6.9	9 - 15	5.8	8 - 15
1800	75,319	10.0	12 - 20	10.0	12 - 20	6.2	8 - 15
2000	83,688	10.7	12.5 - 20	10.7	12.5 - 20	6.6	8.5 - 15
2200	92,056	12.8	15.5 - 20	12.8	15.5 - 20	6.5	9.5 - 15

Boiler HP	Gas Flow SCFH	Elite WITH 4" FISHER 1098EGR REGULATOR & 6" MAXON GAS TRAIN					
		Uncontrolled		30 ppm		9 ppm	
		Regulated Pressure (psi)	Supply Pressure (psi)	Regulated Pressure (psi)	Supply Pressure (psi)	Regulated Pressure (psi)	Supply Pressure (psi)
1600	66,950	5.8	8 - 15	5.8	8 - 15	4.7	6.5 - 15
1800	75,319	8.6	10.5 - 15	8.6	10.5 - 15	4.8	7 - 15
2000	83,688	8.9	11 - 20	8.9	11 - 20	4.9	7.5 - 15
2200	92,056	10.7	13.5 - 20	10.7	13.5 - 20	4.4	7.5 - 15

Notes:

Table is based on Maxon gas train, which includes a Fisher 1098EGR regulator.

Pressures are based on a boiler nominal efficiency of 80%.

UNDERSIZE

STANDARD

OVERSIZE

Table A13-12. Blower Motor Sizes

Burner Type	BHP	Blower motor size - HP		
		Uncontrolled Nox	30 ppm	9 ppm
Upright	1300	60	75	100
	1400	75	100	100
	1500	75	125	125
Floor mount	1600	75	100	150
	1800	75	100	150
	2000	100	125	200
	2200	100	125	200

MODEL 4WI

100 - 800 HP
Steam and Hot Water
Wet-back Integral Burner



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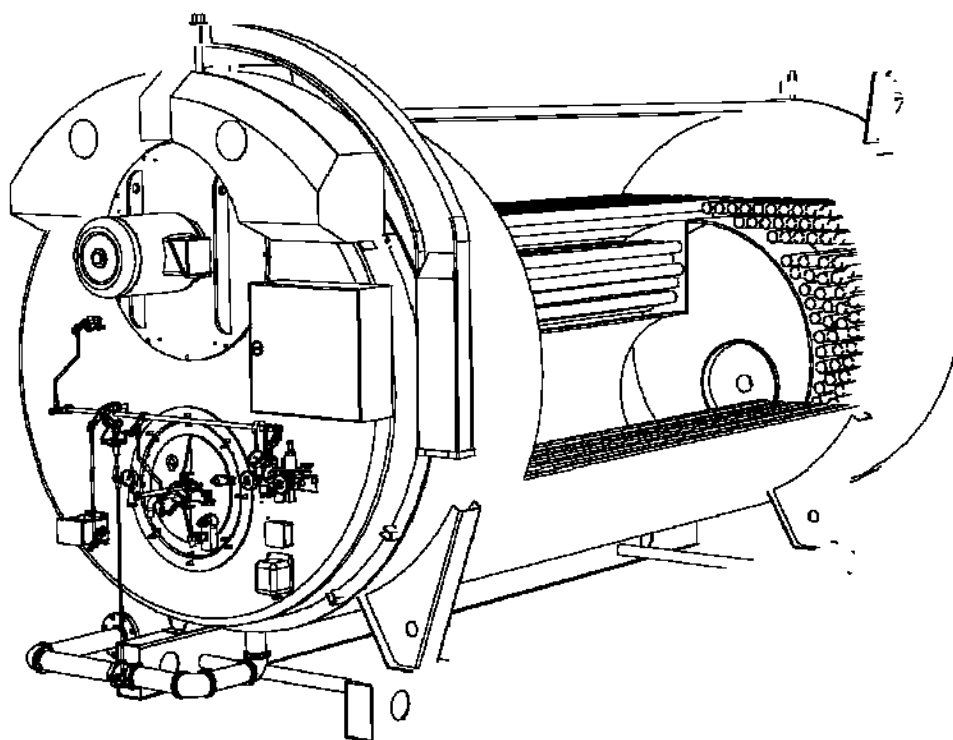
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Table A2-30. Turndown Guarantee 4WI NTI Boilers - Natural Gas & #2 Oil	A2-28

*Table A2-1. Horsepower vs Shell Diameter*

Wet-Back Boilers	
HP	Dia. (IN)
4WI 100-125	60
4WI 150-200	67
4WI 250-300	78
4WI 350-400	85
4WI 500-600	96
4WI 700-800	106

GENERAL

The Promethean Boiler Model 4WI (100 - 800 hp), provides NO_x control, top performance, and reliable Cleaver-Brooks efficiency. The Low Emission capabilities combines the packaging of induced flue gas recirculation with the Cleaver-Brooks integral front head and the Nat-Com burner internal components to gain the ultra-low NO_x of 15 to <9 ppm levels on natural gas demanded by the environmental concerns of today. The burner head combines advanced burner technology to match the geometric and aerodynamic parameters to meet the stringent NO_x and CO standards for all applications. The front head routes a portion of the flue gases from the fourth pass to the fan and burner assembly for reliable low NO_x performance. The enhanced burner design

assures maximum NOx reduction at all firing rates while maintaining top of the line boiler performance.

Low Emission Options include packages from 60 ppm to ultra-low < 9 ppm. (all NOx emission levels are given for natural gas and on a dry volume basis and corrected to 3% O₂):

- Fan diameters and motor horsepower will vary in size depending on NOx reduction requirements with the lower NOx levels requiring larger fans and more horsepower.

Cleaver-Brooks' commitment to lowering emissions is based on more than 2000 low NOx installations - all passing guaranteed emission performance levels.

FEATURES AND BENEFITS

The Cleaver-Brooks Promethean Firetube Boiler model 4WI, is a 4 pass wet-back design including five square feet of heating surface per boiler horsepower, and maximum guaranteed efficiencies. The shell sizes can be found in Table A2-1.

The Promethean model 4WI includes a complete package; pressure vessel, integral burner and controls including the revolutionary Level Master water level control on High pressure steam units. Additionally, options can be added to further enhance the package...

One such option is the CB Hawk ICS, integrated control system providing boiler control, monitoring, communication and system integration in a single PLC based package. To this system you may also add a VSD (variable speed drive) for controlling combustion air, parallel positioning for independent control of fuel and air, modulating feed water valve, and Oxygen trim for additional energy savings in an integrated package.

Promethean Boilers

The Promethean model 4WI is offered with;

- 4-pass wetback design
- 100-800 boiler horsepower, steam or hot water
- Compact footprint; optimized shell and furnace geometry
- Lower furnace heat release
- Integral burner
- Low emissions on natural gas; selections from 60 to Ultra-low NOx reduction (ULNOx(tm)) of 15 - <9 PPM
- Low emissions on #2 oil; 70 PPM with 0.015% fuel bound nitrogen.
- Level Master water level control on high pressure steam units
- Multiple fuel firing
- CB 780E burner management control
- UL/ULC approved package.
- Single point positioning of fuel and air ensures ease of startup and reliable operation.

DIMENSIONS AND RATINGS

The 4 pass Wet-Back boiler ratings for the steam boiler are on Table A2-2 and the 4 pass Wet-Back hot water boilers ratings are on Table A2-4. Dimensions and weights for the 4 pass Wet-Back steam boiler is on Table A2-3. The 4 pass Wet-Back hot water boiler dimension and weights are on Table A2-5.

Notes

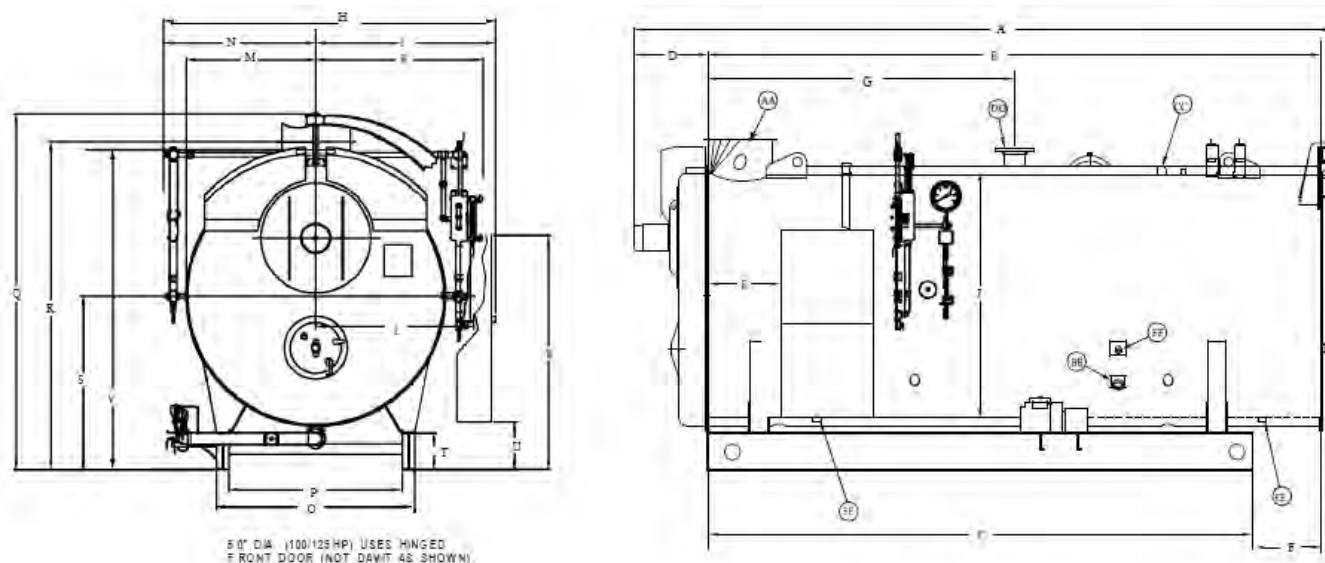


Figure A2-1. Model 4WI Steam Boiler 100-800 HP

Table A2-2. Model 4WI Steam Boiler Ratings 100 to 800 HP

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
RATINGS - SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr from and at 212°F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.0	116.6	145.8	174.9	204.1	233.3
Gas CFH (1000 Btu)	4082	5102	6123	8164	10205	12246	14287	16328	20410	24492	28574	32656
Gas (Therm/hr)	40.8	51.0	61.2	81.6	102.0	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp (60 ppm) (See Note "A")	2	5	5	7-1/2	10	15	15	20	15	25	30	50
Blower Motor hp (30 ppm) (See Note "A")	3	7-1/2	7-1/2	15	15	20	20	25	30	40	50	75
"Oil Pump Motor, No. 2 Oil"	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Air Compressor Motor hp (No. 2 Oil firing Only)	3	3	3	3	5	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	See Note "B"

NOTE:

A. Blower motor size for boiler operating pressures 125 psig and less, contact your local Cleaver-Brooks authorized representative for higher pressures and altitude.

B. 800 hp boilers are available w/ 3500 or 4000 sq. ft. of heating surface

Table A2-3. Model 4WI Steam Boiler Dimensions

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700/800	*800
LENGTHS													See Note "C"
Overall Length (60 PPM system)	A	161.63	185.63	175	208	200	220.13	223.5	238.75	245.75	282.75	270.75	297.75
Overall Length (30 PPM system)	A	161.63	185.63	175	208	200	220.13	223.5	247	253.5	287.25	276.75	303.75
Shell	B	131	155	143	176.5	172.3	196.1	189.75	207.75	213.75	248.75	232.75	259.75
Base Frame	C	110	134.13	122	156	150.1	174.1	167.25	185.25	188.25	223.25	207.25	234.25
Front Head Extension (60 PPM system)	D	27	27	28	27.63	28	30	34.25	27	28	34	34	34
Front Head Extension (30 PPM system)	D	27	27	28	27.63	28	30	34.25	35.25	36.75	38.5	38.5/40.5	40.5
Shell Ring Flange to Panel	E	17	17	17	17	17	23	23	26	26	26	26	26
Rear Ring Flange to Base	F	20.5	20.5	20.63	20.5	22	22	22.5	22	25	25	25	25
Shell Flange to Steam Nozzle 15 psi	G	78.38	88.38	87.38	93.38	84.38	98.38	94.5	104.5	101.5	124.5	110.5	128.5
Shell Flange to Steam Nozzle 150 psi	G	70.38	90.38	73.38	87.38	92.38	98.38	95.5	104.5	106.5	124.5	115.5	128.5
WIDTHS													
Overall Width	H	90.25	90.25	94.38	94.38	107	107	114	114	124.75	124.75	134.68	134.68
Center to Panel	II	48.5	48.5	52	52	58	58	61.5	61.5	67	67	72	72
I.D. Boiler	J	60	60	67	67	78	78	85	85	96	96	106	106
Center to Water Column	K	44.38	44.38	48.5	48.5	54	54	57.5	57.5	63	63	68	68
Center to Outside Davit/Hinge	L	35	35	41.5	41.5	51	51	58	56.5	62	64.65	67	67
Center to Lagging	M	32.5	32.5	36.75	36.75	42	42	45	45	50.46	50.46	56	56
Center to Auxiliary LWCO	N	38.75	38.75	42.38	43.38	49	49	52	52	59	57.68	62.68	62.68
Base Outside	O	52.5	52.5	51	51	64	64	60	60	71.88	71.88	74.75	74.75
Base Inside	P	44.5	44.5	43	43	56	56	47	47	58.88	58.88	61.75	61.75
HEIGHTS													
Overall Height	Q	86	86	101.75	101.75	115	115	123.5	123.5	134	134	145.5	145.5
Base to Vent Outlet	R	85	85	92.63	92.63	106	106	115	115	126	126	135.63	135.63
Base to Boiler Centerline	S	46	46	50	50	56	56	61	61	67	67	71	71
Height of Base Frame	T	12	12	12	12	12	12	12	12	12	12	12.25	12.25
Base to Bottom of Panel	U	16.5	16.5	14.75	14.75	15.5	15.5	17	17	16.5	16.5	16.75	16.75
Base to Steam Nozzle	V	82.38	82	89.88	89.88	101.5	103.5	110	109.5	121	122	130.5	130.5
BOILER CONNECTIONS													
Feedwater Inlet (Both Sides)	BB	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Surface Blowoff (150 lb only)	CC	1	1	1	1	1	1	1	1	1	1	1	1
Steam Nozzle 15 lb (See Note "A")	DD	8	8	8	10	10	12	12	12	12	12	12	12
Steam Nozzle 150 lb (See Note "B")	DD	4	4	4	4	6	6	6	6	8	8	8	8
Blowdown-Front & Rear (15 lb)	EE	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2
Blowdown-Front & Rear (150 lb)	EE	1.25	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
Chemical Feed	FF	1	1	1	1	1	1	1	1	1	1	1	1
VENT STACK													
Vent Stack Diameter (Flanged)	AA	16	16	16	16	20	20	24	24	24	24	24	24
MINIMUM CLEARANCES													
Rear Door Swing		36	36	40	40	46	46	50	50	55	55	60	60
Front Door Swing		67	67	78	78	89	89	97	97	108	108	118	118
Tube Removal - Front Only		96	120	108	142	132.5	156.5	148	166	169	204	188	215
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Thru Window or Door		234	258	261	295	308	332	337	355	377	412	411	438
Front of Boiler		263	311	291	359	351	399	388	424	438	508	481	535
WEIGHTS IN LBS													
Normal Water Weight	-	5,870	7,310	7,625	10,000	12,590	14,848	16,025	17,960	21,055	25,355	28,700	32,770
Approx. Shipping Weight - (15psig)	-	11,760	12,980	14,200	16,260	20,130	22,080	25,810	27,950	33,810	38,170	41,980	46,300
Approx. Shipping Weight - (150psig)	-	12,500	13,900	15,200	17,700	22,640	24,200	28,000	30,400	36,700	39,580	45,940	50,480

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": ANSI 300 psig Flange

NOTE "C": *800 hp w/ 4000 sq. ft. of heating surface

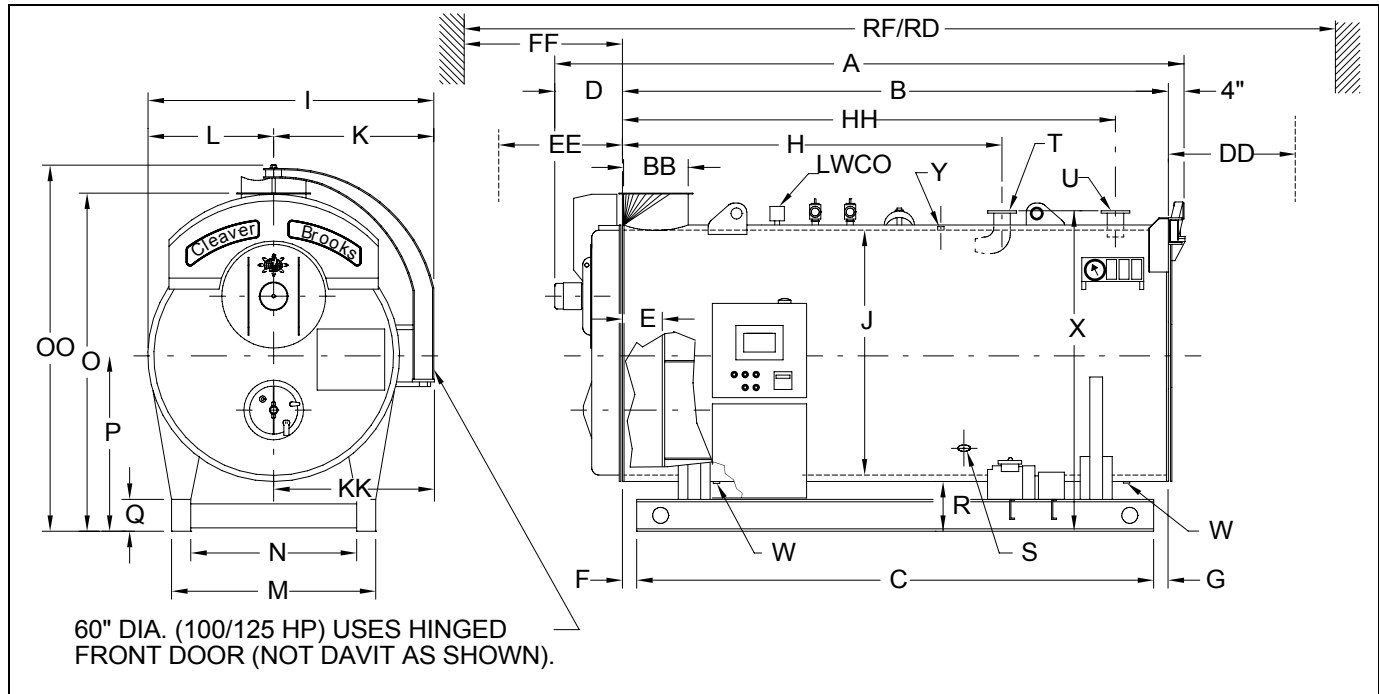


Figure A2-2. Model 4WI Hot Water Boiler 100-800HP

Table A2-4. Model 4WI Hot Water Boiler Ratings

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
RATINGS - SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.0	116.6	145.8	174.9	204.1	233.3
Gas CFH (1000 Btu)	4082	5102	6123	8164	10205	12246	14287	16328	20410	24492	28574	32656
Gas (Therm/hr)	40.8	51.0	61.2	81.6	102.0	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp (60 ppm)	2	5	5	7-1/2	10	15	15	20	15	25	30	50
Blower Motor hp (30 ppm)	3	7-1/2	7-1/2	15	15	20	20	25	30	40	50	75
Oil Pump Motor, No. 2 Oil	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Air Compressor Motor hp (No. 2 Oil firing Only)	3	3	3	3	5	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	See Note "A"

NOTE 'A': 800 hp boilers are available w/ 3500 or 4000 sq. ft. of heating surface

Table A2-5. 4WI Hot Water Boiler Dimensions

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700/800	*800
LENGTHS													See Note "C"
Overall Length (60 PPM system)	A	162	186	175	209	200	225.5	221.75	238.75	245.75	282.75	270.75	297.75
Overall Length (30 PPM system)	A	162	186	175	209	200	225.5	221.75	247	253.5	287.25	276.75	303.75
Shell	B	131	155	143	177	172.5	196.5	189.75	207.75	213.75	248.75	232.75	259.75
Base Frame	C	110	124	122	156	150.12	174.12	167.25	185.25	188.25	223.25	207.25	207.25
Front Head Extension (60 PPM)	D	27	27	28	28	23.5	25	28	27	28	30	34	34
Front Head Extension (30 PPM)	D	27	27	28	28	23.5	25	28	35.25	35.75	34.5	40	40
Shell Extension	E	12	12	12	12	14.5	14.5	16.75	16.75	16.25	16.25	16.75	16.75
Shell Ring Flange to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rear Ring Flange to Base	G	20.5	20.5	20.5	20.5	22	22	22	22	25	25	25	25
Shell Flange to Return	H	78	99	87	121	113.5	137.5	130.75	148.75	143	151.75	146.75	173.75
Shell Flange to Outlet	HH	103	124	112	146	139.5	163.5	156.75	174.75	179	187.75	182.75	209.75
WIDTHS													
Overall Width	I	75.5	75.5	82.75	82.75	93	93	102	102	113	113	123	123
I.D. Boiler	J	60	60	67	67	78	78	85	85	96	96	106	106
Center to Entrance Box	K	42.5	42.5	46	46	51	51	56.5	56.5	62	62	67	67
Center to Outside Davit/Hinge	KK	35	35	41.5	41.5	51	51	56.5	56.5	62	62	67	67
Center to Lagging	L	33	33	36.75	36.75	42	42	45.5	45.5	51	51	56	56
Base Outside	M	52.5	52.5	51	51	64	64	60	60	71.88	71.88	74.75	74.75
Base Inside	N	44.5	44.5	43	43	56	56	47	47	58.88	58.88	61.75	61.75
HEIGHTS													
Overall Height	OO	86	86	101.75	101.75	115	115	123.5	123.5	134	134	145.5	145.5
Base to Vent Outlet	O	85	85	92.63	92.63	106	106	115	115	126	126	135.63	135.63
Base to Boiler Centerline	P	46	46	50	50	56	56	61	61	67	67	71	71
Height of Base Frame	Q	12	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Boiler	R	15.63	15.63	16.13	16.13	16.5	16.5	18	18	18.5	18.5	17.5	17.5
Base to Return & Outlet	X	82.38	82.38	89.88	89.88	101.5	101.5	110	110	121.5	121.5	130.5	130.5
BOILER CONNECTIONS													
Waterfill Connection (Both Sides)	S	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Water Return (See Note "A")	T	4	6	6	6	8	8	8	10	10	12	12	12
Water Outlet (See Notes "A & B")	U	4	6	6	6	8	8	8	10	10	12	12	12
Drain-Front & Rear	W	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2
Air Vent	Y	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
VENT STACK													
Vent Stack Diameter (Flanged)	BB	16	16	16	16	20	20	24	24	24	24	24	24
MINIMUM CLEARANCES													
Rear Door Swing	DD	36	36	40	40	46	46	50	50	55	55	60	60
Front Door Swing	EE	67	67	78	78	89	89	97	97	108	108	118	118
Tube Removal - Front Only	FF	96	120	108	142	132.5	156.5	148	166	169	204	188	215
MINIMUM BOILER ROOM LENGTH													
Thru Window or Door	RD	234	258	261	295	308	332	337	355	377	412	411	438
Front of Boiler	RF	263	311	291	359	351	399	388	424	438	508	481	535
WEIGHTS IN LBS													
Normal Water Weight	-	6,888	8,569	8,857	11,590	14,746	17,368	19,212	21,507	26,251	31,571	35,878	40,930
Approx. Shipping Weight - (30psig)	-	11,760	12,980	14,200	16,260	20,130	22,080	25,810	27,950	33,810	38,170	41,980	45,960
Approx. Shipping Weight - (125psig)	-	12,500	13,870	15,150	17,680	21,690	24,170	27,980	30,370	35,900	40,560	45,090	49,400

NOTES: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": Water Outlet includes 2" Dip Tube

NOTE "C": 800 HP w/ 4000 sq. ft. of heating surface

Table A2-6. Steam Boiler Safety Valve Openings

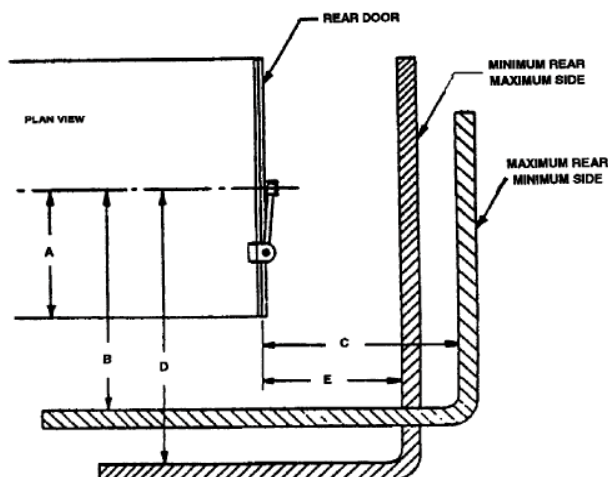
VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM		300 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100	1	2-1/2	1	1-1/2	1	1-1/2	1	1-1/4	1	1-1/4
125	1	3	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/4 (1) 1	2	1	2	1
150	1	3	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1 (1) 1-1/4	2	1	2	1
200	2	2-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4	2	(1) 1 (1) 1-1/4
250	2	(1) 2-1/2 (1) 3	2	(1) 2 (1) 1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4
300	2	3	2	(1) 2 (1) 1-1/2	2	1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
350	3	(1) 2 (2) 3	2	2	2	(1) 1-1/2 (1) 2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
400	3	(2) 3 (1) 2-1/2	2	(1) 2-1/2 (1) 2	2	(1) 1-1/2 (1) 2	2	(1) 1-1/2 (1) 2	2	1-1/2
500	3	3	2	2-1/2	2	(1) 2-1/2 (1) 2	2	2	2	(1) 1-1/2 (1) 2
600	4	(3) 3 (1) 2-1/2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2	2	(1) 1-1/2 (1) 2
700	5	(3) 3 (2) 2-1/2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2
800	5	(3) 3 (2) 2-1/2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	(1) 2 (1) 2-1/2

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

Table A2-7. Hot Water Boiler Safety Valve Openings

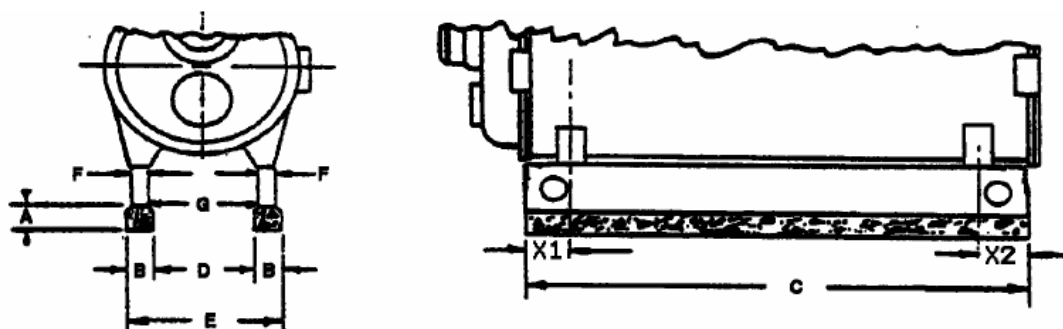
VALVE SETTING	30 PSIG HW		125 PSIG HW		150 PSIG HTHW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100	1	2-1/2	1	1-1/4	1	2
125	1	2-1/2	1	1-1/4	2	(1) 1-1/2 (1) 2
150	1	2-1/2	1	2	2	(1) 1-1/2 (1) 2
200	2	(1) 2-1/2 (1) 1-1/4	1	2	2	2
250	2	(1) 2 (1) 2-1/2	1	2	2	(1) 2 (1) 2-1/2
300	2	2-1/2	1	2-1/2	2	2-1/2
350	3	(2) 2-1/2 (1) 1	1	2-1/2	2	(1) 2-1/2 (1) 3
400	3	(1) 2 (2) 2-1/2	1	2-1/2	2	(1) 2-1/2 (1) 3
500	4	(1) 1 (3) 2-1/2	2	(1) 1 (1) 2-1/2	2	3
600	4	(3) 2-1/2 (1) 2	2	(1) 1-1/4 (1) 2-1/2	3	(2) 3 (1) 2-1/2
700, 800	5	(1) 1 (4) 2-1/2	2	(1) 2-1/2 (1) 2	3	3

NOTE: Relief valve is Kunkle #537 for 30# & 125#(Section IV) boiler and is Kunkle #927 for 150# HTHW(Section I) boiler.



BOILER HP	ALL DIMENSIONS IN INCHES				
HP	A	B	C	D	E
100-125	33	47	52	80	36
150-200	36.5	49	56	83	40
250-300	42	56	61	92	46
350-400	45.5	58	68	99	50
500-600	51	66	75	111	55
700-800	56	74	80	121	60

Table A2-8. Space Required to Open Rear Head on Promethean Boilers Equipped with Davits (4WI)

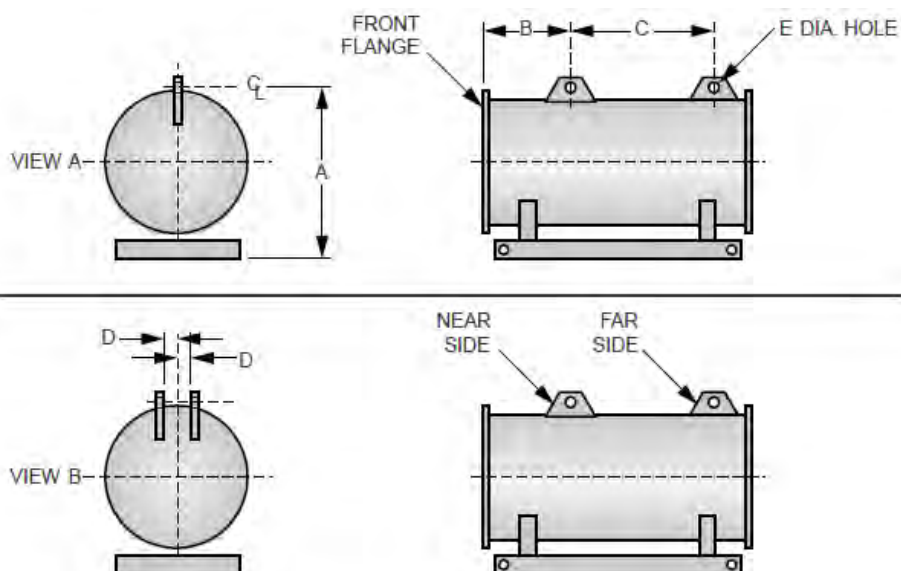


BOILER HP	ALL DIMENSIONS IN INCHES								
	A	B	C	D	E	F	G	X1	X2
100	6	9	110	39.5	57.5	4	44.5	12	8
125	6	9	124	39.5	57.5	4	44.5	12	8
150	6	9	122	38	56	4	43	12	8
200	6	9	156	38	56	4	43	12	8
250	6	9	150.125	51	69	4	56	16.125	11.5
300	6	9	174.125	51	69	4	56	16.125	11.5
350	6	12	167.25	41.5	65.5	6.5	47	17.75	11.5
400	6	12	185.25	41.5	65.5	6.5	47	17.75	11.5
500	6	12	188.25	53.375	77.375	6.5	58.875	18.75	10.5
600	6	12	223.25	53.375	77.375	6.5	58.875	18.75	10.5
700-800	6	12	207.25	56.25	80.25	6.5	61.75	18.75	10.5

NOTE:

6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the boiler and added height for washing down the area beneath the boiler.

Table A2-9. Boiler Mounting Piers



BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
100	79.5	21.375	84.75	10	3
125	79.5	21.375	108.75	10	3
150	87.125	21.375	96.75	10	3
200	87.125	21.375	130.75	10	3
250	99	28.75	104.25	10	3
300	99	28.75	128.25	10	3
350	107.625	33.25	126	10	3
400	107.625	33.25	144	10	3
500	125.375	34.5	145	10	3
600	125.375	34.5	180	10	3
700-800	134.5	34.5	164	10	3

NOTE: A, B, and C dimensions may vary by 1 inch.

Table A2-10. Lifting Lug Locations

PERFORMANCE DATA

The Low Emission Option provides NO_x reduction at current published and predicted fuel-to-steam efficiencies. Refer to Table A2-12 and Table A2-13.

Specifying Boiler Efficiency

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for Promethean 4WI Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7768 for a detailed description of efficiency calculations).

When specifying the efficiencies in the tables, be sure to include the specific guarantee conditions to maximize the effectiveness of your efficiency specification. If you have any questions regarding the efficiency specifications, please contact your local Cleaver-Brooks authorized representative.

Efficiency Specification

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam/water efficiency (as shown in Table A2-12 and Table A2-13) at 100% firing rate (Reference efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, ten thousand dollars (\$10,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:

- Natural Gas
 - Carbon,% (wt) = 69.98
 - Hydrogen,% (wt) = 22.31
 - Sulfur,% (wt) = 0.0
 - Heating value, Btu/lb. = 21,830
- No. 2 Oil
 - Carbon,% (wt) = 85.8
 - Hydrogen,% (wt) = 12.7
 - Sulfur,% (wt) = 0.2
 - Heating value, Btu/lb. = 19,420
- No. 6 Oil
 - Carbon,% (wt) = 86.6
 - Hydrogen,% (wt) = 10.9
 - Sulfur,% (wt) = 2.09
 - Heating value, Btu/lb. = 18,830

2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.

3. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).

4. Any efficiency verification testing will be based on the stack loss method.

For efficiencies and stack temperatures at operating pressures not listed, follow these procedures:



When the operating steam pressure is between 10 psig and 125 psig, interpolate the values from the efficiency tables.

When the operating steam pressure is above 125 psig, estimated efficiency can be calculated as follows:

Example:

Boiler: 350 hp.

Fuel: natural gas.

Operating steam pressure: 200 psig.

Find the fuel-to-steam efficiency at 100% firing rate. From Table A2-12 a boiler operating at 100% firing rate and an operating steam pressure of 125 psig, the efficiency is 82.1%.

Using Figure A2-3, note that the stack temperature increases 36 °F at the higher operating pressure. To estimate boiler efficiency, use this rule of thumb: For every 40 °F increase in stack temperature, efficiency decreases by 1%. Since the stack temperature rise is 36 °F, the decrease in the boiler efficiency at 200 psig operating pressure is calculated as follows: $36/40 = .9\%$. Therefore, the boiler efficiency at 200 psig operating pressure is $82.1 - .9 = 81.2\%$

Emissions

The emission data included in this section consists of typical emission levels for the 4WI boiler equipped with 60 & 30 ppm reduction with natural gas or No. 2 oil.

Table A2-11. Firing Rates 4WI Boilers with Integral Burner

BHP	Natural Gas, 1000 Btu/hr		No. 2 Oil, GPH	
	Low	High	Low	High
100	1021	4082	7.3	29.2
125	1276	5103	9.1	36.4
150	1531	6124	10.9	43.7
200	2041	8165	14.6	58.3
250	1021	10206	9.1	72.9
300	1225	12247	10.9	87.5
350	1428	14280	12.8	102.1
400	1633	16329	14.6	116.6
500	2042	20415	18.2	145.8
600	2449	24494	21.9	175
700	2858	28576	25.5	204.1
750	3062	30617	27.3	218.7
800	3266	32659	29.2	233.3

Notes:

Fuel input rates are based on nominal 82% efficiency.

No. 2 Oil = 140,000 Btu/Gal

Table A2-12. Predicted Fuel-to-Steam Efficiencies - Natural Gas - Model 4WI

BHP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
100	84.4	84.6	84.1	83.6	81.6	82.0	81.7	81.3
125	84.6	85.0	84.7	84.3	81.8	82.3	82.2	82.0
150	84.5	84.8	84.4	83.9	81.6	82.0	81.7	81.3
200	84.7	85.2	85.1	84.8	81.8	82.4	82.3	82.2
250	84.7	85.1	84.9	84.5	81.8	82.4	82.3	82.1
300	84.8	85.3	85.2	85.0	81.9	82.6	82.6	82.5
350	84.7	85.2	85.1	84.8	81.8	82.4	82.3	82.1
400	85.4	85.6	85.5	85.2	82.6	82.9	82.8	82.6
500	85.4	85.6	85.5	85.3	82.6	83.0	82.9	82.8
600	85.5	85.8	85.7	85.6	82.7	83.2	83.2	83.1
700	85.5	85.7	85.7	85.6	82.7	83.1	83.1	83.0
800	85.5	85.8	85.7	85.6	82.7	83.1	83.1	83.0

Note: Using the ultra low NOx burner (15-<9ppm) will result in a slight reduction of fuel-to-steam efficiency.

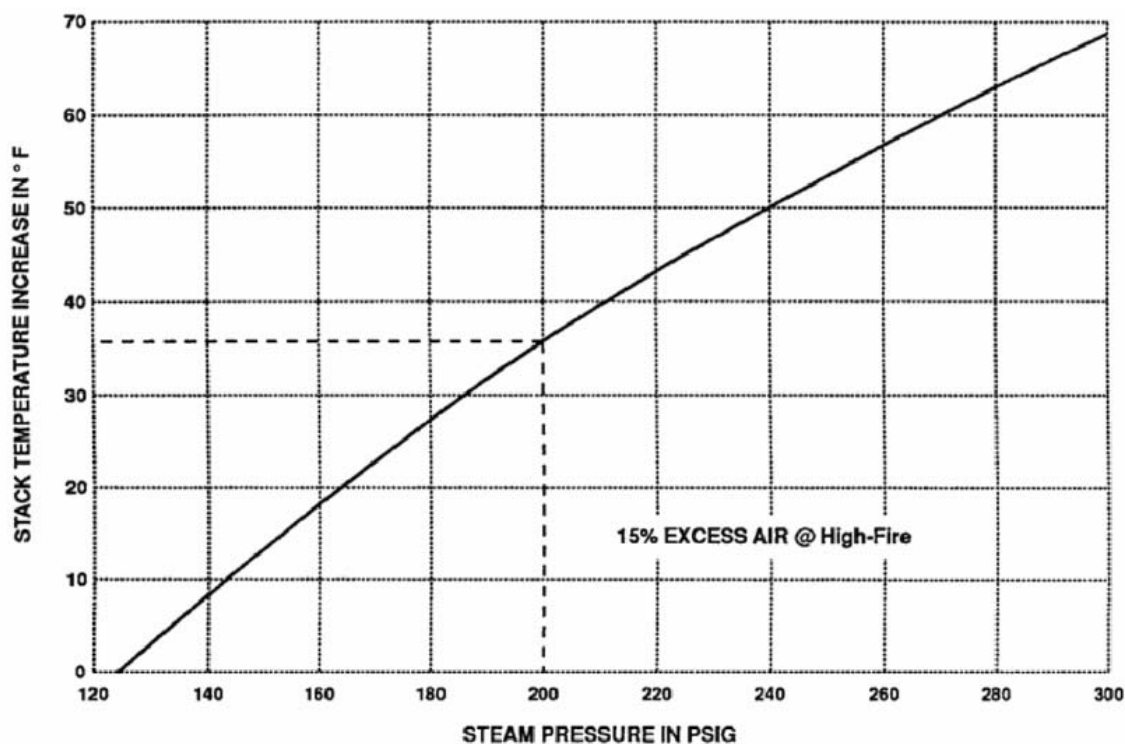
**Figure A2-3. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig - Model 4WI**

Table A2-13. Predicted Fuel-to-Steam Efficiencies - No. 2 Oil - Model 4WI

BHP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
100	87.9	88.1	87.6	87.0	85.1	85.4 85.1	84.7	
125	88.0	88.5	88.2	87.8	85.2	85.7 85.7	85.5	
150	88.0	88.3	87.9	87.4	85.1	85.4 85.1	84.8	
200	88.2	88.7	88.5	88.2	85.3	85.8 85.7	85.6	
250	88.1	88.6	88.3	88.0	85.3	85.8 85.7	85.6	
300	88.2	88.8	88.6	88.4	85.4	86.0 86.0	86.0	
350	88.2	88.7	88.5	88.2	85.3	85.8 85.7	85.6	
400	88.8	89.0	88.9	88.7	86.0	86.3 86.2	86.0	
500	88.8	89.0	88.9	88.7	86.1	86.4 86.4	86.2	
600	88.9	89.2	89.2	89.1	86.2	86.6 86.6	86.6	
700	88.9	89.2	89.1	89.0	86.1	86.5 86.5	86.4	
800	88.9	89.2	89.2	89.1	86.1	86.5 86.5	86.4	

Note: Using the ultra low NOx burner (15-<9ppm) will result in a slight reduction of fuel-to-steam efficiency.

Table A2-14. Promethean Boilers - Natural Gas, Emission Levels - Model 4WI

POLLUTANT	UNITS	60 PPM SYSTEM	30 PPM SYSTEM
CO	ppm*	50/150**	50/150**
	lb/MMbtu	0.04/0.11	0.04/0.11
NOx	ppm*	60	30
	lb/MMbtu	0.07	0.035
SOx	ppm*	1	1
	lb/MMbtu	0.001	0.001
HC/VOC ₅	ppm*	10	10
	lb/MMbtu	0.004	0.004
PM	ppm*	-	-
	lb/MMbtu	0.01	0.01

* ppm levels are given on a dry volume basis and are corrected to 3% oxygen (15% excess air)
 ** CO emission is 50 ppm when boiler is operating above 50% of rated capacity. CO emission is 150 ppm when boiler is operating below 50% of rated capacity.

Table A2-15. Promethean Boilers - No. 2 Oil, Emission Levels - Model 4WI

POLLUTANT	UNITS	60 PPM SYSTEM	30 PPM SYSTEM
CO	ppm*	50	50
	lb/MMbtu	0.04	0.04
NOx	ppm*	140	90
	lb/MMbtu	0.186	0.12
SOx	ppm*	278	278
	lb/MMbtu	0.52	0.52
HC/VOC ₅	ppm*	4	4
	lb/MMbtu	0.002	0.002
PM	ppm*	-	-
	lb/MMbtu	0.025	0.025

* ppm levels are given on a dry volume basis and are corrected to 3% oxygen (15% excess air) BASED ON THE FOLLOWING CONSTITUENT LEVELS:
 Fuel-bound Nitrogen content = 0.015% by weight
 Sulfur content = 0.5% by weight
 Ash content = 0.01% by weight

Table A2-16. 4WI Gas Pressure at Entrance to Standard, Undersized, and Oversized Gas Trains

Boiler HP	Pipe Size	30 PPM	60 PPM
		Pressure Range PSI	Pressure Range PSI
100	1.5"	0.6 - 2.0	0.5 - 2.0
125	1.5"	0.8 - 3.0	0.8 - 3.0
150	1.5"	1.0 - 3.0	0.9 - 3.0
200	1.5"	1.7 - 4.0	1.6 - 4.0
	2"	1.1 - 1.7	1.1 - 1.6
250	1.5"	2.4 - 5.0	2.5 - 5.0
	2"	1.5 - 2.4	1.6 - 2.5
300	1.5" - 2"	2.9 - 5.0	3.1 - 5.0
	2"	1.9 - 2.9	2.1 - 3.1
	3"	1.2 - 1.9	1.4 - 3.1
350	1.5" - 2"	3.8 - 5.0	3.8 - 5.0
	2"	2.8 - 3.8	2.8 - 3.8
	2.5"	2.1 - 2.8	2.1 - 2.8
	3"	1.4 - 2.1	1.4 - 2.1
400	1.5" - 2"	5.0 - 7.0	5.0 - 7.0
	2"	3.5 - 5.0	3.5 - 5.0
	2.5"	2.7 - 3.5	2.7 - 3.5
	3"	1.8 - 2.7	1.9 - 2.7
500	1.5" - 2.5"	6.6 - 10.0	6.6 - 10.0
	2" - 2.5"	4.7 - 6.6	4.7 - 6.6
	2.5"	3.3 - 4.7	3.3 - 4.7
	3"	1.9 - 3.3	1.9 - 3.3
600	1.5" - 2.5"	9.5 - 10.0	9.5 - 10.0
	2" - 2.5"	6.8 - 9.5	6.8 - 9.5
	2.5"	4.8 - 6.8	4.8 - 6.8
	2.5" - 3"	4.1 - 4.8	4.1 - 4.8
	3"	2.8 - 4.1	2.7 - 4.1
700	2" - 3"	8.5 - 10.0	8.4 - 10.0
	2.5" - 3"	5.4 - 8.5	5.3 - 8.4
	3"	3.6 - 5.4	3.5 - 5.3
	4"	2.7 - 3.6	2.6 - 3.5
750	2.5" - 3"	6.4 - 10.0	6.4 - 10.0
	3"	4.6 - 6.4	4.6 - 6.4
	4"	3.1 - 4.6	3.1 - 4.6
800	2.5" - 3"	6.8 - 10.0	7.0 - 10.0
	3"	4.6 - 6.8	4.8 - 7.0
	4"	3.3 - 4.6	3.5 - 4.8

Note: Some units list two diameters because the gas train increases in size after the regulating valve. The first number is the customer connection size.

UNDERSIZE

STANDARD

OVERSIZE

Table is based on Siemens gas train, which includes a regulating actuator.

Table A2-17. Recommended NTI Gas Train Sizes and Pressure Ranges

Boiler HP	4WI 15 PPM			4WI 9 PPM	
	Gas Train Size, in	Pressure Range PSI		Gas Train Size, in	Pressure Range PSI
100	1.5	2.3 - 5.0		1.5	2.3 - 5.0
125	1.5	3.3 - 6.0		1.5	3.3 - 6.0
150	1.5	3.9 - 6.0		1.5	4.1 - 6.0
200	1.5	4.5 - 7.0		1.5	4.5 - 7.0
250	1.5 - 2	4.5 - 7.0		1.5 - 2	4.2 - 7.0
300	1.5 - 2	6.1 - 9.0		1.5 - 2	5.9 - 9.0
	2	4.8 - 6.1		2	4.6 - 5.9
350	1.5 - 2	5.1 - 7.5		1.5 - 2	6.2 - 9.0
	2	4.0 - 5.1		2	5.2 - 6.2
				2.5	4.5 - 5.2
400	1.5 - 2	7.3 - 10.0		1.5 - 2	7.2 - 10.0
	2	5.8 - 7.3		2	5.7 - 7.2
	2.5	5.0 - 5.8		2.5	4.9 - 5.7
	3	4.1 - 5.0			
500	1.5 - 2	8.1 - 10.0		1.5 - 2	8.1 - 10.0
	2	6.1 - 8.1		2	6.1 - 8.1
	2.5	4.7 - 6.1		2.5	4.7 - 6.1
	3	3.4 - 4.7		3	3.4 - 4.7
600	2 - 3	7.8 - 10.0		2 - 3	7.8 - 10.0
	2.5 - 3	5.8 - 7.8		2.5 - 3	5.8 - 7.8
	3	4.4 - 5.8		3	4.4 - 5.8
700	2.5 - 3	7.7 - 10.0		2.5 - 3	7.9 - 10.0
	3	5.9 - 7.7		3	6.1 - 7.9
720				2.5 - 3	8.1 - 10.0
				3	6.3 - 8.1
750	2.5 - 3	8.6 - 10.0			
	3	6.7 - 8.6			

Note: Some units list two diameters because the gas train increases in size after the regulating valve. The first number is the customer connection size.

UNDERSIZE
STANDARD
OVERSIZE

Table is based on Siemens gas train, which includes a regulating actuator.

Table A2-18. Predicted Sound Levels (30 ppm NOx system) at High Fire - Model 4WI

BHP	Sound Level-dBA
100	79
125	83
150	83
200	84
250	83
300	84
350	84
400	85
500	85
600	87
700	88
800	90

ENGINEERING DATA

Sound Level

Table A2-18 gives a summary of predicted sound pressure levels for the CB boilers with 30 ppm LE Options. Contact your local Cleaver-Brooks authorized representative for sound levels for other LE Options.

Units

The units for the sound level tables are dbA (decibels, measured on the A-weighted scale) in reference to 0.0002 microbars (20 micro-Newtons per square meter). Their reference are standardly used in specifying and reporting sound pressure levels on industrial equipment.

Test Method

The sound pressure levels in the above tables were obtained from tests in accordance with the "ABMA Test Code for the Measurement of Sound from Packages Boilers." In accordance with this code the sound pressure levels reported were measured on the boiler centerline 4-1/2 feet vertically above the bottom of the base rails and 3 feet horizontally in front of the end of the blower motor or front surface of the electrical cabinet.

Sound Level Meter

The sound level meter used complies with ANSI S1.4, Type 1 (Precision). The readings are taken with the meter set for slow response and corrected for background levels.

Sound Pressure

With larger sized boilers, the need for auxiliary equipment, and the necessary interconnecting piping make it impractical (and sometimes impossible) to provide a boiler testing environment which is suitable for taking the data needed to develop Sound Pressure Power levels.

Typical Values

Sound pressure levels (dbA) for the same boiler will vary between boiler rooms. Sound levels will vary with motor type, NO_x levels, and altitudes. In addition, variations will occur between different people using different sound meters on the same boiler. And finally, no two boilers can be expected to give precisely the same sound levels. For these reasons, we can only predict, but not guarantee, sound levels (dbA).

Gas-Fired Burners

Table A2-16 shows gas pressure ranges for standard, oversized, and undersized gas trains.

Table A2-19 shows minimum required gas pressure altitude conversion.

C-B O₂ Trim Systems: If a C-B O₂ Trim system will be utilized, contact your local Cleaver-Brooks authorized representative to be sure that a compatible regulator is selected.

Table A2-20 shows maximum gas consumption for natural gas and propane vapor.

Table A2-21 shows standard gas train sizes and locations for Model CB Firetube Boilers.

Figure A2-4 shows typical gas train piping layouts for multiple boiler applications.

Oil-Fired Burners

Fuel oil consumption information is shown on the boiler rating sheets in the Dimensions and Rating Section.

Table A2-23 shows the oil connection sizes and locations for Model CB Boilers firing No. 2 oil.

Figures Figure A2-5 through Figure A2-8 show typical oil systems and layouts.

Figure A2-8 show the detail of an oil transfer tank (day tank) typically utilized to provide a storage reservoir between the oil system supply pump and the boiler oil pump.

**Table A2-19. Minimum Required Gas Pressure
Altitude Conversion**

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

Oz/sq-in x 1.732 = Inches WC

Inches WC x 0.0361 = psig.

Oz/sq-in x 0.0625 = psig.

Psig x 27.71 = Inches WC

Psig x 16.0 = Oz/sq-in.

**Table A2-20. Maximum Gas Consumption (CFH)
for Natural Gas and Propane Vapor**

BOILER HP	TYPE OF GAS AND HEAT CONTENT	
	NATURAL GAS 1000 (Btu/cu-ft)	PROPANE GAS 2550 (Btu/cu-ft)
125	5103	2000
150	6124	2402
200	8165	3202
250	10206	4002
300	12247	4802
350	14280	5600
400	16329	6404
500	20415	8006
600	24494	9605
700	28576	11206
750	30618	12007
800	32659	12807

BOILER HP	MODEL 4WI	
	CONNECTION SIZE (IN.) (NPT)	LOCATION DIMENSION "A" (IN.)
100-125	1-1/2	52
150-200	1-1/2	47-1/2
250-400	2	50
500	2-1/2	60
600	2-1/2 - 3	71
700-800	3	65

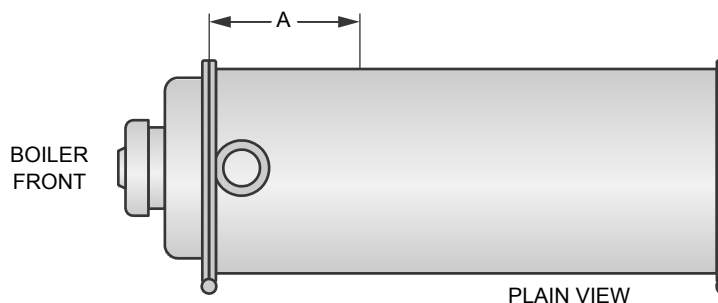
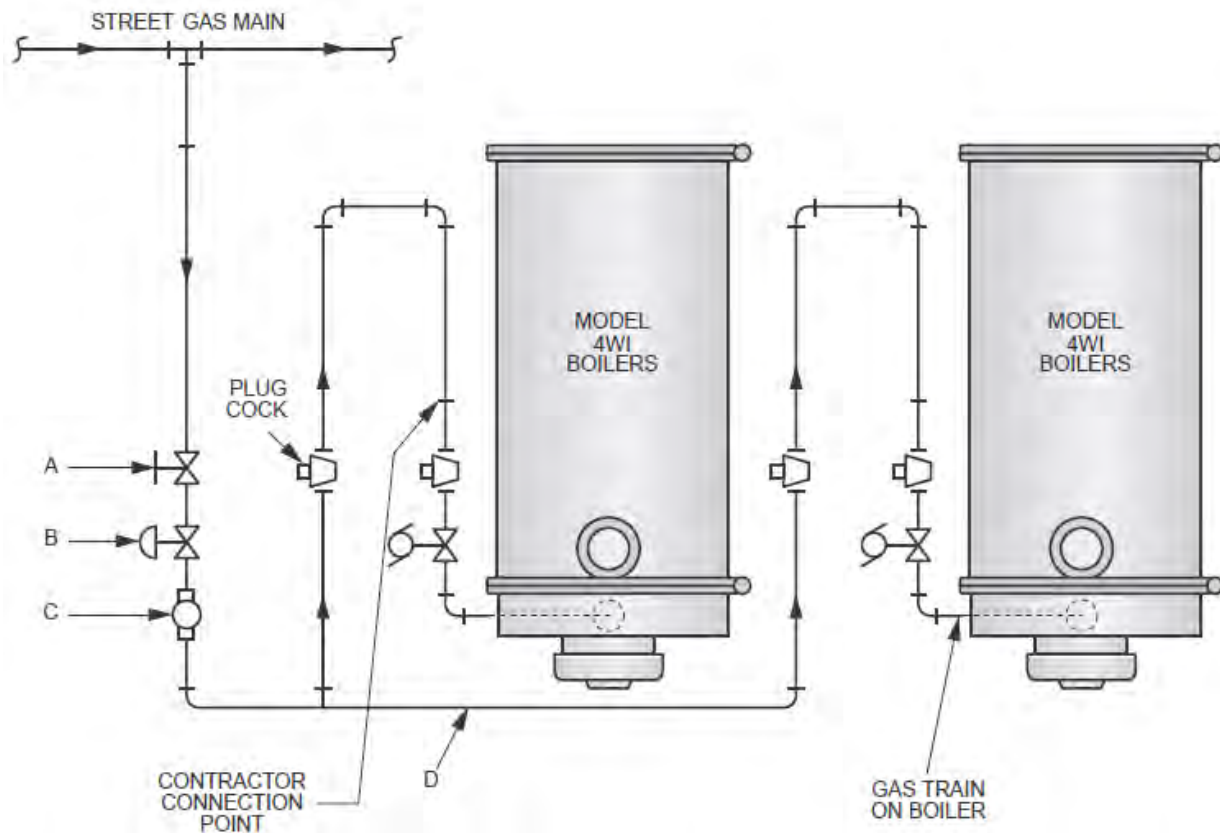


Table A2-21. Standard Gas Train Connection Size and Location

This figure illustrates the basic gas valve arrangement on Cleaver-Brooks Model 4WI boiler and shows the contractor's connection point. The valves and controls between the contractor connection point and the gas main in the street are representative of a typical installation. Actual requirements may vary depending on local codes or local gas company requirements which should be investigated prior to preparation of specifications and prior to construction.



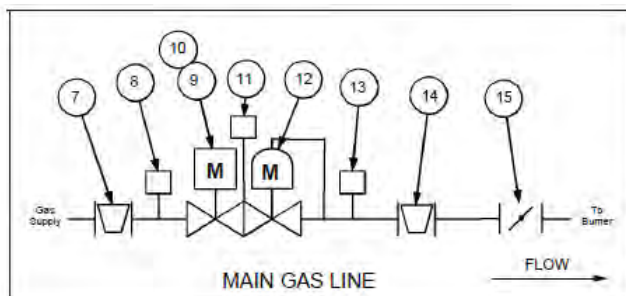
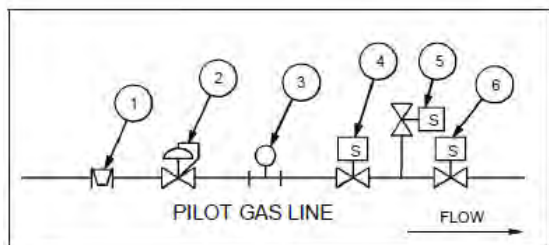
- A. Utilities service valve.
- B. Utilities service regulator.
- C. Gas meter.
- D. Piping from meter to boiler.

The size of the gas line from the meter to the gas pressure regulator at the boiler can be very important if gas pressures are marginal. The gas line sizing is dependent on:

1. Gas pressure at outlet of gas meter (C)
2. Rate of gas flow required, CFH
3. Length of pipe run (D)
4. Pressure required at contractor connection point.

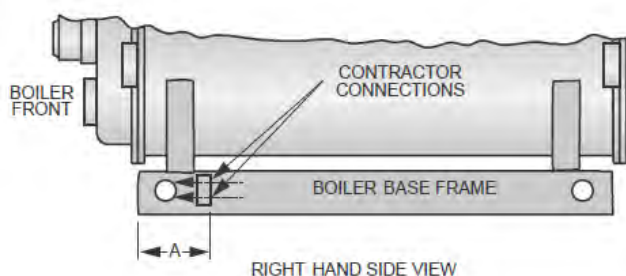
The local gas utility will advise the pressure that is available at the outlet of their meter.

Figure A2-4. Typical Gas Piping Layout



ITEM	DESCRIPTION	UL		FM		CSD-1	NFPA-85
		125 hp - 300 hp	350 hp - 800 hp	125 hp - 300 hp	350 hp - 800 hp	125 hp - 300 hp	350 hp - 800 hp
1	Pilot Shut Off Cock	X	X	X	X	X	X
2	Pilot Pressure Regulator	X	X	X	X	X	X
3	Pilot Pressure Gauge	X	X	X	X	X	X
4	Gas Pilot Valve	X	X	X	X	X	X
5	Pilot Vent Valve						X
6	Gas Pilot Valve						X
7	Manual Shut Off Valve	X	X	X	X	X	X
8	Low Gas Pressure Switch	X	X	X	X	X	X
9	Main Gas Valve w/o POC	X	X	X		X	
10	Main Gas Valve w/ POC				X		X
11	Vent Valve or Valve Proving Switch		X		X		X
12	Regulating Gas Valve w/ POC	X	X	X	X	X	X
13	High Gas Pressure Switch	X	X	X	X	X	X
14	Manual Shut Off Valve	X	X	X	X	X	X
15	Butterfly Valve	X	X	X	X	X	X

Table A2-22. Gas Train Components



BOILER HP	SUPPLY AND RETURN CONN SIZES (IN.) (NPT)	A (IN.)	MODEL 4WI RECOMMENDED OIL LINE ^A SIZES (STANDARD PIPE) (IN. - IPS)		
			STORAGE TANK TO BOILER OR PUMP CONNECT	PUMP TO BOILER	RETURN LINE TO TANK
100 150 200	3/4	12-1/2	1	1	1
250 300 350	3/4	34	1	1	1
400 500 600	3/4	11-3/4	1	1	1
700 750 800	1	11-3/4	1	1	1

NOTE: See No. 2 Oil Line Sizing Instruction for systems with other conditions.

A. For suction line condition with a maximum of 10 Feet of lift and a total of 100 feet of suction line.

Table A2-23. No. 2 Oil Connection Size, Location and Recommended Line Sizes

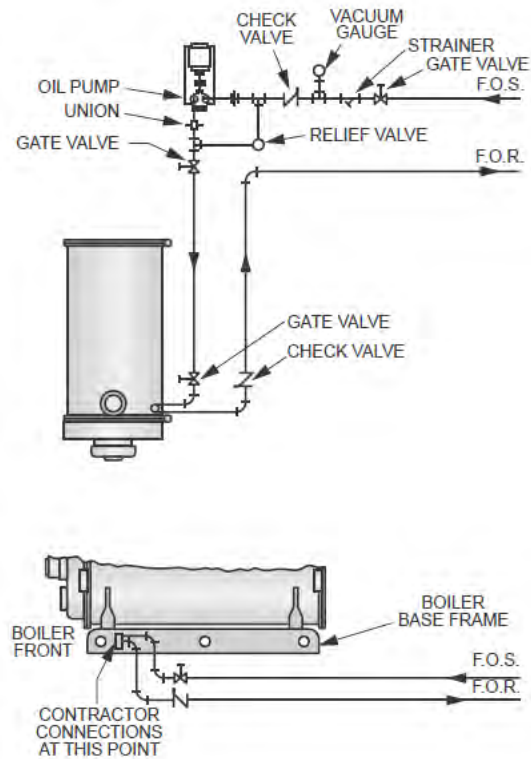


Figure A2-5. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump

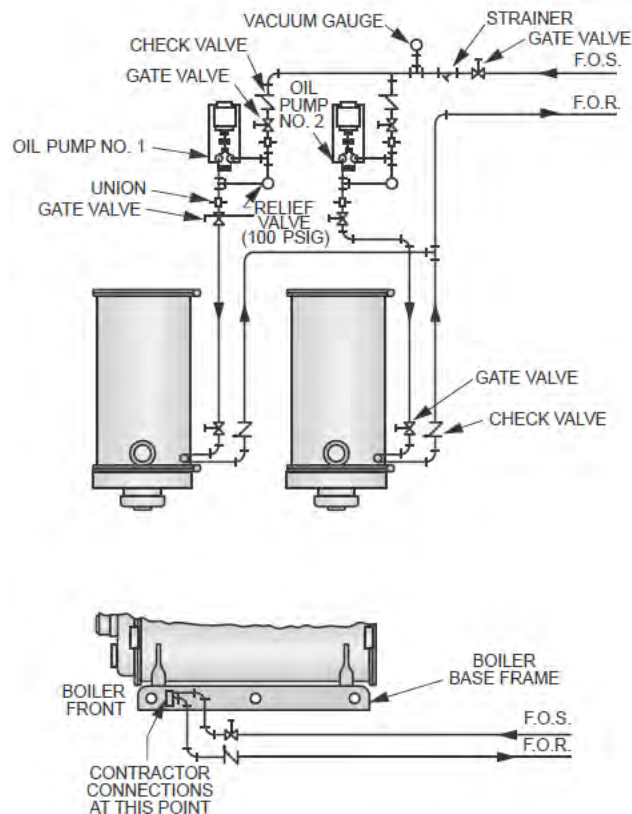


Figure A2-6. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

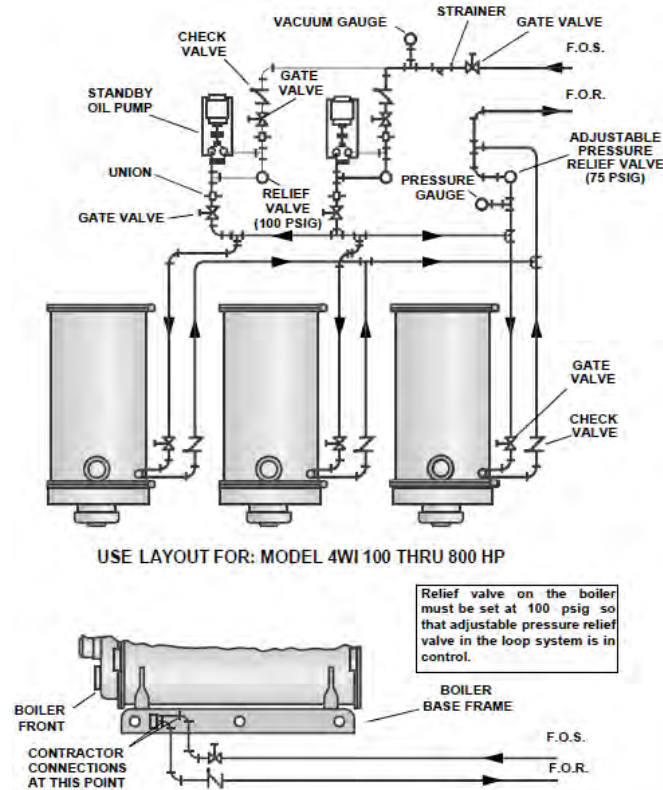


Figure A2-7. No. 2 Oil Piping, Multiple Boiler Installation

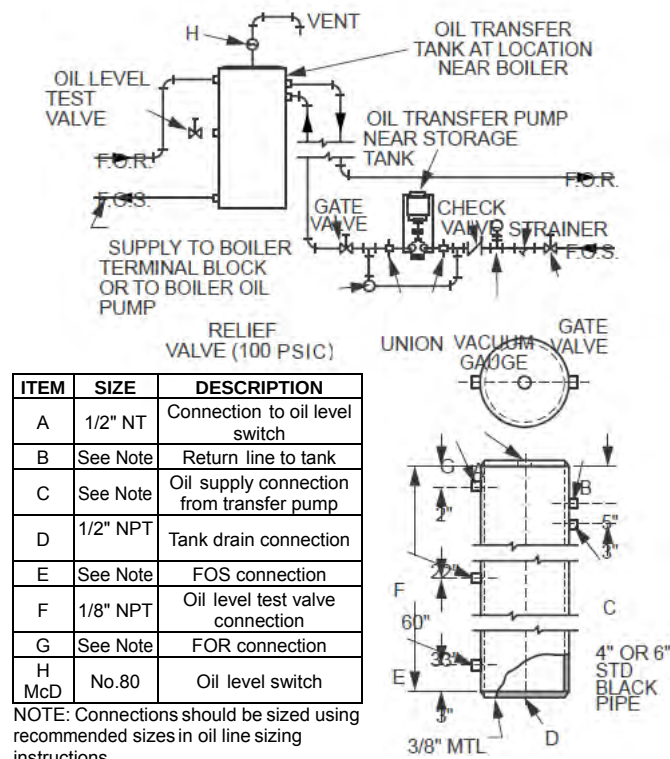
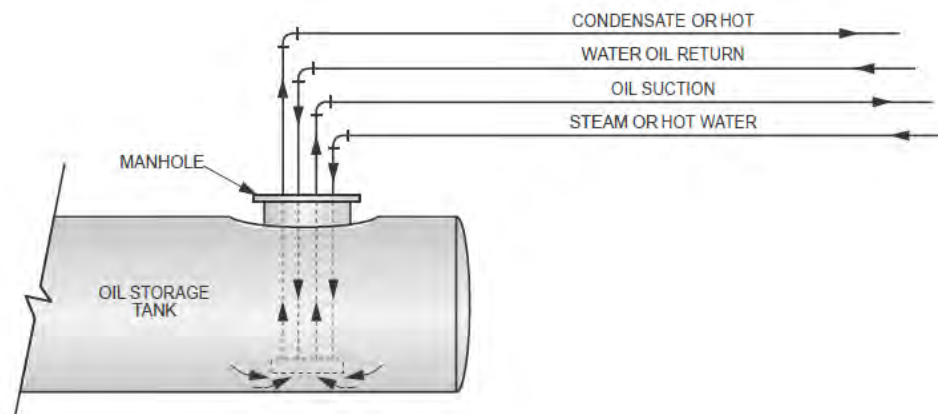


Figure A2-8. No. 2 Oil Transfer Tank Detail (For consideration with elevated boiler rooms)



Note: Observe all local and national (eg. Fire underwriters) code requirements governing the installation of fuel oil storage tanks and supply systems.

Figure A2-9. Typical Fuel Storage Tank Arrangement

General Boiler Information

Table A2-24 shows blowdown tank sizing information.

Table A2-25 provides heating surface information.

Table A2-26 provides steam volume and disengaging area information.

Table A2-27 provides recommended steam nozzle sizes.

Table A2-28 provides recommended non-return valve sizes.

Boiler Room Information

Figure A2-10 shows typical boiler room length requirements.

Figure A2-11 shows typical boiler room width requirements.

Figure A2-12 shows typical breeching arrangements.

Stack Support Capabilities

All standard Cleaver-Brooks Firetube Boilers can support up to 2,000 lbs without additional support.

Boilers 250 hp through 800 hp can be reinforced to support 3,000 lbs.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is – 0.25" W.C. to +0.25" W.C.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.

- 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 by dust or dirt. 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 unsatisfactory burner performance.
 - C. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - D. Size the openings by using the formula: $\text{Area (sq-ft)} = \text{CFM/FPM}$
2. Amount of air required (cfm).
- A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp
 - C. Total recommended air = 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
- A. From floor to (7) foot height - 250 fpm
 - B. Above (7) foot height - 500 fpm

Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} / 250 = 3000 / 250 = 12$ sq-ft total.
- Area/Opening: $12 / 2 = 6$ sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Table A2-24. Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
100	85
125	104
150	102
200	131
250	145
300	169
350	178
400	198
500	233
600	278
700	286
800	286

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Table A2-25. Heating Surface

BOILER HP	HEATING SURFACE (SQ-FT)	
	FIRESIDE	WATERSIDE
100	500	
125	625	679
150	750	820
200	1000	1092
250	1250	1346
300	1500	1623
350	1750	1932
400	2000	2151
500	2500	2691
600	3000	3262
700 & 800	3500	3810

Table A2-26. Steam Volume Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA SQ-IN	
	HIGH PRESSURE (A)	LOW PRESSURE (B)	HIGH PRESSURE (A)	LOW PRESSURE (B)
100	16.5	22.3	4565	4954
125	20.3	27.4	5587	6077
150	19.9	26.8	5443	5918
200	25.7	34.6	7013	7632
250	34.8	49.5	7790	8597
300	40.6	57.9	9115	10051
350	51.3	69.6	9734	10570
400	57.2	77.5	10843	11779
500	83.6	107.6	12874	13781
600	100	128.6	15394	16474
700	115.6	144.9	15826	16819
800	115.6	144.9	15826	16819

NOTE:

1. Based on normal water level.
- A. Based on 150 psig design pressure.
- B. Based on 15 psig design pressure.

Table A2-27. Recommended Steam Nozzle Size (To Maintain 4000 to 5000 fpm Nozzle Velocity)**Model 4WI Recommended Steam Nozzle Size**

OPERATING PRESSURE PSIG	BOILER HP											
	100	125	150	200	250	300	350	400	500	600	700	800
15	8	8	8	10	10	12	12	12	12	12	12	12
30	6	6	6 8		8	8	10	10	10	12	12	12
40	6	6	6 6		8	8 8		10	10	10	12	12
50	4	6	6 6		6	8 8		8	10	10	10	12
75	4	4	4 6		6	6 8		8	8	8	10	10
100	4	4	4 6		6	6 6		6	8	8	8	10
125	4	4	4 4		6	6 6		6	8	8	8	8
150	2.5	3	3 4		4	6 6		6	6	6	8	8
200	2.5	2.5	3	4	4	4 4		6	6	6	6	6
250	2	2.5	3	3	4	4 4		4	6	6	6	6

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.
3. All standard steam nozzle sizes for 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.
4. Shaded area denotes special surge load baffles must be installed to avoid possible water carryover.
5. For incremental operating pressure, see Table I3-1 Steam System Fundamentals.

Table A2-28. Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURES (PSIG)							
		50	75	100	125	150	175	200	250
100	3450	2-1/2	2-1/2	NA	NA	NA	NA	NA	NA
125	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA	NA
150	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA	NA
200	6900	3*	3	3 3		3	2-1/2	2-1/2	2-1/2
250	8625	4	3*	3	3	3	3 3 3		
300	10350	4	4 4		3*	3	3 3 3		
350	12025	4	4 4 4			4	3*	3	3
400	13800	5	4 4 4			4	4 4		3*
500	17210	6	5 5 4			4	4 4 4		
600	20700	6	6 5 5			5	4 4 4		
700	24150	6	6 6 5			5	5 5 4		
800	27600	6	6 6 6			6	5 5 5		

NOTE: Valve sizes (300 # Flanges) given in inches.

Standard Non-Return valve selections limited to a maximum 2 to 1 turndown (50% of full load); selections based on typical non-return valve sizing recommendations. For final valve selection contact your C-B authorized representative. For high turndown applications see Boiler Book Section I3, Table I3-3.

* Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table A2-29. Blower Motor Selection 4WI NTI Boilers

Altitude: 700 ft and less - Design Pressure: 150 psi and less

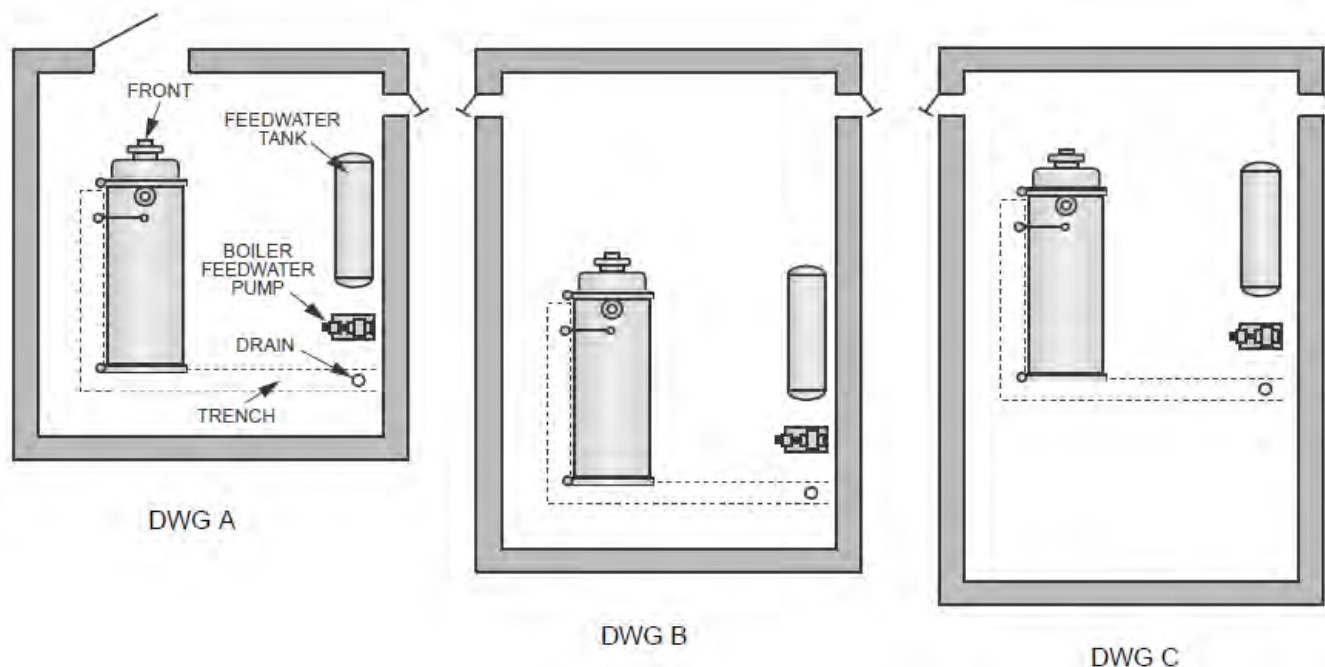
Nominal Boiler Size	15 ppm Blower Motor HP	9 ppm Blower Motor HP
100	3	3
125	75	75
150	5	75
200	10	15
250	10	10
300	20	20
350	15	20
400	25	40
500	25	30
600	50	50
700	0	75
800	75	75

* 800 HP to be derated to 720 HP for 9 ppm and 750 HP for 15 ppm.

Table A2-30. Turndown Guarantee 4WI NTI Boilers - Natural Gas & #2 Oil

Boiler Size	Turndown	
	9 ppm	15 ppm
100	4:1	4:1
125	4:1	4:1
150	4:1	5:1
200	4:1	5:1
250	5:1	5:1
300	5:1	5:1
350	5:1	5:1
400	5:1	6:1
500	5:1	6:1
600	6:1	6:1
700	7:1	7:1
800*	7:1	7:1

* 800 HP to be derated to 720 HP for 9 ppm and 750 HP for 15 ppm.



1. Shortest boiler room length (DWG A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

2. Next shortest boiler room length (DWG B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

3. A slightly longer boiler room (DWG C) is obtained by allowing for possible future tube replacement from the rear of the boiler. Allowance for door swing at the front provides sufficient aisle and working space at the front.

Figure A2-10. Boiler Room Length (Typical Layouts)

BOILER HP	100 125	150 200	250 300	350 400	500 600	700 800
Dimension A	87	91"	96"	100"	105	110
Dimension B	120	127"	144"	151"	174	184

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of:
 42" - 125-200 hp
 48" - 250-350 hp
 60" - 400-800 hp
 If space permits, this aisle should be widened.

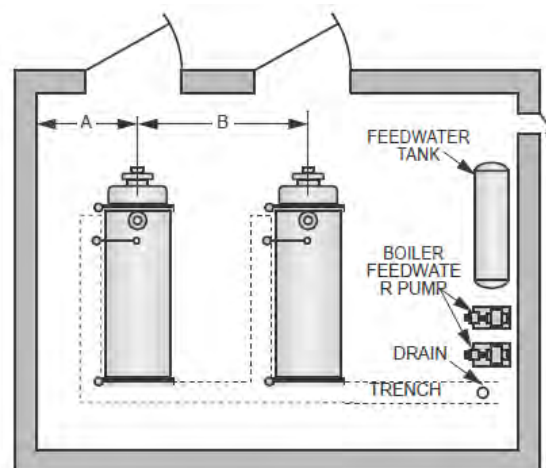
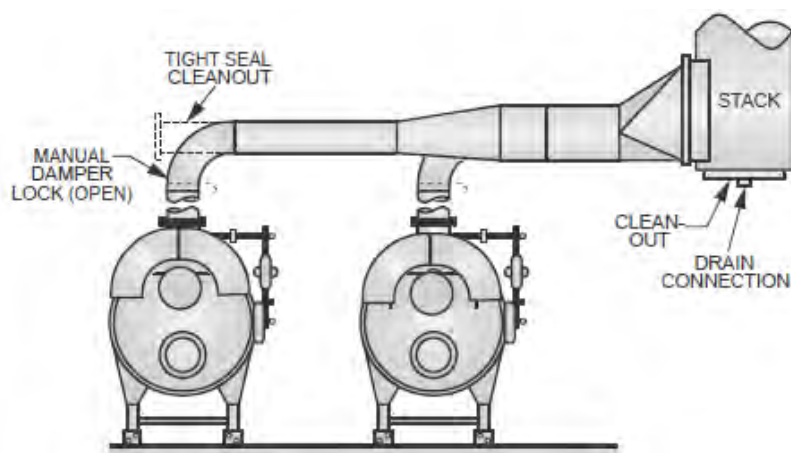


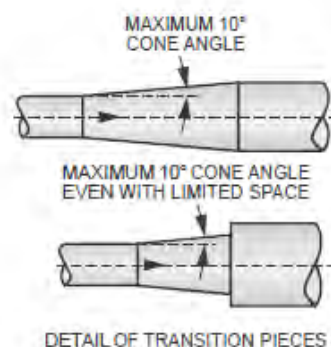
Figure A2-11. Boiler Room Width (Typical Layout)



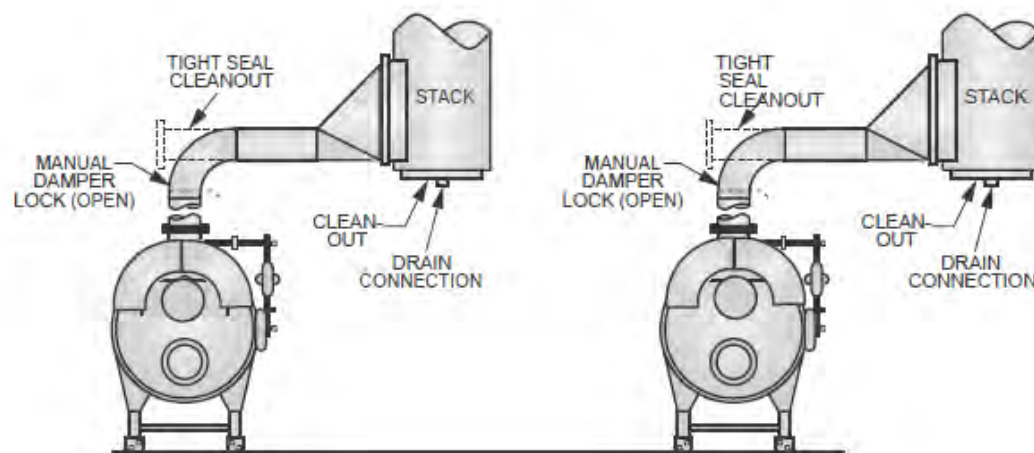
MULTIPLE BOILERS WITH A COMMON STACK

NOTE: These stack breeching arrangements for multiple boilers are typical and not intended for your specific design requirements. For additional information, review Section F, Stacks.

Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on your specific criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of stack and breeching design.



DETAIL OF TRANSITION PIECES



MULTIPLE BOILERS WITH INDIVIDUAL STACKS

Figure A2-12. Breeching Arrangement

SAMPLE SPECIFICATIONS - MODEL 4WI STEAM BOILERS

PART 1 GENERAL

1.1 SCOPE

- A. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled steam boiler(s) as described in the specifications herein.

1.2 REFERENCES

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Maintenance Data: Include parts list, maintenance guide, and wiring diagrams for each boiler.
- G. ASME Section I or IV (Power boilers or Heating Boilers)
- H. NSI Z21.13 (Gas Fired Low Pressure Boilers)
- I. NFPA 54 (ANSI Z221.3) National Fuel Gas Code
- J. Factory Mutual
- K. ASME CSD-1 (Controls and Safety Devices)
- L. XL-GAP (formerly GE-GAP GE Global Asset Protection)
- M. UBC (Uniform Building Code)
- N. MC (Uniform Mechanical Code)
- O. NEC (National Electrical Code)
- P. UL (Underwriters Laboratories)
- Q. NFPA 85

1.3 QUALITY ASSURANCE

- A. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, appurtenances, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.
- B. The equipment shall be of the type, design, and size that the manufacturer currently offered for sale and appears in the manufacturer's current catalogue. The equipment shall be new and fabricated from new materials and shall be free from defects in materials and workmanship.

- C. The equipment must fit within the allocated space, leaving ample allowance for maintenance and cleaning, and must leave suitable space for easy removal of all equipment appurtenances. Tube pull clearance space from either the front or rear of boiler must be maintained.
- D. All units of the same classification shall be identical to the extent necessary to insure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.
- E. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified. The boiler manufacturer shall be responsible for guarantying that the boiler provides the performance as specified herein.

1.4 SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval by the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. The engineer shall review and stamp submittals. Work may proceed and equipment released for fabrication after contractor receives returned submittals stamped with "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
- C. The bidder must submit in writing to the engineer any request for a proposed deviation, omission, modification, or substitution to this specification for evaluation no later than ten (10) days prior to the bid date. A request for any substitution shall be accompanied by technical data, drawings, product samples, and complete data substantiating compliance of proposed substitution with these specifications. No materials shall be deemed acceptable if not in strict and full compliance with these specifications. All bidders must bid solely on the specified materials unless acceptance by the engineer of a deviation, omission, modification, or substitution is granted in writing to all bidders prior to the bid date.
- D. Shop Drawings - Shop drawings shall be submitted to the engineer for approval and shall consist of:
- E. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
- F. Schematic flow diagram of gas valve trains.
- G. Schematic wiring diagram of boiler control system of the ladder-type showing all components, all interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring.
- H. Installation Instructions: Manufacturer's printed instructions for installation shall be submitted to the engineer for approval.
- I. Manufacturer's Warranties: Manufacturer's printed warranties, as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- J. Manufacturer's Field Service: Manufacturer's printed field service procedures and reports, as specified hereinafter, shall be submitted prior to final acceptance by the engineer. Report forms shall contain all information as required to do start-up and testing as specified in the products section.

1.5 CERTIFICATIONS

- A. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 - 3. ASME certification.
 - 4. UL and CSD-1 certification.
 - 5. The equipment furnished has been installed in accordance with the manufacturer's installation instructions.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.
- B. Contractor's Certification: The contractor shall certify the following:
 - 1. The products and systems installed are in strict compliance with the specifications.
 - 2. The specified field tests have been satisfactorily performed.
- C. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- D. Test Reports: Factory and field test reports as described above and as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- E. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall be responsible for the timely delivery of the equipment to the job site. The contractor shall be responsible for unloading and rigging of the equipment. The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as job site conditions during construction.
- B. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.
- C. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled, low pressure hot water boilers as described in the specifications herein.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Contractor shall furnish and install Cleaver Brooks Model 4WI natural gas (combination Gas/Oil fired) steam boiler(s) with design pressure as scheduled on the drawings.
- B. Alternate manufacturers complying with plans and specifications must be submitted and approved by the consulting engineer within 10 days prior to bid date.

2.2 GENERAL DESCRIPTION

Factory packaged unit shall include boiler, burner, heavy duty skids, painted steel jacket with two inches of fiberglass insulation, controls and accessories all piped and wired for single point field connections. Units shall carry packaged label of Underwriters Laboratory (UL) and be in accordance with ASME/CSD-1, all codes required by the local governing authorities and as indicated on the design performance data sheet. A certified factory fire-test shall be provided on all fuels with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for _____ PSIG steam in accordance with Section (I or IV) of ASME Code. Unit shall be designed to Seismic Zone requirements and be provided with tie down clips and calculations showing bolt diameter requirements. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements.

2.3 PERFORMANCE: BOILER SIZE AND RATINGS

- A. The capacity of each unit shall be indicated on the drawing schedule.
- B. Performance Criteria:

Performance Criteria	
Manufacturer:	CLEAVER-BROOKS
Model:	Promethean Line
Horsepower:	_____ HP
Output:	_____ #/hr (from and at 212°F)
Gas Input:	_____ MBH
Oil Input:	_____ GPH
Design Pressure:	_____ PSIG
Operating Pressure	_____ PSIG
Steam Disengaging Area (minimum)	_____ Sq. Inches
Steam storage area (minimum)	_____ Cu. Ft.
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Heating Release (maximum):	_____ BTU/Cu. Ft
Burner Turndown Ratio Natural Gas:	
Overall Efficiency (Fuel to Steam)	
Natural Gas (%):	_____ % at High Fire
No. 2 Oil (%):	_____ % at High Fire
NOX Emission (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
CO Emissions (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
Electrical:	_____ V / _____ H / _____ P
Fan Motor:	_____ HP
Air Compressor Motor:	_____ HP
Oil Pump Motor:	_____ HP
Noise Level (3' from burner):	_____ dBA
Available Gas Supply Pressure:	_____ PSIG
Weight	
Dry:	_____
Flooded:	_____
Seismic Zone:	_____
Altitude:	_____ ASL
Code Requirements:	ASME / NATIONAL BOARD CSD-1 NFPA 8501 Underwriter's Lab (UL) State Of _____ Factory Mutual (FM) Industrial Risk Insurers (IRI)

- C. Noise Sound Levels: Based on ABMA test code for packaged boilers measured 4-1/2 feet vertically above the bottom of the base rail and 3'0" horizontally in front of the end of the blower motor or front surface of control cabinet. Sound levels dBA on the scale in reference to 0.0002 microbars.

High Fire	#2 oil	dBA
Low Fire	#2 oil	dBA
High Fire	Nat Gas	dBA
Low Fire	Nat Gas	dBA

2.4 BOILER DESIGN

- A. Four pass steel scotch marine firetube boiler for positive pressurized firing with forced draft burner. Wet back design with a minimum five (5) square feet of heating surface per boiler horsepower. Front and rear doors shall be davited and sealed with tad-pole gaskets using heavy duty cap screws threaded into replaceable brass nuts. When opened, doors shall expose all tubes, tubesheets and furnace for ease of inspection and maintenance. Lifting loops shall be provided. Rear door shall be refractory lined with air cooled observation port. Tubes shall be rolled, beaded and/or welded into tube sheets and tubes shall be cleanable and removable from either front or back. Tubes shall be a minimum 2.5" O.D., with a tube wall thickness of not less than .095".
- B. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint.

2.5 BURNER DESIGN

- A. GENERAL: Forced draft burner mounted in and integral with boiler hinged front boiler door so when door is opened burner head, furnace, tubesheet and tubes are exposed; reversed curve cast aluminum blower fan; motor(s); ACCU-LINK single point positioning system consisting of rotary air damper located on fan discharge, straight line linkage and characterized cams; air flow switch; fuel trains and control panels. To conform to UL and other insurance requirements as indicated.
- B. GAS BURNER: Shall be of the high radiant multi-port type for natural gas. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Minimum main gas train shall include manual shut-off valve, pressure regulating valve, dual safety gas valves, manual test valve high-low pressure switches, manifold pressure gauge and butterfly gas valve with (14) point characterized cam assembly. Gas train shall be factory packaged to meet insurance requirements as indicated. Gas turn down shall be minimum _____. 4:1 up to 200 HP, 10:1 from 250 HP and above.
- C. OIL BURNER Oil burner shall be of the low pressure air atomizing type for No. 2 oil. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Oil train shall consist of retractable nozzle with flexible hoses; gauges, manifold block; air purge valve; fuel-oil controller with (14) point characterized cam assembly; dual oil solenoids; temperature switch, air compressor assembly and oil pump assembly. (For heavy oil, an oil preheat system shall be provided to include a water to water to oil safety type preheater and thermostatically controlled electric preheater.) Oil train

shall be factory packaged to meet insurance requirements as indicated. Oil turn down shall be minimum 8:1(250 hp-800 hp), 4:1 (up to 200 hp).

- D. COMBINATION BURNER: Provide gas-oil fuel selector switch to provide fuel switch over without any required adjustments to burner linkage.
- E. FUEL-AIR CONTROL: Modulating fire with proven low fire start. Provide manual potentiometer with manual-auto switch on boiler control panel in addition to automatic fuel-air controller. Linkage system shall be Cleaver-Brooks ACCU-LINK single point positioning with rotary air damper, linkage and (14) point characterized cam assembly for all fuels. Provide automatic operating control and manual reset high limit.
- F. FORCED DRAFT BLOWER: All air for combustion shall be supplied by a blower mounted in the front boiler door above the burner. The Backward curved cast aluminum radial impeller shall be directly connected to a flanged type ODP motor. This rigid mounting with the blower wheel inside the head shall eliminate vibration and reduce noise level. The balanced blower wheel shall be cast aluminum with radial blades. The combustion air damper shall be an integral rotating damper and shall be automatically adjusted for proper air quantity by a mod motor to maintain proper fuel-air ratios.
- G. EMISSION CONTROL: Boiler NO_x shall be furnished with guaranteed internal induced NO_x control for 60 PPM (30, 15 & <9 PPM NO_x systems are optional) corrected to 3% O₂ over the entire turndown range. Boiler capacity, turndown, flame stability and efficiency shall not be affected by the internal NO_x control. External FGR piping shall not be allowed. Low NO_x system shall be part of the Boiler/Burner UL package label and manufacture shall have Twelve (12) years of emission control experience in the state of _____.

2.6 BOILER TRIM

- A. To include the following:
 - 1. _____" diameter pressure gauge.
 - 2. ASME safety relief valve(s).
 - 3. Auxiliary Low Water Cutoff, Warrick 3C-2.
 - 4. Primary low water cut-off.
 - 5. Operating control.
 - 6. Limit control with manual reset.
 - 7. _____" stack thermometer.
 - 8. Feedwater regulating valve with 3 valve bypass
 - 9. Low fire hold controller (optional).
 - 10. 1 Slow Opening Blowdown Valve, Size _____", Class 200#
 - 11. 2 Quick Opening Blowdown Valves, Size _____", Class 490#
 - 12. Feedwater Globe Valve, Size _____", Class 240#
 - 13. 1 Feedwater Check Valve, Size _____", Class 240#
 - 14. 1 ASME Spool Piece, Inlet Size _____", Outlet Size _____", Length _____"
 - 15. 1 Stop Valve (Steam Header Valve), Size _____", Flanged, Cast Iron, Class 250"
 - 16. 1 Stop Check Valve (Non-Return Valve), Size _____", Flanged, Cast Iron, Class 250", Straight Pattern, with Free Blow Drain Valve

17. Factory mounted, installed, tested, and certified piping (by A, S, or PP ASME stamp holder) and valves per ASME Code, including:
 - Water Column piping
 - Bottom Blowdown (from boiler to last code valve)
 - Feedwater assembly (shipped loose)
 - Surface Blowdown piping with stop valve and metering valve.
18. Modulating Feedwater Control Valve, including 3-Valve Bypass
19. Oil Pump, Mounted and Wired
20. Air Atomizing Compressor, Mounted and Wired
21. Platforms and ladder to access steam header and safety relief valves. Built to OSHA requirements.
- B. WATER COLUMN/LOW WATER CUTOFF AND WATER LEVEL CONTROL SYSTEM (150-250 psig design): Shall be a CB LEVEL MASTER Water level control system and shall be comprised of a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows: The electronic controller shall be mounted in the common control panel and operate in ambient temperatures from 32 degrees F to 125 degrees F, the pressure chamber shall be boiler mounted and operate to pressures of 250 psig and the level sensor shall operate to pressures of 250 psig and temperatures to 400 degrees F. The pressure containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase- 60 Hz. All wiring shall be in compliance with the National Electrical Code.

The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/menu switch and the following features:

 1. Continuous Level Indication
 2. Low Water Cutoff & Alarm
 3. High Water Alarm
 4. Low & High Water Warning
 5. Full Modulating Control of Modulating Feedwater Control Valve
 6. Continuous Monitoring of Float Operation
 7. Column Blowdown Detection and Reminder
 8. Auto or Manual Reset
 9. Real Time Clock
 10. Alarm Annunciation
 11. Alarm History Files with Time Stamp
 12. Water Column Blowdown Record
 13. Auxiliary Low Water Cutoff Check
 14. RS 232 Interface
 15. Maximum Contacts Rating 15 amps Resistive Load

2.7 BOILER CONTROLS

- A. A common enclosure shall house the control panel and the entrance panel. Enclosure shall be NEMA 4 rated and shall be mounted at the side of the boiler in a location convenient to the operator. Enclosure shall consist of upper and lower sections divided by a partition with a separate hinged door for each section. Upper section (low voltage) will house boiler controls including flame safeguard, water level system controller, and Hawk ICS if so equipped. Lower panel section (high voltage) will house entrance panel.
- B. OPTION 1) BURNER MANAGEMENT SYSTEM (CB 780E Standard): Mounted at side of boiler in control panel enclosure. Microprocessor-based control to monitor all critical boiler and burner interlocks control and supervise burner light off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. Dynamic self checking. System to provide pre-post purge status, fault history, and diagnostic information by means of a two-line alpha-numeric display with alarm/status LEDs.

- C. (OPTION 2) CB-HAWK ICS Boiler Control Sstem (Optional upgrade): Integrated Boiler Control and Management System:

Boiler shall be factory equipped with a Boiler Control System combining a Digital Burner

Management System for flame safety, and a Programmable Logic Controller for boiler modulation and operator interface functions.

The factory pre-configured Boiler Control System shall integrate the Burner Management functions and the PLC based modulation and operator interface functions. The logic of the Burner Management System and the modulating controls will not be run in the same processor or powered by the same DC supply. The PLC and Operator Interface Hardware shall be as manufactured by Allen Bradley.

Major system components shall include:

- Programmable Logic Controller
- Touch Screen HMI
- One Burner Management Controller with Wiring Sub-Base
- One Flame Scanner and amplifier
- Various Temperature and Pressure Sensors

Major functions provided by the Boiler Control System shall be:

- Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout and post-purge
- Full modulating control of fuel and air
- Utilize solid state controls and sensors to provide various control functions, such as:

Modulating control (algorithm shall be Proportional-Integral-Derivative (PID) type)

Thermal shock protection

High and Low limit alarms and shutdowns

- Touch Screen graphical operator interface and monitoring
 - Manual control of the boiler firing rate using control screens on the HMI to increment or decrement the firing rate
 - On screen indication of burner management controller status and diagnostics
 - On screen display of system alarms and faults
 - On screen history of alarms and faults
 - On screen recommendations for troubleshooting of fault conditions
 - On screen water level indication and alarm(s)
- Stack Flue Gas, Combustion Air and Shell (water) temperature indication
- Boiler efficiency calculation
- Low Fire Hold with Minimum Temperature Control
- Assured Low Fire Cut-Off (ALFCO)

The Boiler Control System shall incorporate the following safety provisions:

- Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the Burner Management System shall lockout on safety shutdown.
- Closed-loop logic test of critical loads (ignition, pilot and main fuel valves) and must be able to lockout on safety.
- Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
- Dynamic checking of the flame signal amplifier.
- Safe start check and expand check to include monitoring flame signal during standby.
- High and Low fire switches checked for proper sequencing.

The Boiler Control System shall provide the ability to communicate with external digital via Ethernet as a standard. OPC compliant Internet communications shall be supported, with the Boiler Control System supplied with its own IP address.

2.8 SHOP TEST

- A. Shop test: The complete packaged boiler shall receive factory tests to check construction and function of all controls. All shop tests may be witnessed by the purchaser at his own c upon sufficient notice to the company.

2.9 ACCESSORIES - BOILER FLUE VENT

2.10 ACCESSORIES - FEEDWATER SYSTEM (BOILER FEEDSET OR DEAERATOR)

2.11 ACCESSORIES - FEEDWATER HEATER OR ECONOMIZER

2.12 ACCESSORIES - BLOWDOWN SEPARATOR AND/OR BLOWDOWN HEAT RECOVERY

2.13 ACCESSORIES – O₂ TRIM SYSTEM

2.14 ACCESSORIES - CHEMICAL FEED SYSTEM AND/OR WATER TREATMENT

2.15 MANUFACTURER FIELD SERVICES

- A. General: The boiler and accessories supplier shall be responsible for performance of inspections, start up and testing of the package boiler and accessory equipment and materials furnished under this section. A detailed written record of the start up performance, including burner setting data entire load range shall be furnished to the test engineer before test personnel leave the site. Equipment and test apparatus shall be furnished by the supplier. All equipment defects discovered by the tests shall be rectified. The minimum time for two (2) boilers is five (5) days.
- B. Equipment inspection: Boiler representative to provide _____ hours of job site assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied or damages. Responsibility of making freight claims to be performed by contractor or owner personnel.
- C. Pre start-up walk through: Boiler representative shall spend _____ hours at job site reviewing with mechanical contractor to be conducted approximately 1 week prior to startup.
- D. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the boiler supplier, and shall include:
 - 1. Demonstrate that boiler, burner, controls and accessories comply with requirement Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 - 2. Readings at different firing rates (25, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the test engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x and overall boiler efficiency.
 - 3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non compliance with referenced standards or overloading as applicable.
 - 4. Commissioning Requirements:
 - a). Fireside inspection
 - b). Waterside inspection
 - c). Closing and resealing of doors, manways and hand holes
 - d). Set up fuel train and combustion air system
 - e). Set up operating set points
 - f). Check all safeties, including: Flame safeguard, LWCO, ALWCO, Air flow, Fuel pressures, High limits
 - g). Set up and verify efficiencies at 25%, 50%, 75%, and 100%
 - h). Set up and verify burner turndown.
 - i). Set up and verify feedwater/level controls
 - j). Set up and verify Emissions Compliance
- E. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures.

Training to be provided in a single _____ hour continuous session to accommodate operator's availability on site.

2.16 OPERATING & MAINTENANCE MANUALS

- A. Provide two (2) Operating and Maintenance manuals including cut-away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.
- B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

2.17 WARRANTY DATA

- A. The entire boiler/burner package shall be guaranteed and warranted by the boiler manufacturer. Warranty shall include all parts for a period of (12) months from the date of start-up or beneficial use or 18 months from shipment, whichever comes first.

PART 3 EXECUTION**3.1 GENERAL**

- A. Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced workman previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.2 INSTALLATION

- A. Install equipment in strict compliance with manufacturer's installation instructions.
- B. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
- C. Maintain manufacturer's recommended clearances around sides and over top of equipment.
- D. Install components that were removed from equipment for shipping purposes.
- E. Install components that were furnished loose with equipment for field installation.
- F. Provide all interconnecting electrical control and power wiring.
- G. Provide all fuel gas vent and service piping.
- H. Provide all piping for boiler pipe connections.

3.3 FIELD TESTING

- A. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced.
- B. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

3.4 START-UP, INSTRUCTION AND WARRANTY SERVICE

The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

SAMPLE SPECIFICATIONS - MODEL 4WI HOT WATER BOILERS

PART 1 GENERAL

1.1 SCOPE

The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled steam boiler(s) as described in the specifications herein.

1.2 REFERENCES

- A. ASME Section IV (Heating Boilers)
- B. ANSI Z21.13 (Gas Fired Low Pressure Boilers)
- C. NFPA 54 (ANSI Z221.3)
- D. National Fuel Gas Code
- E. FACTORY MUTUAL
- F. ASME CSD-1 (Controls and Safety Devices)
- G. GE-GAP (GE Global Asset Protection)
- H. UBC (Uniform Building Code)
- I. UMC (Uniform Mechanical Code)
- J. NEC (National Electrical Code)
- K. UL (Underwriters Laboratories)

1.3 QUALITY ASSURANCE

- A. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, appurtenances, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.
- B. The equipment shall be of the type, design, and size that the manufacturer currently offered for sale and appears in the manufacturer's current catalogue. The equipment shall be new and fabricated from new materials and shall be free from defects in materials and workmanship.
- C. The equipment must fit within the allocated space, leaving ample allowance for maintenance and cleaning, and must leave suitable space for easy removal of all equipment appurtenances.
- D. All units of the same classification shall be identical to the extent necessary to insure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.
- E. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified. The boiler manufacturer shall be responsible for guarantying that the boiler provides the performance as specified herein.

1.4 SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval by the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. The engineer shall review and stamp submittals. Work may proceed and equipment released for fabrication after contractor receives returned submittals stamped with “NO EXCEPTIONS TAKEN” or “MAKE CORRECTIONS NOTED”.
- C. The bidder must submit in writing to the engineer any request for a proposed deviation, omission, modification, or substitution to this specification for evaluation no later than ten (10) days prior to the bid date. A request for any substitution shall be accompanied by technical data, drawings, product samples, and complete data substantiating compliance of proposed substitution with these specifications. No materials shall be deemed acceptable if not in strict and full compliance with these specifications. All bidders must bid solely on the specified materials unless acceptance by the engineer of a deviation, omission, modification, or substitution is granted in writing to all bidders prior to the bid date.
- D. Shop Drawings - Shop drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
 - 2. Schematic flow diagram of gas valve trains.
 - 3. Schematic wiring diagram of boiler control system of the ladder-type showing all components, all interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring.
- E. Manufacturer's Warranties: Manufacturer's printed warranties, as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- F. Manufacturer's Field Service: Manufacturer's printed field service procedures and reports, as specified hereinafter, shall be submitted prior to final acceptance by the engineer. Report forms shall contain all information as required to do start-up and testing as specified in the products section.

1.5 CERTIFICATIONS

- A. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in compliance with the specifications, except as clarified in the bid package.
 - 2. The boiler and burner have all been properly coordinated and integrated to provide a complete and operable boiler.
 - 3. ASME certification.
 - 4. UL and CSD-1 (if applicable) certification.
 - 5. The equipment furnished has been installed in accordance with the manufacturer's installation instructions.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.
- B. Contractor's Certification: The contractor shall certify the following:
 - 1. The products and systems installed are in strict compliance with the specifications.

2. The specified field tests have been satisfactorily performed.
- C. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- D. Test Reports: Factory and field test reports as described above and as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- E. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, etc.

1.6 SHIPMENT, STORAGE, AND HANDLING

- A. The contractor shall be responsible for the timely shipment of the equipment to the job site. The contractor shall be responsible for unloading and rigging of the equipment. The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as job site conditions during construction.
- B. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.
- C. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and new factory assembled, low pressure hot water boilers as described in the specifications herein.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Contractor shall furnish and install Cleaver Brooks Model 4WI _____ natural gas (combination Gas/Oil fired) hot water boiler(s) with design pressure as scheduled on the drawings.
- B. Alternate manufacturers complying with plans and specifications must be submitted and approved by the consulting engineer within 10 days prior to bid date.

2.2 GENERAL DESCRIPTION

- A. Factory packaged unit shall include boiler, burner, heavy duty skids, painted steel jacket with two inches of fiberglass insulation, controls and accessories all piped and wired for single point field connections. Units shall carry packaged label of Underwriters Laboratory (UL) and be in accordance with ASME, all codes required by the local governing authorities and as indicated on the design performance data sheet. A certified factory fire-test shall be provided on all fuels with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for _____ PSIG water in accordance with Section IV of ASME Code. Unit shall be designed to Seismic Zone requirements applicable to boiler location. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements.

2.3 PERFORMANCE: BOILER SIZE AND RATINGS

- A. The capacity of each unit shall be indicated on the drawing schedule.
- B. Performance Criteria:

Performance Criteria	
Manufacturer:	CLEAVER-BROOKS
Model:	Promethean Line
Horsepower:	_____ HP
Output:	_____ #/hr (from and at 212°F)
Gas Input:	_____ MBH
Oil Input:	_____ GPH
Design Pressure:	_____ PSIG
Operating Pressure	_____ PSIG
Operating Temperature	_____ degrees F
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Burner Turndown Ratio Natural Gas:	
Overall Efficiency	
Natural Gas (%):	_____ % at High Fire
No. 2 Oil (%):	_____ % at High Fire
NOX Emission (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
CO Emissions (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
Electrical:	_____ V / _____ H / _____ P
Fan Motor:	_____ HP
Air Compressor Motor:	_____ HP
Oil Pump Motor:	_____ HP
Noise Level (3' from burner):	_____ dBA
Available Gas Supply Pressure:	_____ PSIG
Weight	
Dry:	_____
Flooded:	_____
Seismic Zone:	_____
Altitude:	_____ ASL
Code Requirements:	ASME / NATIONAL BOARD CSD-1 NFPA 85 (optional) Underwriter's Lab (UL) State Of _____ Factory Mutual (FM) (optional) GE-GAP (optional)

- C. Noise Sound Levels: Based on ABMA test code for packaged boilers measured 4-1/2 feet vertically above the bottom of the base rail and 3'0" horizontally in front of the end of the blower motor or front surface of control cabinet. Sound levels dBA on the scale in reference to 0.0002 microbars.

High Fire	#2 oil	dBA
Low Fire	#2 oil	dBA
High Fire	Nat Gas	dBA
Low Fire	Nat Gas	dBA

2.4 EFFICIENCY GUARANTEE

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve _____ fuel-to-steam efficiency at 100% firing rate when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, ten thousand dollars (\$10,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

Natural Gas

Carbon, % (wt) = 69.98
 Hydrogen, % (wt) = 22.31
 Sulfur, % (wt) = 0.0
 Heating value, Btu/lb. = 21,830

No. 2 Oil

Carbon, % (wt) = 85.8
 Hydrogen, % (wt) = 12.7
 Sulfur, % (wt) = 0.2
 Heating value, Btu/lb. = 19,420

No. 6 Oil

Carbon, % (wt) = 86.6
 Hydrogen, % (wt) = 10.9
 Sulfur, % (wt) = 2.09
 Heating value, Btu/lb. = 18,830

Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.

Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).

Any efficiency verification testing will be based on the stack loss method.

Warranty

All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

Shop Tests

The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

Start-up Service

After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.

A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

2.5 GENERAL BOILER DESIGN

- A. The boiler shall be a four pass horizontal firetube updraft boiler with five (5) square feet (except 750 or 800 hp) of heating surface per rated boiler horsepower. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls.
- B. The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label, except in the case where 50 Hz has been selected.
- C. The boiler shall be completely pre assembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
- D. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, ASME CSD-1).

2.6 BOILER SHELL (HOT WATER)

- A. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
- B. The hot water return and outlet connections shall be located on the top center line of the boiler. The boiler shall be designated to rapidly mix the return water with the boiler water. Forced internal circulation shall be used.
- C. A dip tube shall be included as an integral part of the water outlet.
- D. Two lifting eyes shall be located on top of the boiler.
- E. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
- F. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
- G. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
- H. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The shell must be furnished with adequate handholes to facilitate boiler inspection and cleaning.
- I. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 1000 lbs and shall contain a stack thermometer.

2.7 EMISSION CONTROLS

- A. Boiler shall be equipped with a low emission (LE) option for guaranteed NOx performance at _____ ppm, dry volume basis and corrected to 3% O₂ when firing natural gas.
- B. The low emission option shall include an integral front head, burner, and boiler package, providing NOx reduction through an internal flue gas recirculation system using the combustion air fan, internal recirculation valve, and enhanced boiler design to achieve the guaranteed NOx levels. The emission control system shall not use an external fan, control valve, and piping. Boiler fuel-to-steam efficiency and rated boiler capacity shall be guaranteed while the boiler is operating at the low NOx performance levels.
- C. Burner, boiler, and low NOx system shall be manufactured as a package by a single manufacturer. The Low Emission Option to the CB Boiler shall include factory testing as a package, and shall bear the UL packaged label. The boiler nameplate shall include the approved UL low NOx boiler model designation. No field assembly of the burner or low NOx equipment shall be required.

2.8 HOT WATER BOILER TRIM

- A. Low Water Cutoff
A low water cutoff control (manual reset) shall be mounted on the top centerline of the boiler wired into the burner control circuit to prevent burner operation if boiler water falls below a safe level.
- B. Pressure and Temperature Gauges
Pressure and temperature gauges shall be mounted on the boiler with temperature sensing element located adjacent to the hot water outlet.
- C. Relief Valves
Water relief valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- D. Temperature Controls
Temperature controls to regulate burner operation shall be mounted on the unit with temperature sensing elements located adjacent to the hot water outlet. Controls shall be high limit (manual reset), operating limit (auto reset), and firing rate control (30-100 hp).

2.9 BURNER AND CONTROLS

- A. Mode of Operation
- B. Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.

2.10 BLOWER

- A. Air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
- B. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
- C. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

2.11 COMBUSTION AIR CONTROL

Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor (remove this sentence when CB-HAWK flame safeguard is used).

2.12 FUEL SPECIFICATION AND PIPING

Select one of the following fuel types:

1. Fuel series 700 - Gas fired (4.4.1).
2. Fuel series 100 - Light oil (No. 2) fired (4.4.2).
3. Fuel series 200 - Light oil or gas fired (4.4.3).
4. Fuel Series 700 - Gas Fired

2.13 BURNER TYPE

The burner shall be integral with the front head of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel and equipped with an LE option.

2.14 GAS PILOT

The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

2.15 GAS BURNER PIPING

- A. Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock on butterfly valve shall be furnished at entrance to gas train. Select one of the following:
- B. 125-300 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
- C. 350-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.

2.16 BURNER TURNDOWN

Select one of the following:

1. 125-200 hp. Turndown range of burner shall be 4:1 when firing natural gas.
2. 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas with a 60 or 30 ppm LE option. (Consult with Cleaver-Brooks Representative regarding high turndown capability based on available gas pressure and 15 and 9 ppm LE options.)

2.17 FUEL SERIES 100

Light Oil Fired

2.18 BURNER TYPE

The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil and equipped with an LE option.

2.19 GAS PILOT

The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

2.20 OIL PUMP

An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.

2.21 OIL BURNER PIPING

Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.

2.22 LOW PRESSURE AIR ATOMIZING

Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

2.23 BURNER TURNDOWN Fuel Series 200 Light Oil or Gas Fired

125 hp through 200 hp. Turndown range shall be 4:1 when firing No. 2 oil. When Firing natural gas refer to section 2.23

2.24 BURNER TYPE

The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas. The burner shall be equipped with an LE option.

2.25 GAS PILOT

The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

2.26 OIL BURNER

Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.

2.27 OIL BURNER PIPING

Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.

2.28 LOW PRESSURE AIR ATOMIZING

Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

2.29 GAS BURNER PIPING

Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:

2.30 BURNER

- A. Boiler Flame Safeguard Controller and Control Panel
- B. CB780E Flame Safeguard
- C. Boilers with CB780E Control - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780.
- D. Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.
- E. Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).
- F. The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre- purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

2.31 CONTROL PANEL

- A. The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet shall have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.
- B. The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers the panel shall contain the fuel selector switch.

- C. The panel shall contain the following lights and switches:
 - 1. Lights
 - 2. White - load demanded.
 - 3. White - fuel valve open.
 - 4. Red - low water.
 - 5. Red - flame failure.
 - 6. Control Switches
 - 7. Burner On-Off.
 - 8. Manual-Automatic.
 - 9. Manual Firing Rate Control.
- D. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
- E. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
- F. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.32 BOILER CONTROLS

- A. **BOILER MANAGEMENT CONTROL SYSTEM CONTROL PANEL:** Boiler mounted NEMA 1 enclosure(s) with key lock; fusing, magnetic starters; step-down control transformer; flame safeguard and burner management system as indicated; annunciator lights for load demand, fuel on, low water and flame failure; selector switches, required by dry contacts, relays and terminal strips. Oil, heat and moisture resistant wire with circuit number corresponding to electrical wiring diagrams. In accordance with UL and National Electric Code.
- B. **(OPTION 1) BURNER MANAGEMENT SYSTEM (CB 780E Standard):** Boiler mounted in control panel enclosure. Microprocessor-based control to monitor all critical boiler and burner interlocks control and supervise burner light off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. Dynamic self checking. System to provide pre-post purge status, fault history, and diagnostic information by means of a two-line alpha-numeric display with alarm/status LEDs.
- C. **(OPTION 2) CB-HAWK ICS Boiler Control System (Optional upgrade):** Integrated Boiler Control And Management System
Boiler shall be factory equipped with a Boiler Control System combining a Digital Burner Management System for flame safety, and a Programmable Logic Controller for boiler modulation and operator interface functions.

The factory pre-configured Boiler Control System shall integrate the Burner Management functions and the PLC based modulation and operator interface functions. The logic of the Burner Management System and the modulating controls will not be run in the same processor or powered by the same DC supply. The PLC and Operator Interface Hardware shall be as manufactured by Allen Bradley.

Major system components shall include:
 - a. Programmable Logic Controller
 - b. Touch Screen HMI

- c. One Burner Management Controller with Wiring Sub-Base
- d. One Flame Scanner and amplifier
- e. Various Temperature and Pressure Sensors

Major functions provided by the Boiler Control System shall be:

Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout and post-purge

1. Full modulating control of fuel and air
2. Utilize solid state controls and sensors to provide various control functions, such as:
 - a. Modulating control (algorithm shall be Proportional-Integral-Derivative (PID) type)
 - b. Thermal shock protection
 - c. High and Low limit alarms and shutdowns
3. Touch Screen graphical operator interface and monitoring
 - a. Manual control of the boiler firing rate using control screens on the HMI to increment or decrement the firing rate
 - b. On screen indication of burner management controller status and diagnostics
 - c. On screen display of system alarms and faults
 - d. On screen history of alarms and faults
 - e. On screen recommendations for troubleshooting of fault conditions
 - f. On screen water level indication and alarm(s)
 - g. Stack Flue Gas, Combustion Air and Shell (water) temperature indication
4. Boiler efficiency calculation
5. Low Fire Hold with Minimum Temperature Control
6. Assured Low Fire Cut-Off (ALFCO)
7. The Boiler Control System shall incorporate the following safety provisions:
 - a. Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the Burner Management System shall lockout on safety shutdown.
 - b. Closed-loop logic test of critical loads (ignition, pilot and main fuel valves) and must be able to lockout on safety.
 - c. Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
 - d. Dynamic checking of the flame signal amplifier.
 - e. Safe start check and expand check to include monitoring flame signal during standby.
 - f. High and Low fire switches checked for proper sequencing.

The Boiler Control System shall provide the ability to communicate with external digital devices via Ethernet as a standard. It shall be possible to communicate with any OPC compliant device. Internet communications shall be supported, with the Boiler Control System supplied with its own IP address.

2.33 ACCESSORIES - BOILER FLUE VENT**2.34 MANUFACTURER FIELD SERVICES**

- A. General: The boiler and accessories supplier shall be responsible for performance of inspections, start up and testing of the package boiler and accessory equipment and materials furnished under this Section. A detailed written record of the start up performance, including burner setting data over the entire load range shall be furnished to the test engineer before test personnel leave the site. All labor, equipment and test apparatus shall be furnished by the supplier. All equipment defects discovered by the tests shall be rectified. The minimum time for two (2) boilers is five (5) days.
- B. Equipment inspection: Boiler representative to provide _____ hours of jobsite assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. Responsibility of making freight claims to be performed by contractor or owner personnel.
- C. Pre start-up walk through: Boiler representative shall spend _____ hours at jobsite reviewing installation with mechanical contractor to be conducted approximately 1 week prior to startup.
- D. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the boiler supplier, and shall include:
 - 1. Demonstrate that boiler, burner, controls and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 - 2. Readings at different firing rates (25, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the test engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x, and overall boiler efficiency.
 - 3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, non compliance with referenced standards or overloading as applicable.
 - 4. Commissioning Requirements:
 - a. Fireside inspection
 - b. Waterside inspection
 - c. Closing and resealing of doors, manways and hand holes
 - d. Set up fuel train and combustion air system
 - e. Set up operating set points
 - f. Check all safeties, including: Flame safeguard, LWCO, ALWCO, Air flow, Fuel pressures, High limits
 - g. Set up and verify efficiencies at 25%, 50%, 75%, and 100%
 - h. Set up and verify burner turndown.
 - i. Set up and verify feedwater/level controls
- E. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single _____ hour continuous session to accommodate operator's availability on site.

2.35 OPERATING & MAINTENANCE MANUALS

- A. Provide two (2) Operating and Maintenance manuals including cut-away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.
- B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

2.36 WARRANTY DATA

The entire boiler/burner package shall be guaranteed and warranted by the boiler manufacturer. Warranty shall include all parts for a period of (12) months from the date of start-up or beneficial use or 18 months from shipment, whichever comes first.

PART 3 EXECUTION**3.1 GENERAL**

Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced workman previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.2 INSTALLATION

- A. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
- B. Install components that were removed from equipment for shipping purposes.
- C. Install components that were furnished loose with equipment for field installation.
- D. Provide all interconnecting electrical control and power wiring.
- E. Provide all fuel gas vent and service piping.
- F. Provide all piping for boiler pipe connections.

3.3 FIELD TESTING

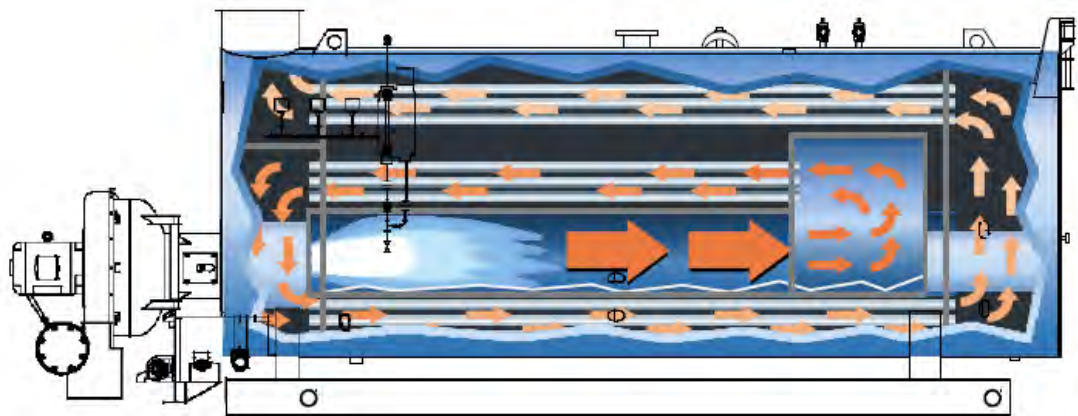
- A. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced.
- B. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

3.4 START-UP, INSTRUCTION AND WARRANTY SERVICE

The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

MODEL 4WG

100 - 800 HP
Steam and Hot Water
Wet-back Packaged Burner



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FEATURES AND BENEFITS

The Cleaver-Brooks Model 4WG Boiler provides an integrated boiler burner package with optimized pressure vessel and furnace working in conjunction with a matching Profire gun burner. Additionally, the boiler/burner package is fully UL and cUL approved and available from 100 - 800 hp. The following features apply:

Four-Pass Wetback Design:

- Four-pass design provides high flue gas velocities and low stack temperatures to maximize efficiency.
- Five square feet of heating surface per boiler horsepower (except for the 750 and 800 hp unless otherwise specified) provides guaranteed efficiency performance and long boiler life.

Hinged Burner, Front and Rear Doors:

- Hinged burner assembly provides ease of access to the furnace.
- Large rear access plug for turnaround and furnace access.
- Rear door completely covers and insulates rear tube sheet.

Natural Gas, No. 2 Oil, or Combination Burners Available:

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.

PRODUCT OFFERING

Cleaver-Brooks Model 4WG Boilers are available in low pressure steam, high pressure steam, and hot water designs. Burners are available to fire natural gas, No. 2 oil, or a combination of oil and gas.

Standard product offering is:

- 100 - 800 hp.
- 30 and 125 psig hot water.
- 15 - 250 psig steam.
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks authorized representative for option details).

Boiler Options:

- Low NOx emission levels from 75, 30, 15 - <9PPM when burning natural gas and 70 PPM on # 2 oil when the fuel bound nitrogen is at 0.02% or less.
- Drain valves.
- Additional screwed or flanged trappings.
- Blowdown valves.
- Non-return valves.
- Feedwater valves and regulators.
- Surface blowdown systems.

- Blend pump.
- Surge load baffles.
- Seismic design.

Burner/Control Options:

- Flame safeguard controllers.
- Lead/lag system.
- High altitude design.
- Special insurance and code requirements (e.g., IRI, FM, CSD-1).
- Alarm bell/silence switch.
- Special motor requirements (TEFC, high efficiency).
- Special indicating lights.
- Main disconnect.
- Elapsed time meter.
- Voltmeter/micro-ammeter.
- NEMA enclosures.
- Low-fire hold control.
- Remote emergency shut-off (115V).
- Circuit breakers.
- Day/night controls.
- Special power requirements.
- Stack thermometer.

Fuel Options:

- Air atomizing oil burner, 125 - 200 hp.
- Gas strainer.
- Gas pressure gauge.
- Future gas conversion.
- Oversized/undersized gas trains.

DIMENSIONS AND RATINGS

Dimensions and ratings for the Model 4WG Boilers are shown in the following tables and illustrations. The information is subject to change without notice.

- Table A3-1 Model 4WG Steam Boiler Ratings
- Table A3-3 Model 4WG Hot Water Boiler Ratings
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Table A3-1. 4WG Ratings - Steam

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	FP-3	FP-3	FP-3	FP-4	FP-4	FP-4	D145P	D175P	D210P	D252P	D300P	D378P
RATINGS - SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr from and at 212 °F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102	116.6	145.8	174.9	204.1	233.3
Gas CFH (1000 Btu)	4082	5102	6123	8164	10205	12246	14287	16328	20410	24492	28574	32656
Gas (Therm/hr)	40.8	51	61.2	81.6	102	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	2	3	5	5	5	7-1/2	15	20	25	30	40	75
Circulating Oil Pump Motor hp (Oil only)	*	*	*	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Oil Metering Pump Motor hp (Oil only)	-	-	-	--		-	-	1/2	3/4	3/4	3/4	1
Integral Oil/Air Motor hp (Oil only)	-	-	-	--		-	2	-	-	-	-	-
Air Compressor Motor hp (Oil only)	**	**	**	3	3	3	-	5	5	7-1/2	7-1/2	15
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	See Note "B"

* Integral oil pump

** No air compressor required (pressure atomized)

NOTES:

A. All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral hp motors will be 3-phase voltage.

B. 800 hp boilers are available w/ 3500 or 4000 sq. ft. of heating surface

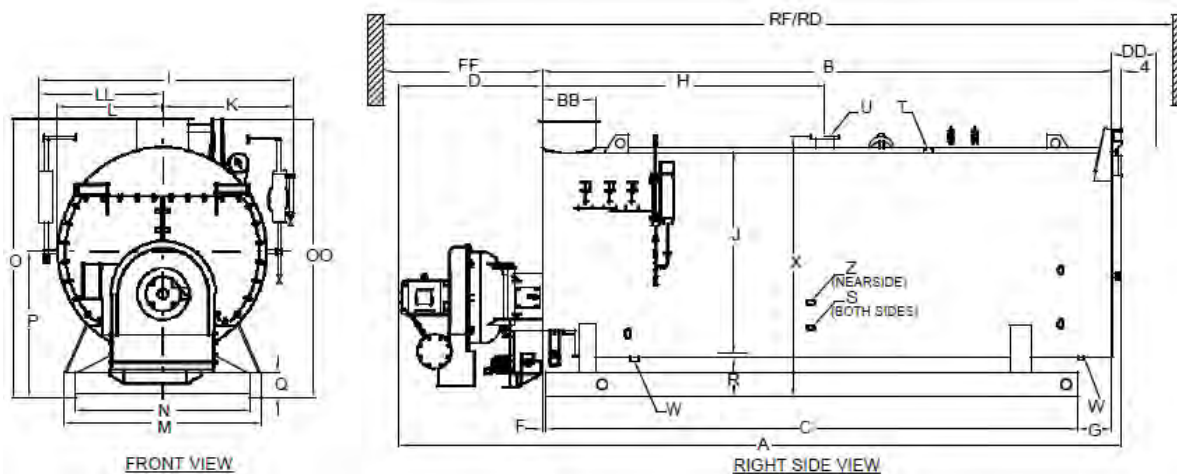


Figure A3-1. 4WG - Steam 100-800 HP

Table A3-2. 4WG Dimensions - Steam

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800	*800
LENGTHS														
														See Note "C"
Overall Length	A	174	198	186	227.5	220.3	244.3	245.3	263.3	276.8	311.8	296.5	304	331
Shell	B	131	155	143	177	172.5	196.5	189.8	207.8	213.8	248.8	232.8	232.8	259.8
Base Frame	C	110	124	122	156	150.12	174.13	167.25	185.25	188.25	223.75	207.25	207.25	234.75
Burner Extension	D	39	39	39	46.5	43.75	43.75	51.5	51.5	59	59	59.75	67.25	67.25
Smokebox to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rear Ring Flange to Base	G	20.5	20.5	20.5	20.5	22	22	22	22	25	25	25	25	25
Smokebox to Steam Nozzle	H	50.88	74.88	63.88	97.88	86.25	110.3	95.63	113.6	106	141	115.6	115.6	142.6
WIDTHS														
Overall Width	I	85	85	92	92	103	103	110	110	123	123	133	133	133
I.D. Boiler	J	60	60	67	67	78	78	85	85	96	96	106	106	106
Center to Water Column	K	45	45	48.5	48.5	54	54	57.5	57.5	64	64	69	69	69
Center to Lagging	L	33	33	36.75	36.75	42	42	45.5	45.5	51	51	56	56	56
Center to Auxiliary LWCO	LL	40	40	43.5	43.5	49	49	52.5	52.5	59	59	64	64	64
Base Outside	M	52.5	52.5	51	51	64	64	60	60	71.88	71.88	74.75	74.75	74.75
Base Inside	N	44.5	44.5	43	43	56	56	47	47	58.88	58.88	61.75	61.75	61.75
HEIGHTS														
Base to Rear Davit	OO	86.12	86.12	92.75	92.75	98.88	98.88	112.8	112.8	125.1	125.1	134.3	134.3	134.3
Base to Vent Outlet	O	85	85	92.63	92.63	106	106	115	115	126	126	135.6	135.6	135.6
Base to Boiler Centerline	P	46	46	50	50	56	56	61	61	67	67	71	71	71
Height of Base Frame	Q	12	12	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Boiler	R	15.63	15.63	16.13	16.13	16.5	16.5	18	18	18.5	18.5	17.5	17.5	17.5
Base to Steam Outlet	X	82.38	82.38	89.88	89.88	101.5	101.5	110	110	121.5	121.5	130.5	130.5	130.5
BOILER CONNECTIONS														
Feedwater Inlet (Both Sides)	S	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Surface Blowoff (150 lb only)	T	1	1	1	1	1	1	1	1	1	1	1	1	1
Steam Nozzle 15 lb (See Note "A")	U	8	8	8	10	10	12	12	12	12	12	12	12	12
Steam Nozzle 150 lb (See Note "B")	U	4	4	4	4	6	6	6	6	8	8	8	8	8
Blowdown-Front & Rear (15 lb)	W	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	2
Blowdown-Front & Rear (15 lb)	W	1.25	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2
Chemical Feed	Z	1	1	1	1	1	1	1	1	1	1	1	1	1
VENT STACK														
Vent Stack Diameter (Flanged)	BB	16	16	16	16	20	20	24	24	24	24	24	24	24
MINIMUM CLEARANCES														
Rear Door Swing	DD	36	36	40	40	46	46	50	50	55	55	60	60	60
Tube Removal - Front Only	FF	96	120	108	142	132.5	156.5	148	166	169	204	188	188	215
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:														
Thru Window or Door	RD	234	258	261	295	307.5	331.5	337	355	377	412	411	411	438
Front of Boiler	RF	263	311	291	359	351	399	388	424	438	508	481	481	535
WEIGHTS IN LBS														
Normal Water Weight	-	5870	7310	7625	9995	12590	14850	16025	17950	21050	25350	28700	28700	32770
Approx. Shipping Weight – (15 psig)	-	10860	12080	13090	15260	19110	21050	24760	27640	33295	38150	42320	42320	46300
Approx. Shipping Weight – (150 psig)	-	11320	12920	13980	16620	21620	23970	26850	29650	36190	39560	46290	46290	50830

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": ANSI 300 psig Flange

NOTE "C": *800 hp w/ 4000 sq. ft. of heating surface

Table A3-3. 4WG Ratings - Hot Water

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	FP-3	FP-3	FP-3	FP-4	FP-4	FP-4	D145P	D175P	D210P	D252P	D300P	D378P
RATINGS - SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.0	116.6	145.8	174.9	204.1	233.3
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Gas (Therm/hr)	40.8	51.0	61.2	81.6	102.0	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	2	3	5	5	5	7-1/2	15	20	25	30	40	75
Circulating Oil Pump Motor hp (Oil only)	*	*	*	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Oil Metering Pump Motor hp (Oil only)	-	-	---			-	-	1/2	3/4	3/4	3/4	1
Integral Oil/Air Motor hp (Oil only)	-	-	-	-	-	-	2	-	-	-	-	-
Air Compressor Motor hp (Oil only)	**	**	**	3	3	3	-	5	5	7-1/2	7-1/2	15
BOILER DATA												
Heating Surface sq-ft. (Fireside)	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	See Note "B"

* Integral oil pump

** No air compressor required (pressure atomized)

NOTES:

A. All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral hp motors will be 3-phase voltage.

B. 800 hp boilers are available w/ 3500 or 4000 sq. ft. of heating surface

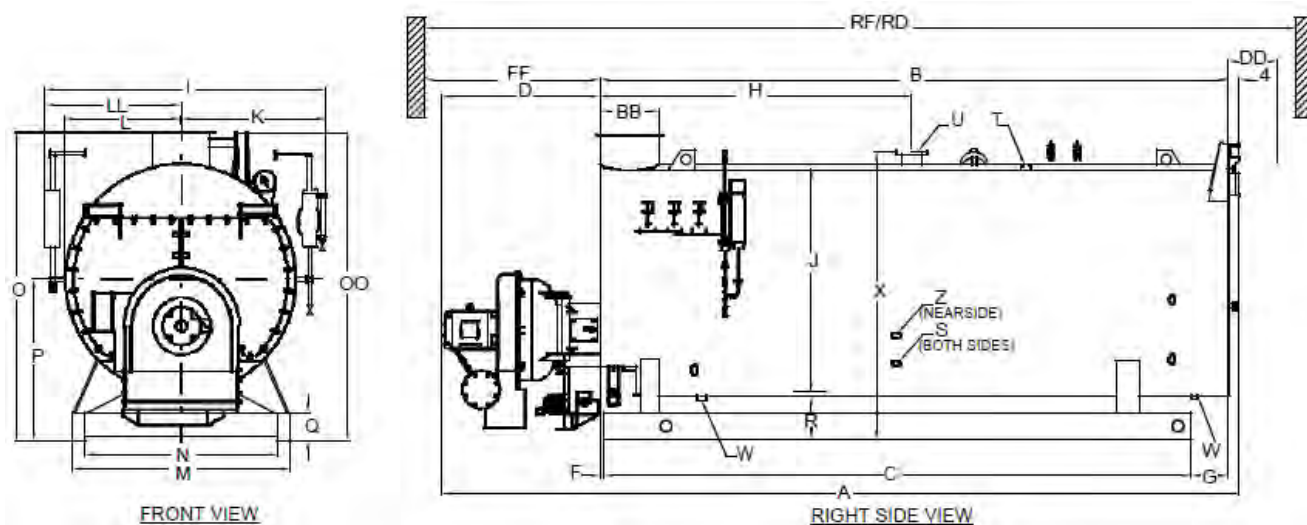


Figure A3-2. 4WG - Hot Water 100-800 HP

Table A3-4. 4WG Dimensions - Hot Water

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800	*800
LENGTHS														See Note "C"
Overall Length	A	174	198	186	227.5	220.25	244.25	245.25	263.25	276.75	311.75	296.5	304	331
Shell	B	131	155	143	177	172.5	196.5	189.75	207.75	213.75	248.75	232.75	232.75	259.75
Base Frame	C	110	124	122	156	150.125	174.125	167.25	185.25	188.25	223.25	207.25	207.25	234.25
Burner Extension	D	39	39	39	46.5	43.75	43.75	51.5	51.5	59	59	59.75	67.25	67.25
Smokebox to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rear Ring Flange to Base	G	20.5	20.5	20.5	20.5	22	22	22	22	25	25	25	25	25
Smokebox to Return	H	78	99	87	121	113.5	137.5	130.75	148.75	143	151.75	146.25	146.75	173.75
Smokebox to Outlet	HH	103	124	112	146	139.5	163.5	156.75	174.75	179	187.75	182.25	182.75	209.75
WIDTHS														
Overall Width	I	70	70	77.5	77.5	88	88	95	95	106	106	116	116	116
I.D. Boiler	J	60	60	67	67	78	78	85	85.96		96	106	106	106
Center to LWCO Controller	K	37	37	40.75	40.75	46	46	49.5	49.5	55	55	60	60	60
Center to Lagging	L	33	33	36.75	36.75	42	42	45.5	45.5	51	51	56	56	56
Base Outside	M	52.5	52.5	51	51	64	64	60	60	71.88	71.88	74.75	74.75	74.75
Base Inside	N	44.5	44.5	43	43	56	56	47	47	58.88	58.88	61.75	61.75	61.75
HEIGHTS														
Base to Rear Davit	OO	86.12	86.12	92.75	92.75	98.88	98.88	112.75	112.75	125.12	125.12	134.25	134.25	134.25
Base to Vent Outlet	O	85	85	92.63	92.63	106	106	115	115	126	126	135.63	135.63	135.63
Base to Boiler Centerline	P	46	46	50	50	56	56	61	61.67		67	71	71	71
Height of Base Frame	Q	12	12	12	12	12	12	12	12.12		12	12	12	12
Base to Bottom of Boiler	R	15.63	15.63	16.13	16.13	16.5	16.5	18	18	18.5	18.5	17.5	17.5	17.5
Base to Return & Outlet	X	82.38	82.38	89.88	89.88	101.5	101.5	110	110	121.5	121.5	130.5	130.5	130.5
BOILER CONNECTIONS														
Waterfill Connection (Both Sides)	S	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Water Return (See Note "A")	T	4	6	6	6	8	8	8	10	10	12	12	12	12
Water Outlet (See Notes "A & B")	U	4	6	6	6	8	8	8	10	10	12	12	12	12
Drain-Front & Rear	W	1.5	1.5	1.5	2	2	2	2	2.2	2.2		2	2	2
Air Vent	Y	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2.2		2	2	2
VENT STACK														
Vent Stack Diameter (Flanged)	BB	16	16	16	16	20	20	24	24.24		24	24	24	24
MINIMUM CLEARANCES														
Rear Door Swing	DD	36	36	40	40	46	46	50	50.55		55	60	60	60
Tube Removal - Front Only	FF	96	120	108	142	132.5	156.5	148	166	169	204	188	188	215
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:														
Thru Window or Door	RD	234	258	261	295	307.5	331.5	337	355	377	412	411	411	438
Front of Boiler	RF	263	311	291	359	351	399	388	424	438	508	481	481	535
WEIGHTS IN LBS														
Normal Water Weight	-	6,890	8,580	8,870	11,600	14,760	17,380	19,220	21,520	26,260	31,580	35,900	35,900	40,930
Approx. Shipping Weight - (30 psig)	-	10,860	12,080	13,090	15,260	19,110	21,050	24,760	27,640	33,295	38,150	42,320	42,320	46,300
Approx. Shipping Weight - (125 psig)	-	11,600	12,980	14,040	16,680	20,670	23,140	26,930	30,060	35,390	40,550	45,430	45,430	49,750

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": Water Outlet includes 2" Dip Tube

NOTE "C": *800 hp w/ 4000 sq. ft. of heating surface

Table A3-5. 4WG Low NOx Ratings - Steam

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	LND54S	LND63P	LND84P	LND105P	LND145S	LND145P	LND175P	LND210P	LND252P	LND300P	LND378P	LND420P
RATINGS - SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr from and at 212 °F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102	116.6	145.8	174.9	204.1	233.3
Gas CFH (1000 Btu)	4082	5102	6123	8164	10205	12246	14287	16328	20410	24492	28574	32656
Gas (Therm/hr)	40.8	51	61.2	81.6	102	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	3	5	7-1/2	10	15	15 20		25	30 40		75	75
Circulating Oil Pump Motor hp (Oil only)	1/2	1/2	1/2	1/2	1/2	3/4 3/4		3/4	3/4 3/4		1	1
Oil Metering Pump Motor hp (Oil only)	-	--		-	-	-	1/2	1/2	3/4	3/4	1	1
Integral Oil/Air Motor hp (Oil only)	1	1	1	1	2	2	-	-	--		-	-
Air Compressor Motor hp (Oil only)	-	--		-	-	-	5	5	5	7-1/2	15	15
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	See Note "B"

NOTES:

A. All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral hp motors will be 3-phase voltage.

B. 800 hp boilers are available w/ 3500 or 4000 sq. ft. of heating surface

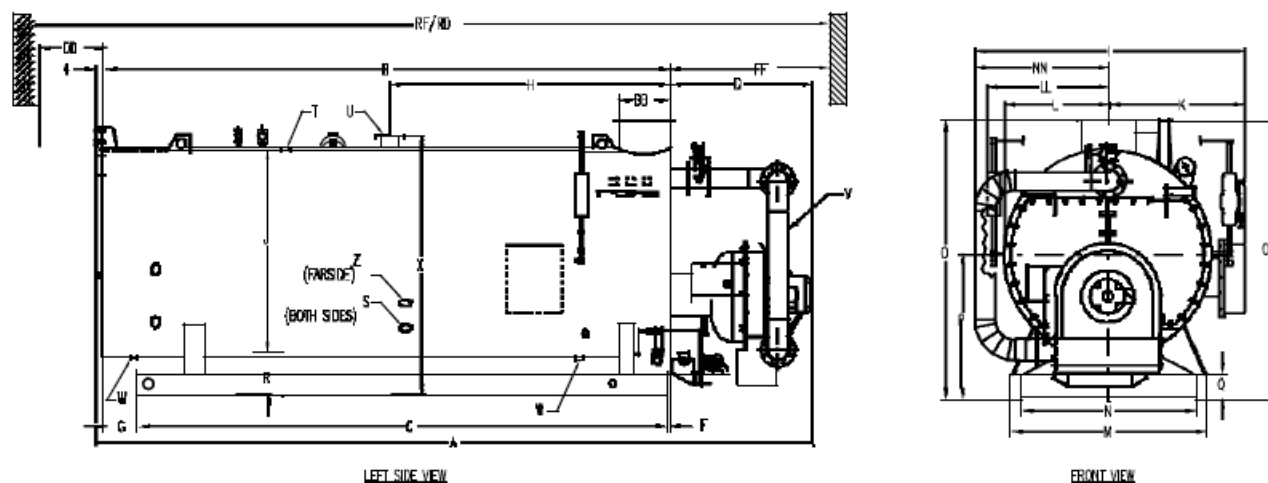


Figure A3-3. 4WG Low NOx - Steam 100-800 HP

Table A3-6. 4WG Low NOx Dimensions - Steam

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700/800	*800
LENGTHS													See Note "C"
Overall Length	A	176	200	189.6	223.6	229.6	253.6	250	270.6	276.6	311.6	304	331
Shell	B	131	155	143	177	172.5	196.5	189.8	207.8	213.8	248.8	232.8	259.8
Base Frame	C	110	124	122	156	150.13	174.13	167.25	185.25	188.25	223.25	207.25	234.25
Burner Extension	D	41	41	42.62	42.62	53.12	53.12	56.25	58.88	58.88	58.88	67.25	67.25
Smokebox to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rear Ring Flange to Base	G	20.5	20.5	20.5	20.5	22	22	22	22	25	25	25	25
Smokebox to Steam Nozzle	H	50.88	74.88	63.88	97.88	86.25	110.3	95.63	113.6	106	141	115.6	142.6
WIDTHS													
Overall Width	I	90.5	85	92	92	103	103	110	110	125	126	133	133
I.D. Boiler	J	60	60	67	67	78	78	85	85	96	96	106	106
Center to Water Column	K	45	45	48.5	48.5	54	54	57.5	57.5	64	64	69	69
Center to Lagging	L	33	33	36.75	36.75	42	42	45.5	45.5	51	51	56	56
Center to Auxiliary LWCO	LL	40	40	43.5	43.5	49	49	52.5	52.5	59	59	64	64
Base Outside	M	52.5	52.5	51	51	64	64	60	60	71.88	71.88	74.75	74.75
Base Inside	N	44.5	44.5	43	43	56	56	47	47	58.88	58.88	61.75	61.75
Center to Outside of FGR Duct	NN	45.5	39.5	39.5	39.5	43.5	43.5	49.75	49.75	61	62	62.5	62.5
FGR Duct Size	V	6	6	6	6	6	8	8	8	8	10	10	10
HEIGHTS													
Base to Rear Davit	OO	86.12	86.12	92.75	92.75	98.88	98.88	112.8	112.8	125.1	125.1	134.3	134.3
Base to Vent Outlet	O	85	85	92.63	92.63	106	106	115	115	126	126	135.6	135.6
Base to Boiler Centerline	P	46	46	50	50	56	56	61	61	67	67	71	71
Height of Base Frame	Q	12	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Boiler	R	15.63	15.63	16.13	16.13	16.5	16.5	18	18	18.5	18.5	17.5	17.5
Base to Steam Outlet	X	82.38	82.38	89.88	89.88	101.5	101.5	110	110	121.5	121.5	130.5	130.5
BOILER CONNECTIONS													
Feedwater Inlet (Both Sides)	S	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Surface Blowoff (150 lb only)	T	1	1	1	1	1	1	1	1	1	1	1	1
Steam Nozzle 15 lb (See Note "A")	U	8	8	8	10	10	12	12	12	12	12	12	12
Steam Nozzle 150 lb (See Note "B")	U	4	4	4	4	6	6	6	6	8	8	8	8
Blowdown-Front & Rear (15 lb)	W	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2
Blowdown-Front & Rear (150 lb)	W	1.25	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
Chemical Feed	Z	1	1	1	1	1	1	1	1	1	1	1	1
VENT STACK													
Vent Stack Diameter (Flanged)	BB	16	16	16	16	20	20	24	24	24	24	24	24
MINIMUM CLEARANCES													
Rear Door Swing	DD	36	36	40	40	46	46	50	50	55	55	60	60
Tube Removal - Front Only	FF	96	120	108	142	132.5	156.5	148	166	169	204	188	215
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Thru Window or Door	RD	234	258	261	295	307.5	331.5	337	355	377	412	411	438
Front of Boiler	RF	263	311	291	359	351	399	388	424	438	508	481	535
WEIGHTS IN LBS													
Normal Water Weight	-	5,870	7,310	7,625	9,995	12,590	14,850	16,025	17,950	21,050	25,350	28,700	32,770
Approx. Shipping Weight - (15 psig)	-	10,860	12,080	13,090	15,260	19,110	21,050	24,760	27,640	33,295	38,150	42,320	46,300
Approx. Shipping Weight - (150 psig)	-	11,320	12,920	13,980	16,620	21,620	23,970	26,850	29,650	36,190	39,560	46,290	50,830

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": ANSI 300 psig Flange

NOTE "C": *800 hp w/ 4000 sq. ft. of heating surface

Table A3-7. 4WG Low NOx Ratings - Hot Water

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	LND54S	LND63P	LND84P	LND105P	LND145S	LND145P	LND175P	LND210P	LND252P	LND300P	LND378P	LND420P
RATINGS - SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr)	3347	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.0	116.6	145.8	174.9	204.1	233.3
Gas CFH (1000 Btu)	4082	5102	6123	8164	10205	12246	14287	16328	20410	24492	28574	32656
Gas (Therm/hr)	40.8	51.0	61.2	81.6	102.0	122.5	142.9	163.3	204.1	244.9	285.7	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	3	5	7-1/2	10	15	15	20	25	30	40	75	75
Circulating Oil Pump Motor hp (Oil only)	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Oil Metering Pump Motor hp (Oil only)	-	--		-	-	-	1/2	1/2	3/4	3/4	1	1
Integral Oil/Air Motor hp (Oil only)	1	1	1	1	2	2	-	-	-	-	-	-
Air Compressor Motor hp (Oil only)	-	--		-	-	-		5	5	7-1/2	15	15
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	See Note "B"

NOTES:

A. All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral hp motors will be 3-phase voltage.

B. 800 hp boilers are available w/ 3500 or 4000 sq. ft. of heating surface

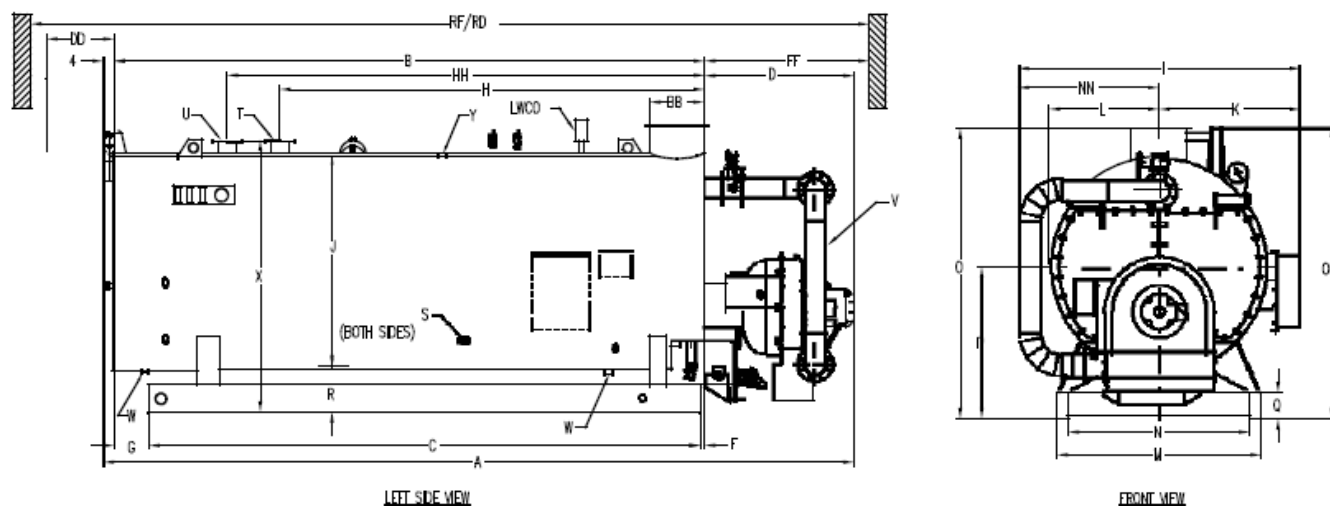
**Figure A3-4. 4WG Low NOx - Hot Water 100-800 HP**

Table A3-8. 4WG Low NOx Dimensions - Hot Water

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700/800	*800
LENGTHS													See Note "C"
Overall Length	A	176	200	189.62	223.62	229.62	253.62	250	270.63	276.63	311.63	304	331
Shell	B	131	155	143	177	172.5	196.5	189.75	207.75	213.75	248.75	232.75	259.75
Base Frame	C	110	124	122	156	150.13	174.13	167.25	185.25	188.25	223.25	207.25	234.25
Burner Extension	D	41	41	42.62	42.62	53.12	53.12	56.25	58.88	58.88	58.88	67.25	67.25
Smokebox to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rear Ring Flange to Base	G	20.5	20.5	20.5	20.5	22	22	22	22	25	25	25	25
Smokebox to Return	H	78	99	87	121	113.5	137.5	130.75	148.75	143	151.75	146.75	173.75
Smokebox to Outlet	HH	103	124	112	146	139.5	163.5	156.75	174.75	179	187.75	182.75	209.75
WIDTHS													
Overall Width	I	82.5	76.5	80.25	80.25	89.5	89.5	99.25	99.25	116	117	122.5	122.5
I.D. Boiler	J	60	60	67	67	78	78	85	85	96	96	106	106
Center to LWCO Controller	K	37	37	40.75	40.75	46	46	49.5	49.5	55	55	60	60
Center to Lagging	L	33	33	36.75	36.75	42	42	45.5	45.5	51	51	56	56
Base Outside	M	52.5	52.5	51	51	64	64	60	60	71.88	71.88	74.75	74.75
Base Inside	N	44.5	44.5	43	43	56	56	47	47	58.88	58.88	61.75	61.75
Center to Outside of FGR Duct	NN	45.5	39.5	39.5	39.5	43.5	43.5	49.75	49.75	61	62	62.5	62.5
FGR Duct Size	V	6	6	6	6	6	8	8	8	8	10	10	10
HEIGHTS													
Base to Rear Davit	OO	86.12	86.12	92.75	92.75	98.88	98.88	112.75	112.75	125.12	125.12	134.25	134.25
Base to Vent Outlet	O	85	85	89.88	89.88	106	106	115	115	126	126	135.63	135.63
Base to Boiler Centerline	P	46	46	50	50	56	56	61	61	67	67	71	71
Height of Base Frame	Q	12	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Boiler	R	15.63	15.63	16.13	16.13	16.5	16.5	18	18	18.5	18.5	17.5	17.5
Base to Return & Outlet	X	82.38	82.38	92.63	92.63	101.5	101.5	110	110	121.5	121.5	130.5	130.5
BOILER CONNECTIONS													
Waterfill Connection (Both Sides)	S	1.25	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Water Return (See Note "A")	T	4	6	6	6	8	8	8	10	10	12	12	12
Water Outlet (See Notes "A & B")	U	4	6	6	6	8	8	8	10	10	12	12	12
Drain-Front & Rear	W	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2
Air Vent	Y	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
VENT STACK													
Vent Stack Diameter (Flanged)	BB	16	16	16	16	20	20	24	24	24	24	24	24
MINIMUM CLEARANCES													
Rear Door Swing	DD	36	36	40	40	46	46	50	50	55	55	60	60
Tube Removal - Front Only	FF	96	120	108	142	132.5	156.5	148	166	169	204	188	215
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Thru Window or Door	RD	234	258	261	295	307.5	331.5	337	355	377	412	411	438
Front of Boiler	RF	263	311	291	359	351	399	388	424	438	508	481	535
WEIGHTS IN LBS													
Normal Water Weight	-	6,890	8,580	8,870	11,600	14,760	17,380	19,220	21,520	26,260	31,580	35,900	40,930
Approx. Shipping Weight - (30psig)	-	10,860	12,080	13,090	15,260	19,110	21,050	24,760	27,640	33,295	38,150	42,320	46,300
Approx. Shipping Weight - (125psig)	-	11,600	12,980	14,040	16,680	20,670	23,140	26,930	30,060	35,390	40,550	45,430	49,750

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing. All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": Water Outlet includes 2" Dip Tube

NOTE "C": *800 hp w/ 4000 sq. ft. of heating surface

BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
100-125	33	47	52	80	36
150-200	36.5	49	56	83	40
250-300	42	56	61	92	46
350-400	45.5	58	68	99	50
500-600	51	66	75	111	55
700-800	56	74	80	121	60

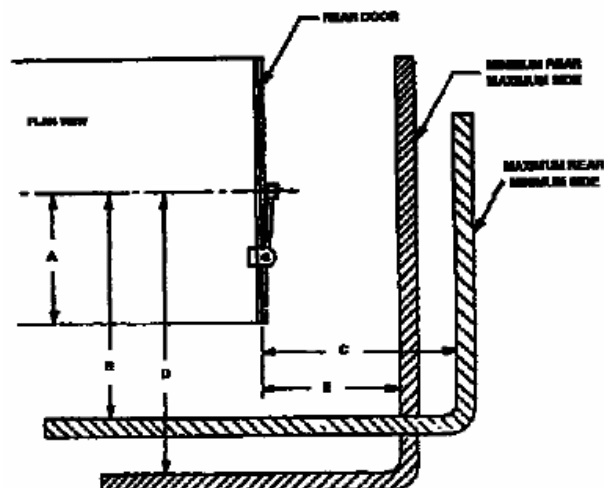
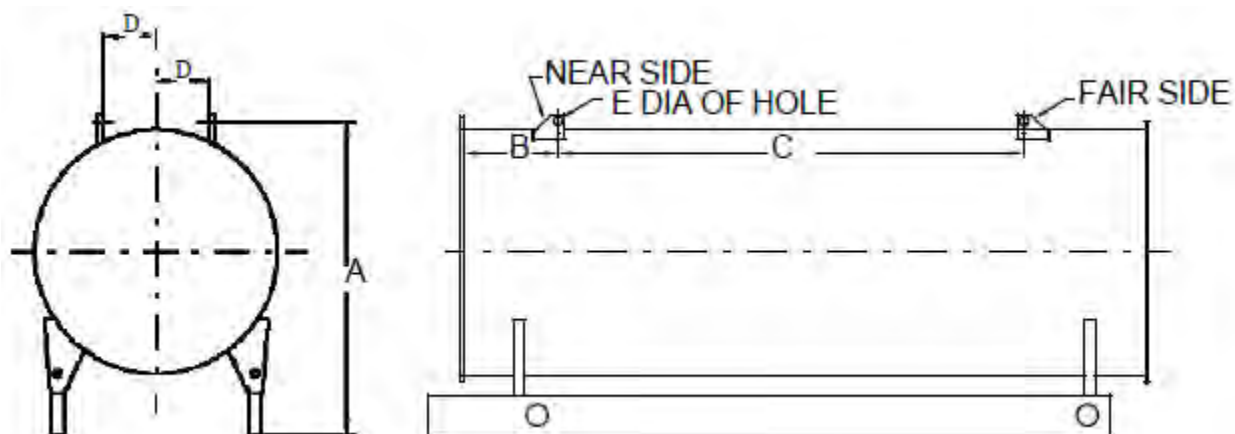


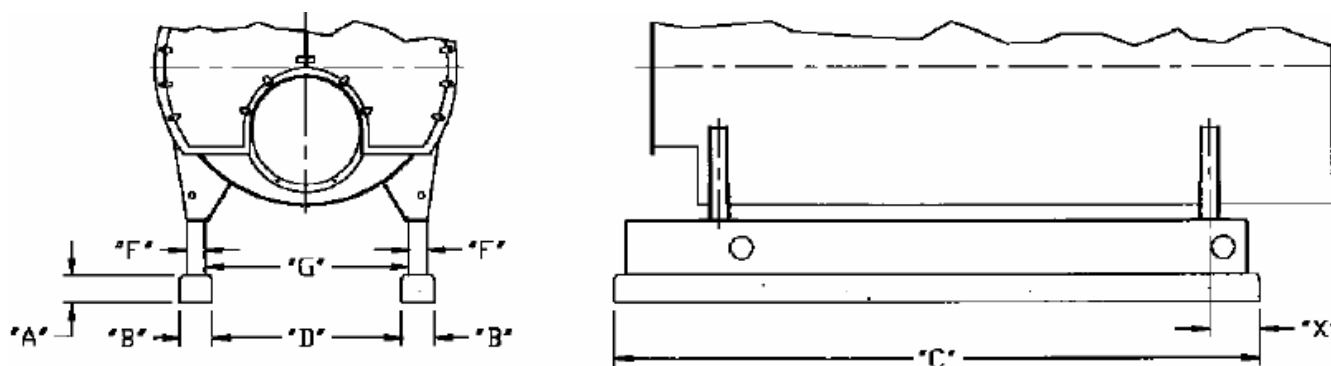
Figure A3-5. Space Required to Open Rear Head on Model 4WG



BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
100	79.5	21.375	84.75	10	3
125	79.5	21.375	108.75	10	3
150	87.125	21.375	96.75	10	3
200	87.125	21.375	130.75	10	3
250	99	28.75	104.25	10	3
300	99	28.75	128.25	10	3
350	107.625	33.25	126	10	3
400	107.625	33.25	144	10	3
500	125.375	34.5	145	10	3
600	125.375	34.5	180	10	3
700-800	134.5	34.5	164	10	3

NOTE: A, B, and C dimensions may vary by 1 inch.

Figure A3-6. Model 4WG Lift Lug Locations



BOILER HP	ALL DIMENSIONS IN INCHES							
	A	B	C	D	E	F	G	X
100	6	9	110	39.5	57.5	4	44.5	8
125	6	9	124	39.5	57.5	4	44.5	8
150	6	9	122	38	56	4	43	8
200	6	9	156	38	56	4	43	8
250	6	9	150.125	51	69	4	56	11.5
300	6	9	174.125	51	69	4	56	11.5
350	6	12	167.25	41.5	65.5	6.5	47	11.5
400	6	12	185.25	41.5	65.5	6.5	47	11.5
500	6	12	188.25	53.375	77.375	6.5	58.875	10.5
600	6	12	223.25	53.375	77.375	6.5	58.875	10.5
700-800	6	12	207.25	56.25	80.25	6.5	61.75	10.5

NOTE:

6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the boiler and added height for washing down the area beneath the boiler.

Figure A3-7. Model 4WG Mounting Piers

PERFORMANCE DATA

Contact your local Cleaver-Brooks authorized representative for efficiencies.

Cleaver-Brooks 4WG boilers are available with the standard burner package, or optional model Profire LE or Profire NT if NO_x reductions of between 75 and <9 PPM on natural gas are required, or 70 PPM on #2 oil with 0.02% fuel bound nitrogen.

ENGINEERING DATA

The following engineering information is provided for Model 4WG Boilers. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

- Table A3-11 shows steam volume and disengaging area for model 4WG boilers.
- Table A3-12 lists quantity and outlet size for safety valves supplied on Model 4WG steam boilers.
- Table A3-13 lists quantity and outlet size for relief valves supplied on Model 4WG hot water boilers.
- Table A3-14 gives recommended steam nozzle sizes on Model 4WG Boilers.
- Table A3-15 shows recommended non-return valve sizes for Model 4WG Boilers.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table A3-9 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks Model 4WG Boilers.

Burner/Control Information

Burner Characteristics

Maximum altitude for standard burners is shown in Table A3-16. Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures.

Gas-Fired Burners

Table A3-16 shows correction factors for gas pressure at elevations over 700 ft. above sea level.

Table A3-17 shows minimum and maximum gas pressure requirements for Standard, FM and IRI 4WG Boiler gas trains upstream of the gas pressure regulator.

For oversized or undersized gas trains or altitude above 2,000 feet, contact your local Cleaver-Brooks authorized representative.

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Figure A3-8 shows a typical fuel oil supply arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Boiler Room Information

Figure A3-9 shows typical boiler room length requirements.

Figure A3-10 shows typical boiler room width requirements.

Stack Support Capabilities

100- 800 hp Model 4WG Boilers can support up to 2000 lbs without additional support.

100 - 800 hp Model 4WG Boilers can be reinforced to support up to 3000 lbs.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than one (1) square foot.
 - E. Size the openings by using the formula: $\text{Area (sq.-ft.)} = \text{CFM/FPM}$

2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
 - A. From floor to (7) foot height - 250 fpm.
 - B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm}/\text{fpm} = 3000/250 = 12$ Sq.-ft. total.
- Area/Opening: $12/2 = 6$ sq.-ft./opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Model 4WG is not required, it is necessary to size the stack/ breeching to limit flue gas pressure variation. The allowable pressure range is -0.25" W.C. to +0.25" W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Table A3-9. 4WG Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
100	85
125	104
150	102
200	131
250	145
300	169
350	178
400	198
500	233
600	278
700	286
800	286

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Table A3-10. 4WG Boilers: Predicted Sound Levels (30 ppm NOx systems) @ High Fire

BHP	Sound Level-dBA
100	81
125	83.5
150	89.5
200	88.6
250	88.5
300	91
350	94
400	91.5
500	93.5
600	93.5
700	93.7
800	93.5

Table A3-11. Steam Volume and Disengaging Areas

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA SQ-IN	
	HIGH PRESSURE (A)	LOW PRESSURE (B)	HIGH PRESSURE (A)	LOW PRESSURE (B)
100	16.5	22.3	4565	4954
125	20.3	27.4	5587	6077
150	19.9	26.8	5443	5918
200	25.7	34.6	7013	7632
250	34.8	49.5	7790	8597
300	40.6	57.9	9115	10051
350	51.3	69.6	9734	10570
400	57.2	77.5	10843	11779
500	83.6	107.6	12874	13781
600	100	128.6	15394	16474
700	115.6	144.9	15826	16819
800	115.6	144.9	15826	16819

NOTE:

1. Based on normal water level.

A. Based on 150 psig design pressure.

B. Based on 15 psig design pressure.

Table A3-12. Model 4WG Steam Boiler Safety Valve Outlet Size

VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM		300 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100	1	2-1/2	1	1-1/2	1	1-1/2	1	1-1/4	1	1-1/4
125	1	3	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/4 (1) 1	2	1	2	1
150	1	3	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1 (1) 1-1/4	2	1	2	1
200	2	2-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4	2	(1) 1 (1) 1-1/4
250	2	(1) 2-1/2 (1) 3	2	(1) 2 (1) 1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4
300	2	3	2	(1) 2 (1) 1-1/2	2	1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
350	3	(1) 2 (2) 3	2	2	2	(1) 1-1/2 (1) 2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
400	3	(2) 3 (1) 2-1/2	2	(1) 2-1/2 (1) 2	2	(1) 1-1/2 (1) 2	2	(1) 1-1/2 (1) 2	2	1-1/2
500	3	3	2	2-1/2	2	(1) 2-1/2 (1) 2	2	2	2	(1) 1-1/2 (1) 2
600	4	(3) 3 (1) 2-1/2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2	2	(1) 1-1/2 (1) 2
700	5	(3) 3 (2) 2-1/2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2
800	5	(3) 3 (2) 2-1/2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	(1) 2 (1) 2-1/2

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

Table A3-13. Model 4WG Hot Water Relief Valve Outlet Size

VALVE SETTING	30 PSIG HW		125 PSIG HW		150 PSIG HTHW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100	1	2-1/2	1	1-1/4	1	2
125	1	2-1/2	1	1-1/4	2	(1) 1-1/2 (1) 2
150	1	2-1/2	1	2	2	(1) 1-1/2 (1) 2
200	2	(1) 2-1/2 (1) 1-1/4	1	2	2	2
250	2	(1) 2 (1) 2-1/2	1	2	2	(1) 2 (1) 2-1/2
300	2	2-1/2	1	2-1/2	2	2-1/2
350	3	(2) 2-1/2 (1) 1	1	2-1/2	2	(1) 2-1/2 (1) 3
400	3	(1) 2 (2) 2-1/2	1	2-1/2	2	(1) 2-1/2 (1) 3
500	4	(1) 1 (3) 2-1/2		(1) 1 (1) 2-1/2	2	3
600	4	(3) 2-1/2 (1) 2	2	(1) 1-1/4 (1) 2-1/2	3	(2) 3 (1) 2-1/2
700, 800	5	(1) 1 (4) 2-1/2	2	(1) 2-1/2 (1) 2	3	3

NOTE: Relief valve is Kunkle #537 for 30# & 125#(Section IV) boiler and is Kunkle #927

Table A3-14. 4WG Recommended Steam Nozzle Size

OPERATING PRESSURE	BOILER HP											
PSIG	100	125	150	200	250	300	350	400	500	600	700	800
15	8	8	8	10	10	12	12	12	12	12	12	12
30	6	6	6 8 8 8				10	10	10	12	12	12
40	6	6	6 6 8 8				8	10	10	10	12	12
50	4	6	6 6 6 8				8	8	10	10	10	12
75	4	4	4 6 6 6				8	8 8		8	10	10
100	4	4	4 6 6 6				6	6 8		8	8	10
125	4	4	4 4 6 6				6	6 8		8	8 8	
150	2.5	3	3 4 4 6				6	6 6		6	8 8	
200	2.5	2.5	3	4 4 4			4	6 6		6	6 6	
250	2	2.5	3	3 4 4			4	4 6		6	6 6	

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.
3. All standard steam nozzle sizes for 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.
4. Shaded area denotes special surge load baffles must be installed to avoid possible water carryover.
5. For incremental operating pressure, see Table I3-1 Steam System Fundamentals.

Table A3-15. 4WG Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURE (PSIG)							
		50	75	100	125	150	175	200	250
100	3450	2-1/2	2-1/2	NA	NA	NA	NA	NA NA	
125	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA NA	
150	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA	NA
200	6900	3*	3	3	3	3	2-1/2	2-1/2	2-1/2
250	8625	4	3*	3	3	3	3	3 3	
300	10350	4	4	4	3*	3	3	3 3	
350	12025	4	4	4	4	4	3*	3	3
400	13800	5	4	4	4	4	4	4	3*
500	17210	6	5	5	4	4	4	4 4	
600	20700	6	6	5	5	5	4	4 4	
700	24150	6	6	6	5	5	5	5 4	
800	27600	6	6	6	6	6	5	5 5	

NOTE: Valve sizes (300 # Flanges) given in inches.

Standard Non-Return valve selections limited to a maximum 2 to 1 turndown (50% of full load); selections based on typical non-return valve sizing recommendations. For final valve selection contact your C-B authorized representative. For high turndown applications see Boiler Book Section I3, Table I3-3.

* Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table A3-16. Altitude Correction for Gas

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

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

oz/sq-in x 1.732 = inches WC.

Inches WC x 0.0361 = psig.

oz/sq-in x 0.0625 = psig.

psig x 27.71 = Inches WC.

psig x 16.0 = oz/sq-in.

Table A3-17. Model 4WG, Standard and Low NOx (30 ppm), Minimum Required Gas Pressure at Entrance to Standard, FM and IRI Gas Trains (Upstream of Gas Pressure Regulator)

BOILER HP	STD PIPE SIZE (Inches)	PRESSURE REQUIRED-STD ("WC)			PRESSURE REQUIRED-30 PPM ("WC)		
		GPR*	Minimum	Maximum	GPR*	Minimum	Maximum
100	2	RV91	9	27.7	RV91	12.3	27.7
125	2	RV91	16.6	27.7	RV91	21.6	27.7
150	2	RV91	23.2	27.7	RV91	21.9	27.7
200	2.5	210G	20.7	277	210G	28.5	277
250	2.5	210G	29.9	277	210G	29	277
300	2.5	210G	40.8	277	210G	39.5	277
350	3	210G	42.7	277	210G	40.7	277
400	1.5-2	S	130	208	S	130	208
	2-2.5	S	89	130	S	89	130
	2.5	S	64	89	S	64	89
	3	S	39	64	S	39	64
500	1.5-2.5	S	183	277	S	175	277
	2-2.5	S	130	183	S	125	175
	2.5	S	89	130	S	83	125
	3	S	50	89	S	44	83
600	2-1.5-2.5	S	233	277	S	241	277
	2-2.5	S	177	233	S	186	241
	2.5	S	119	177	S	127	186
	2.5-3	S	100	119	S	108	127
	3	S	61	100	S	69	108
700	2-3	S	222	277	S	213	277
	2.5-3	S	133	222	S	125	213
	3	S	83	133	S	75	125
	4	S	55	83	S	44	75
800	2-3	S	255	277	S	260	277
	2.5-3	S	152	255	S	155	260
	3	S	94	152	S	94	155
	4	S	53	94	S	55	94

NOTE: Where multiple gas train sizes are shown, the shaded row indicates standard size. For altitudes above 700 feet, contact your local Cleaver-Brooks authorized representative.

* GPR Gas Pressure Regulator

S-Siemens regulating actuator.

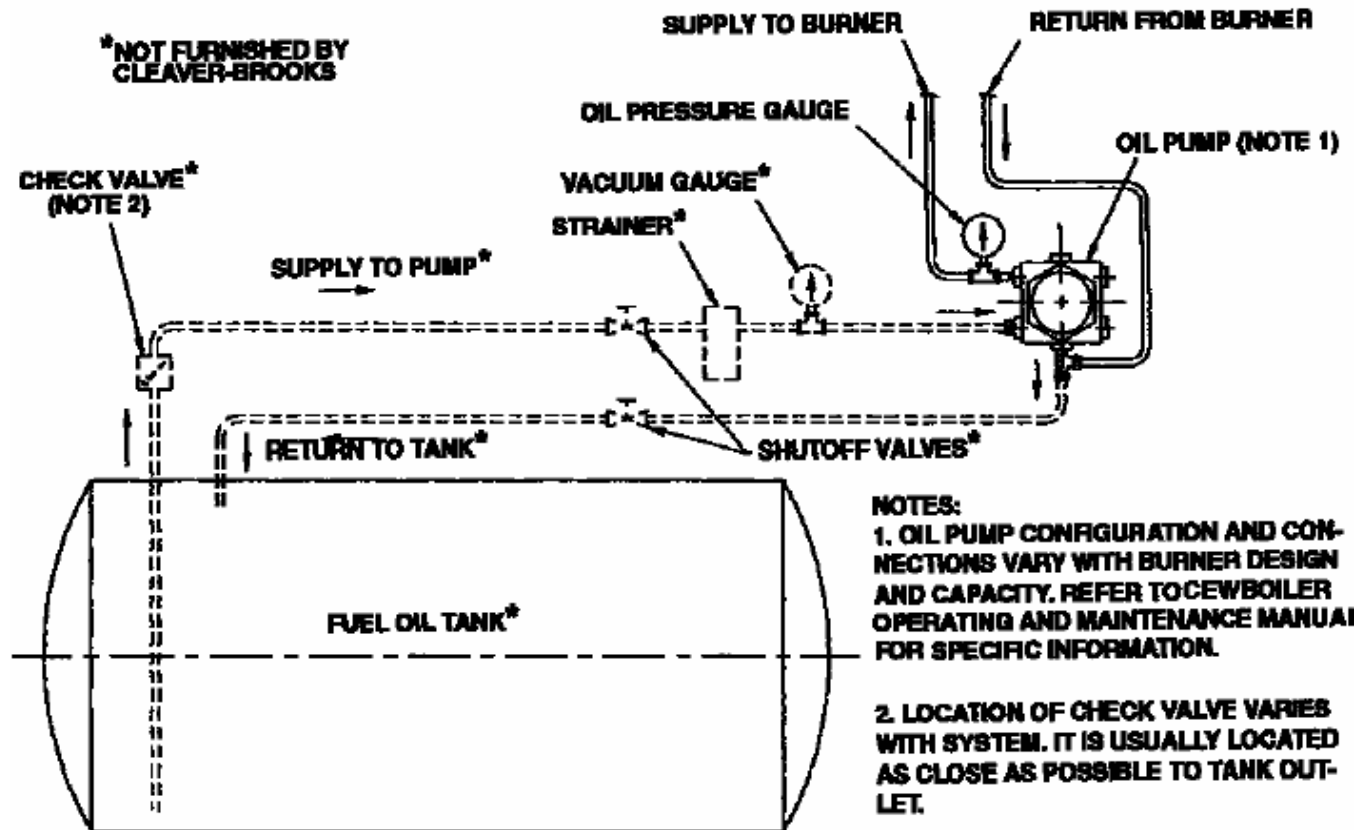
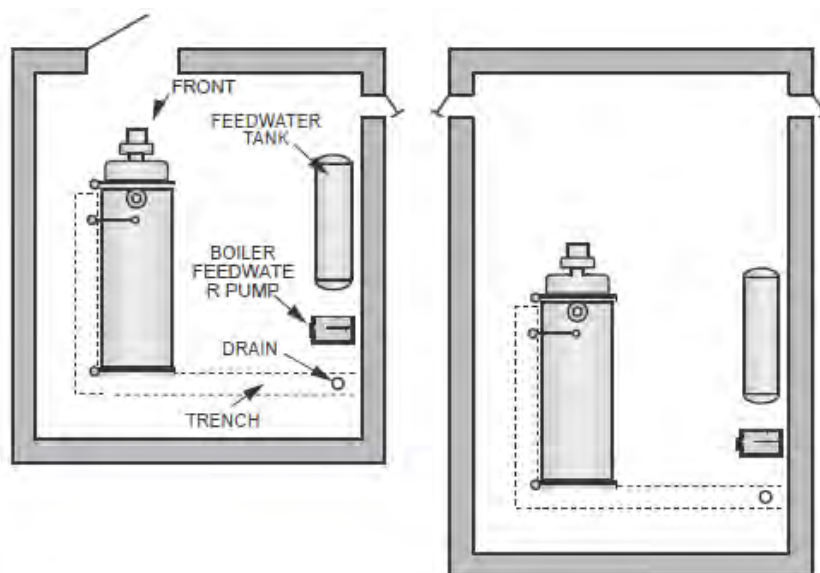


Figure A3-8. Typical Fuel Oil Supply Arrangement



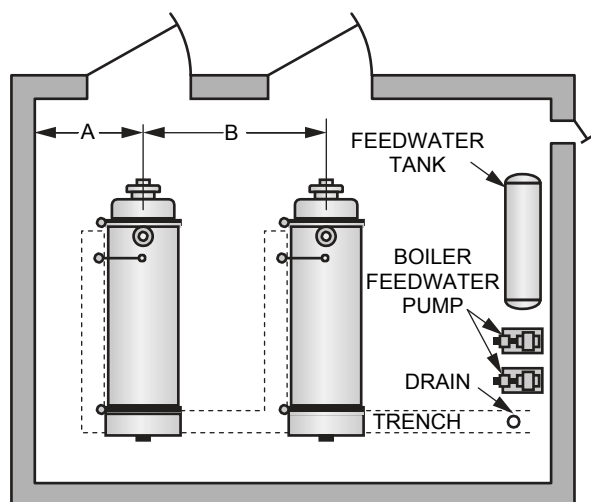
1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

Figure A3-9. Boiler Room Length (Typical Layouts) - Model 4WG



BOILER HP	100-125	150-200	250-300	350-400	500-600	700-800
DIM. "A"	87	91 96		100	105	110
DIM. "B"	120	127 144		151	174	184

NOTES:

Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.

Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of:

42" - 100-200 HP

48" - 250-400 HP

60" - 500-800 HP

If space permits, this aisle should be widened.

Figure A3-10. Boiler Room Width (Typical Layouts) - Model 4WG

SAMPLE SPECIFICATIONS Model 4WG STEAM BOILERS

PART 1 GENERAL

STEAM BOILERS

Cleaver Brooks Model 4WG

1.01 SCOPE

- A. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled steam boiler(s) as described in the specifications herein.
- B. Related Sections include the following:
 - 1. Division 15 Section "Chemical Water Treatment" for feedwater treatment and connections.
 - 2. Division 15 Section "Breechings, Chimneys, and Stacks" for connections to breechings, chimneys, and stacks.
 - 3. Division 15 Sections for control wiring for automatic temperature control.

1.02 REFERENCES

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include parts list, maintenance guide, and wiring diagrams for each boiler.
 - 1. ASME Section (I or IV) (Power boilers or Heating Boilers)
 - 2. ANSI Z21.13 (Gas Fired Low Pressure Boilers)
 - 3. NFPA 54 (ANSI Z221.3) National Fuel Gas Code
 - 4. FACTORY MUTUAL
 - 5. ASME CSD-1 (Controls and Safety Devices)
 - 6. IRI (Industrial Risks Insurance)
 - 7. UBC (Uniform Building Code)
 - 8. UMC (Uniform Mechanical Code)
 - 9. NEC (National Electrical Code)
 - 10. UL (Underwriters Laboratories)
 - 11. NFPA 85

1.03 QUALITY ASSURANCE

- A. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, appurtenances, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.
- B. The equipment shall be of the type, design, and size that the manufacturer currently offered for sale and appears in the manufacturer's current catalogue. The equipment shall be new and fabricated from new materials and shall be free from defects in materials and workmanship
- C. The equipment must fit within the allocated space, leaving ample allowance for maintenance and cleaning, and must leave suitable space for easy removal of all equipment appurtenances. Tube pull clearance space from either the front or rear of boiler must be maintained.
- D. All units of the same classification shall be identical to the extent necessary to insure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.
- E. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified. The boiler manufacturer shall be responsible for guarantying that the boiler provides the performance as specified herein.

1.04 SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval by the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. The engineer shall review and stamp submittals. Work may proceed and equipment released for fabrication after contractor receives returned submittals stamped with "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
- C. The bidder must submit in writing to the engineer any request for a proposed deviation, omission, modification, or substitution to this specification for evaluation no later than ten (10) days prior to the bid date. A request for any substitution shall be accompanied by technical data, drawings, product samples, and complete data substantiating compliance of proposed substitution with these specifications. No materials shall be deemed acceptable if not in strict and full compliance with these specifications. All bidders must bid solely on the specified materials unless acceptance by the engineer of a deviation, omission, modification, or substitution is granted in writing to all bidders prior to the bid date.
- D. Shop Drawings - Shop drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
 - 2. Schematic flow diagram of gas valve trains.
 - 3. Schematic wiring diagram of boiler control system of the ladder-type showing all components, all interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring.
- E. Installation Instructions: Manufacturer's printed instructions for installation shall be submitted to the engineer for approval.
- F. Manufacturer's Warranties: Manufacturer's printed warranties, as specified hereinafter, shall be submitted prior to final acceptance by the engineer.

- G. Manufacturer's Field Service: Manufacturer's printed field service procedures and reports, as specified hereinafter, shall be submitted prior to final acceptance by the engineer. Report forms shall contain all information as required to do start-up and testing as specified in the products section.

1.05 CERTIFICATIONS

- A. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 - 3. ASME certification.
 - 4. UL and CSD-1 certification.
 - 5. The equipment furnished has been installed in accordance with the manufacturer's installation instructions.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.
- B. Contractor's Certification: The contractor shall certify the following:
 - 1. The products and systems installed are in strict compliance with the specifications.
 - 2. The specified field tests have been satisfactorily performed.
- C. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- D. Test Reports: Factory and field test reports as described above and as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- E. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall be responsible for the timely delivery of the equipment to the job site. The contractor shall be responsible for unloading and rigging of the equipment. The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as job site conditions during construction.
- B. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.
- C. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled, low pressure hot water boilers as described in the specifications herein.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Contractor shall furnish and install Cleaver Brooks Model 4WG natural gas (combination Gas/Oil fired) steam boiler(s) with design pressure as scheduled on the drawings.
- B. Alternate manufacturers complying with plans and specifications must be submitted and approved by the consulting engineer within 10 days prior to bid date.

2.02 GENERAL DESCRIPTION

Factory packaged unit shall include boiler, burner, heavy duty skids, painted steel jacket with two inches of fiberglass insulation, controls and accessories all piped and wired for single point field connections. Units shall carry packaged label of Underwriters Laboratory (UL) and be in accordance with ASME/CSD-1, all codes required by the local governing authorities and as indicated on the design performance data sheet. A certified factory fire-test shall be provided on all fuels with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for _____ PSIG steam in accordance with Section (I or IV) of ASME Code. Unit shall be designed to Seismic Zone _____ requirements and be provided with tie down clips and calculations showing bolt diameter requirements. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements.

2.03 PERFORMANCE: BOILER SIZE AND RATINGS

- A. The capacity of each unit shall be indicated on the drawing schedule.
- B. Performance Criteria:

Performance Criteria	
Manufacturer:	CLEAVER-BROOKS
Model:	4WG
Horsepower:	_____ HP
Output:	_____ #/hr (from and at 212°F)
Gas Input:	_____ MB
Oil Input:	_____ GPH
Design Pressure:	_____ PSIG
Operating Pressure	_____ PSIG
Steam Disengaging Area (minimum)	_____ Sq. Inches
Steam storage area (minimum)	_____ Cu. Ft.
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Heating Release (maximum):	_____ BTU/Cu. Ft.
Burner Turndown Ratio Natural Gas:	
No. 2 Oil:	
Overall Efficiency (Fuel to Steam)	
Natural Gas (%):	_____ % at High Fire
No. 2 Oil (%):	_____ % at High Fire
NOX Emission (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
CO Emissions (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)

Performance Criteria	
Electrical:	_____ V / _____ H / _____ P
Fan Motor:	_____ HP
Air Compressor Motor:	_____ HP
Oil Pump Motor:	_____ HP
Noise Level (3' from burner):	_____ dBA
Available Gas Supply Pressure:	_____ PSIG
Weight	
Dry:	_____
Flooded:	_____
Seismic Zone:	_____
Altitude:	_____ ASL
Code Requirements:	ASME / NATIONAL BOARD CSD-1 NFPA 8501 Underwriter's Lab (UL) State Of _____ Factory Mutual (FM) Industrial Risk Insurers (IRI)

A. Noise Sound Levels: Based on ABMA test code for packaged boilers measured 4-1/2 feet vertically above the bottom of the base rail and 3'0" horizontally in front of the end of the blower motor or front surface of control cabinet. Sound levels dBA on the scale in reference to 0.0002 microbars.

High Fire	#2 oil	_____ dBA
Low Fire	#2 oil	_____ dBA
High Fire	Nat Gas	_____ dBA
Low Fire	Nat Gas	_____ dBA

2.04 BOILER DESIGN

- A. Four pass steel scotch marine firetube boiler for positive pressurized firing with forced draft burner. Wet-Back design with a minimum five (5) square feet of heating surface per boiler horsepower. Front and rear doors shall be davited and sealed with tad-pole gaskets using heavy duty cap screws threaded into replaceable brass nuts. When opened, doors shall expose all tubes, tubesheets and furnace for ease of inspection and maintenance. Lifting loops shall be provided. The rear door shall be insulated with a blanket material and a steel covering to give the surface a hard durable finish. The boiler tubes shall not include turbulators, swirlers or other add- on appurtenances. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning.
- B. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint. The entire boiler based frame and other components shall be factory painted before shipment using a hard finish enamel coating.

2.05 BURNER DESIGN

- A. GENERAL: Forced draft burner of the gun design with hinged access for inspection and service. Reversed curve fabricated aluminum blower fan; motor(s); single point positioning system consisting of rotary air damper located on the combustion air intake, straight line linkage and characterized cams; air flow switch; fuel trains and control panels. To conform to UL and other insurance requirements as indicated.
- B. GAS BURNER: Shall be of the high radiant multi-port type for natural gas. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Minimum main gas train shall include manual shut-off valve, pressure regulating valve, dual safety gas valves, manual test valve high-low pressure switches, manifold pressure gauge and butterfly gas valve with (14) point characterized cam assembly. Gas train shall be factory packaged to meet insurance requirements as indicated. Gas turn down shall be minimum 5:1 for 250 to 800 HP.
- C. OIL BURNER Oil burner shall be of the low pressure air atomizing type for No. 2 oil. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Oil train shall consist of gauges, air purge valve; (14) point characterized cam assembly; dual oil solenoids; temperature switch, air compressor assembly and oil pump assembly. Oil train shall be factory packaged to meet insurance requirements as indicated. Oil turn down shall be minimum 5:1 for #2 Oil and 4:1 for Heavy Oil for 250 to 800 HP.
- D. COMBINATION BURNER: Provide gas-oil fuel selector switch to provide fuel switch over without any required adjustments to burner linkage.
- E. FUEL-AIR CONTROL: Modulating fire with proven low fire start. Provide manual potentiometer with manual-auto switch on boiler control panel in addition to automatic fuel-air controller. Linkage system shall be single point positioning with rotary air damper, linkage and (14) point characterized cam assembly for all fuels. Provide automatic operating control and manual reset high limit.
- F. FORCED DRAFT BLOWER: Backward curved aluminum radial impeller shall be directly connected to a flanged type ODP motor. The combustion air damper shall be an integral rotating damper and shall be automatically adjusted for proper air quantity by a mod motor to maintain proper fuel-air ratios.
- G. EMISSION CONTROL (optional): Boiler NOx shall be furnished with guaranteed external induced NOx control for 30 PPM corrected to 3% O₂ over the entire turndown range. Boiler capacity, turndown, flame stability and efficiency shall not be affected by the internal NOx control. Low NOx system shall be part of the Boiler/Burner UL package label and manufacture shall have Twelve (12) years of emission control experience in the state of _____.

2.06 BOILER TRIM

- A. To include the following:
 - 1. _____" diameter pressure gauge.
 - 2. ASME safety relief valve(s).
 - 3. Auxiliary Low Water Cutoff, (optional)
 - 4. Primary low water cut-off.
 - 5. Operating control.
 - 6. Limit control with manual reset.
 - 7. _____" stack thermometer.
 - 8. Feedwater regulating valve with 3 valve bypass
 - 9. Low fire hold controller (optional).
 - 10. 1 Slow Opening Blowdown Valve, Size _____", Class 200#

11. 2 Quick Opening Blowdown Valves, Size _____", Class 490#
 12. Feedwater Globe Valve, Size _____", Class 240# m.
 13. 1 Feedwater Check Valve, Size _____", Class 240# n.
 14. 1 ASME Spool Piece, Inlet Size _____", Outlet Size _____", Length _____"
 15. 1 Stop Valve (Steam Header Valve), Size _____", Flanged, Cast Iron, Class 250"
 16. 1 Stop Check Valve (Non-Return Valve), Size _____", Flanged, Cast Iron, Class 250", Straight Pattern, with Free Blow Drain Valve
 17. Factory mounted, installed, tested, and certified piping (by A, S, or PP ASME stamp holder) and valves per ASME Code, including:
 - Water Column piping
 - Bottom Blowdown (from boiler to last code valve)
 - Feedwater assembly (shipped loose)
 - Surface Blowdown piping with stop valve and metering valve.
 18. JHB Modulating Feedwater Control Valve, including 3-Valve Bypass
 19. Oil Pump, Mounted and Wired
 20. Air Atomizing Compressor, Mounted and Wired
 21. Platforms and ladder to access steam header and safety relief valves. Built to OSHA requirements.
- B. WATER COLUMN/LOW WATER CUTOFF AND WATER LEVEL CONTROL SYSTEM: McDonnell & Miller 157.

2.07 BOILER CONTROLS

- A. BOILER MANAGEMENT CONTROL SYSTEM CONTROL PANEL: Boiler mounted NEMA 1 enclosure(s) with key lock; fusing, magnetic starters; step-down control transformer; flame safeguard and burner management system as indicated; annunciator lights for load demand, fuel on, low water and flame failure; selector switches, required by dry contacts, relays and terminal strips. Oil, heat and moisture resistant wire with circuit number corresponding to electrical wiring diagrams. In accordance with UL and National Electric Code.
- B. (OPTION 1) BURNER MANAGEMENT SYSTEM (CB 120; standard): Boiler mounted in control panel enclosure. Microprocessor-based control to monitor all critical boiler and burner interlocks control and supervise burner light off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. Dynamic self checking. System to provide pre-post purge status, fault history, and diagnostic information by means of a two-line alpha-numeric display (optional) with alarm/status LEDs.
- C. (OPTION 2) CB-HAWK ICS Boiler Control System - Integrated Boiler Control and Management System combining a Digital Burner Management System for flame safety, and a Programmable Logic Controller for boiler modulation and operator interface functions. The factory pre-configured Boiler Control System shall integrate the Burner Management functions and the PLC based modulation and operator interface functions. The logic of the Burner Management System and the modulating controls will not be run in the same processor or be powered by the same DC supply. The PLC and Operator Interface Hardware shall be as manufactured by Allen Bradley. Major system components shall include:
 1. Programmable Logic Controller
 2. Touch Screen HMI

3. One Burner Management Controller with Wiring Sub-Base
 4. One Flame Scanner and amplifier
 5. Various Temperature and Pressure Sensors
- D. Major functions provided by the Boiler Control System shall be:
1. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout and post-purge
 2. Full modulating control of fuel and air
 3. Utilize solid state controls and sensors to provide various control functions, such as:
 - a. Modulating control (algorithm shall be Proportional-Integral-Derivative (PID) type)
 - b. Thermal shock protection
 - c. High and Low limit alarms and shutdowns
 4. Touch Screen graphical operator interface and monitoring
 - a. Manual control of the boiler firing rate using control screens on the HMI to increment or decrement the firing rate
 - b. On screen indication of burner management controller status and diagnostics
 - c. On screen display of system alarms and faults
 - d. On screen history of alarms and faults
 - e. On screen recommendations for troubleshooting of fault conditions
 - f. On screen water level indication and alarm(s)
 5. Stack Flue Gas, Combustion Air and Shell (water) temperature indication
 6. Boiler efficiency calculation
 7. Low Fire Hold with Minimum Temperature Control
 8. Assured Low Fire Cut-Off (ALFCO)
- E. The Boiler Control System shall incorporate the following safety provisions:
1. Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the Burner Management System shall lockout on safety shutdown.
 2. Closed-loop logic test of critical loads (ignition, pilot and main fuel valves) and must be able to lockout on safety.
 3. Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
 4. Dynamic checking of the flame signal amplifier.
 5. Safe start check and expand check to include monitoring flame signal during standby.
 6. High and Low fire switches checked for proper sequencing.
 7. The Boiler Control System shall provide the ability to communicate with external digital via Ethernet as a standard. It shall be possible to communicate with any OPC compliant Internet communications shall be supported, with the Boiler Control System supplied with its own IP address.

2.08 SHOP TEST

- A. Shop test: The complete packaged boiler shall receive factory tests to check construction and function of all controls. All shop tests may be witnessed by the purchaser at his own c upon sufficient notice to the company.

2.9 ACCESSORIES - BOILER FLUE VENT**2.10 ACCESSORIES - FEEDWATER SYSTEM (BOILER FEEDSET OR DEAERATOR)****2.11 ACCESSORIES - FEEDWATER HEATER OR ECONOMIZER****2.12 ACCESSORIES - BLOWDOWN SEPARATOR AND/OR BLOWDOWN HEAT RECOVERY****2.13 ACCESSORIES - O₂ TRIM SYSTEM AND/OR****2.14 ACCESSORIES - CHEMICAL FEED SYSTEM AND/OR WATER TREATMENT****2.15 MANUFACTURES FIELD SERVICES**

- A. General: The boiler and accessories supplier shall be responsible for performance of insp up and testing of the package boiler and accessory equipment and materials furnished under Section. A detailed written record of the start up performance, including burner setting data entire load range shall be furnished to the test engineer before test personnel leave the site equipment and test apparatus shall be furnished by the supplier. All equipment defects discovered by the tests shall be rectified. The minimum time for two (2) boilers is five (5) days.
- B. Equipment inspection: Boiler representative to provide _____ hours of job site assistance to i boilers and other equipment upon arrival, verifying completeness of equipment supplied ar damages. Responsibility of making freight claims to be performed by contractor or owner personnel.
- C. Pre start-up walk through: Boiler representative shall spend _____ hours at job site reviewing with mechanical contractor to be conducted approximately 1 week prior to startup.
- D. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the boiler supplier, and shall include:
1. Demonstrate that boiler, burner, controls and accessories comply with requirement Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 2. Readings at different firing rates (25, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the test engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x and overall boiler efficiency.
 3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non compliance with referenced standards or overloading as applicable.
 4. Commissioning Requirements:
 - a. Fireside inspection
 - b. Waterside inspection
 - c. Closing and resealing of doors, manways and hand holes
 - d. Set up fuel train and combustion air system

- e. Set up operating set points
 - f. Check all safeties, including: Flame safeguard, LWCO, ALWCO, Air flow, Fuel pressures, High limits
 - g. Set up and verify efficiencies at 25%, 50%, 75%, and 100%
 - h. Set up and verify burner turndown.
 - i. Set up and verify feedwater/level controls
 - j. Set up and verify Emissions Compliance
5. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single-hour continuous session to accommodate operator's availability on site.
6. Special tool / safety equipment:
- a. Boiler/burner supplier to include in their proposal safety equipment required to perform annual inspections and maintenance per OSHA requirements, Section 29CFR, 1910.146, date 4115193, Paragraphs 5.6.4.2 through 5.6.6.6 confined space requirements on rear furnace and flue gas turnaround area. Items to include respirator, tag out devices, atmospheric tester, acid suit, harness, wrist straps, life wire, and safety belt
 - b. Special Safety Training on safety procedures by a qualified trainer to be provided per OSHA Section 1910.146, Paragraph 5.6.5.2, to all owners and employees who are operating specified equipment. The cost of training to be included in boiler supplier's proposal

2.16 OPERATING & MAINTENANCE MANUALS

- A. Provide two (2) Operating and Maintenance manuals including cut-away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures. Operating and maintenance manuals shall be provided including cut-away views of boiler and burner schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.
- B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

2.17 WARRANTY DATA

- A. The entire boiler/burner package shall be guaranteed and warranted by the boiler manufacturer. Warranty shall include all parts for a period of (12) months from the date of start-up or beneficial use or 18 months from shipment, whichever comes first.

PART 3 EXECUTION

3.01 GENERAL

- A. Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced workman previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.02 INSTALLATION

- A. Install equipment in strict compliance with manufacturer's installation instructions.
- B. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
- C. Maintain manufacturer's recommended clearances around sides and over top of equipment.
- D. Install components that were removed from equipment for shipping purposes.
- E. Install components that were furnished loose with equipment for field installation.
- F. Provide all interconnecting electrical control and power wiring.
- G. Provide all fuel gas vent and service piping.
- H. Provide all piping for boiler pipe connections.

3.03 FIELD TESTING

- A. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced.
- B. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

3.04 START-UP, INSTRUCTION AND WARRANTY SERVICE

The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

Notes

SAMPLE SPECIFICATIONS MODEL 4WG HOT WATER BOILERS

PART 1 GENERAL

HOT WATER

Cleaver Brooks Model 4WG

1.01 SCOPE

- A. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled steam boiler(s) as described in the specifications herein.
- B. Related Sections include the following:
 - 1. Division 15 Section "Chemical Water Treatment" for feedwater treatment and connections.
 - 2. Division 15 Section "Breechings, Chimneys, and Stacks" for connections to breechings, chimneys, and stacks.
 - 3. Division 15 Sections for control wiring for automatic temperature control.

1.02 REFERENCES

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include parts list, maintenance guide, and wiring diagrams for each boiler.
 - 1. ASME Section (I or IV) (Power boilers or Heating Boilers)
 - 2. ANSI Z21.13 (Gas Fired Low Pressure Boilers)
 - 3. NFPA 54 (ANSI Z221.3) National Fuel Gas Code
 - 4. FACTORY MUTUAL
 - 5. ASME CSD-1 (Controls and Safety Devices)
 - 6. IRI (Industrial Risks Insurance)
 - 7. UBC (Uniform Building Code)
 - 8. UMC (Uniform Mechanical Code)
 - 9. NEC (National Electrical Code)
 - 10. UL (Underwriters Laboratories)
 - 11. NFPA 85

1.03 QUALITY ASSURANCE

- A. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, appurtenances, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.
- B. The equipment shall be of the type, design, and size that the manufacturer currently offered for sale and appears in the manufacturer's current catalogue. The equipment shall be new and fabricated from new materials and shall be free from defects in materials and workmanship
- C. The equipment must fit within the allocated space, leaving ample allowance for maintenance and cleaning, and must leave suitable space for easy removal of all equipment appurtenances. Tube pull clearance space from either the front or rear of boiler must be maintained.
- D. All units of the same classification shall be identical to the extent necessary to insure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.
- E. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified. The boiler manufacturer shall be responsible for guarantying that the boiler provides the performance as specified herein.

1.04 SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval by the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. The engineer shall review and stamp submittals. Work may proceed and equipment released for fabrication after contractor receives returned submittals stamped with "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
- C. The bidder must submit in writing to the engineer any request for a proposed deviation, omission, modification, or substitution to this specification for evaluation no later than ten (10) days prior to the bid date. A request for any substitution shall be accompanied by technical data, drawings, product samples, and complete data substantiating compliance of proposed substitution with these specifications. No materials shall be deemed acceptable if not in strict and full compliance with these specifications. All bidders must bid solely on the specified materials unless acceptance by the engineer of a deviation, omission, modification, or substitution is granted in writing to all bidders prior to the bid date.
- D. Shop Drawings - Shop drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
 - 2. Schematic flow diagram of gas valve trains.
 - 3. Schematic wiring diagram of boiler control system of the ladder-type showing all components, all interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring.
- E. Installation Instructions: Manufacturer's printed instructions for installation shall be submitted to the engineer for approval.
- F. Manufacturer's Warranties: Manufacturer's printed warranties, as specified hereinafter, shall be submitted prior to final acceptance by the engineer.

- G. Manufacturer's Field Service: Manufacturer's printed field service procedures and reports, as specified hereinafter, shall be submitted prior to final acceptance by the engineer. Report forms shall contain all information as required to do start-up and testing as specified in the products section.

1.05 CERTIFICATIONS

- A. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 - 3. ASME certification.
 - 4. UL and CSD-1 certification.
 - 5. The equipment furnished has been installed in accordance with the manufacturer's installation instructions.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.
- B. Contractor's Certification: The contractor shall certify the following:
 - 1. The products and systems installed are in strict compliance with the specifications.
 - 2. The specified field tests have been satisfactorily performed.
- C. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- D. Test Reports: Factory and field test reports as described above and as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- E. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall be responsible for the timely delivery of the equipment to the job site. The contractor shall be responsible for unloading and rigging of the equipment. The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as job site conditions during construction.
- B. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.
- C. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled, low pressure hot water boilers as described in the specifications herein.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Contractor shall furnish and install Cleaver Brooks Model 4WG natural gas (combination Gas/Oil fired) steam boiler(s) with design pressure as scheduled on the drawings.
- B. Alternate manufacturers complying with plans and specifications must be submitted and approved by the consulting engineer within 10 days prior to bid date.

2.02 GENERAL DESCRIPTION

Factory packaged unit shall include boiler, burner, heavy duty skids, painted steel jacket with two inches of fiberglass insulation, controls and accessories all piped and wired for single point field connections. Units shall carry packaged label of Underwriters Laboratory (UL) and be in accordance with ASME/CSD-1, all codes required by the local governing authorities and as indicated on the design performance data sheet. A certified factory fire-test shall be provided on all fuels with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for _____ PSIG steam in accordance with Section (I or IV) of ASME Code. Unit shall be designed to Seismic Zone _____ requirements and be provided with tie down clips and calculations showing bolt diameter requirements. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements.

2.03 PERFORMANCE: BOILER SIZE AND RATINGS

- A. The capacity of each unit shall be indicated on the drawing schedule.
- B. Performance Criteria:

Performance Criteria	
Manufacturer:	CLEAVER-BROOKS
Model:	4WG
Horsepower:	_____ HP
Output:	_____ #/hr (from and at 212°F)
Gas Input:	_____ MB
Oil Input:	_____ GPH
Design Pressure:	_____ PSIG
Operating Pressure	_____ PSIG
Steam Disengaging Area (minimum)	_____ Sq. Inches
Steam storage area (minimum)	_____ Cu. Ft.
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Heating Release (maximum):	_____ BTU/Cu. Ft.
Burner Turndown Ratio Natural Gas:	
No. 2 Oil:	
Overall Efficiency (Fuel to Steam)	
Natural Gas (%):	_____ % at High Fire
No. 2 Oil (%):	_____ % at High Fire
NOX Emission (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
CO Emissions (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)

Performance Criteria	
Electrical:	_____ V / _____ H / _____ P
Fan Motor: Air Compressor Motor:	_____ HP
Oil Pump Motor:	_____ HP
Noise Level (3' from burner):	_____ dBA
Available Gas Supply Pressure:	_____ PSIG
Weight	
Dry:	_____
Flooded:	_____
Seismic Zone:	_____
Altitude:	_____ ASL
Code Requirements:	ASME / NATIONAL BOARD CSD-1 NFPA 8501 Underwriter's Lab (UL) State Of _____ Factory Mutual (FM) Industrial Risk Insurers (IRI)

A. Noise Sound Levels: Based on ABMA test code for packaged boilers measured 4-1/2 feet vertically above the bottom of the base rail and 3'0" horizontally in front of the end of the blower motor or front surface of control cabinet. Sound levels dBA on the scale in reference to 0.0002 microbars.

High Fire	#2 oil	_____ dBA
Low Fire	#2 oil	_____ dBA
High Fire	Nat Gas	_____ dBA
Low Fire	Nat Gas	_____ dBA

2.04 BOILER DESIGN

- A. Four pass steel scotch marine firetube boiler for positive pressurized firing with forced draft burner. Wet back design with a minimum five (5) square feet of heating surface per boiler horsepower. Front and rear doors shall be davited and sealed with tad-pole gaskets using heavy duty cap screws threaded into replaceable brass nuts. When opened, doors shall expose all tubes, tubesheets and furnace for ease of inspection and maintenance. Lifting loops shall be provided. The rear door shall be insulated with a blanket material and a steel covering to give the surface a hard durable finish. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning.
- B. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint. The entire boiler based frame and other components shall be factory painted before shipment using a hard finish enamel coating.

2.05 BURNER DESIGN

- A. GENERAL: Forced draft burner of the gun design with hinged access for inspection and service. Reversed curve fabricated aluminum blower fan; motor(s); single point positioning system consisting of rotary air damper located on the combustion air intake, straight line linkage and characterized cams; air flow switch; fuel trains and control panels. To conform to UL and other insurance requirements as indicated.
- B. GAS BURNER: Shall be of the high radiant multi-port type for natural gas. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Minimum main gas train shall include manual shut-off valve, pressure regulating valve, dual safety gas valves, manual test valve high-low pressure switches, manifold pressure gauge and butterfly gas valve with (14) point characterized cam assembly. Gas train shall be factory packaged to meet insurance requirements as indicated. Gas turn down shall be minimum 5:1 for 250 to 800 HP.
- C. OIL BURNER Oil burner shall be of the low pressure air atomizing type for No. 2 oil. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Oil train shall consist of gauges, air purge valve; (14) point characterized cam assembly; dual oil solenoids; temperature switch, air compressor assembly and oil pump assembly. Oil train shall be factory packaged to meet insurance requirements as indicated. Oil turn down shall be minimum 5:1 for #2 Oil and 4:1 for Heavy Oil for 250 to 800 HP.
- D. COMBINATION BURNER: Provide gas-oil fuel selector switch to provide fuel switch over without any required adjustments to burner linkage.
- E. FUEL-AIR CONTROL: Modulating fire with proven low fire start. Provide manual potentiometer with manual-auto switch on boiler control panel in addition to automatic fuel-air controller. Linkage system shall be Cleaver-Brooks single point positioning with rotary air damper, linkage and (14) point characterized cam assembly for all fuels. Provide automatic operating control and manual reset high limit.
- F. FORCED DRAFT BLOWER: The Backward curved aluminum radial impeller shall be directly connected to a flanged type ODP motor. This rigid mounting shall eliminate vibration and reduce noise level. The balanced blower wheel shall be aluminum with radial blades. The combustion air damper shall be an integral rotating damper and shall be automatically adjusted for proper air quantity by a mod motor to maintain proper fuel-air ratios.
- G. EMISSION CONTROL (optional): Boiler NO_x shall be furnished with guaranteed external induced NO_x control for 30 PPM corrected to 3% O₂ over the entire turndown range. Boiler capacity, turndown, flame stability and efficiency shall not be affected by the internal NO_x control. Low NO_x system shall be part of the Boiler/Burner UL package label and manufacture shall have Twelve (12) years of emission control experience in the state of _____.

2.06 BOILER TRIM

- A. To include the following:
 - 1. _____" diameter temperature gauge.
 - 2. _____" diameter pressure gauge.
 - 3. ASME safety relief valve(s).
 - 4. Low water cutoff McD-M No. PS-750 MT-120
 - 5. Operating control.
 - 6. Limit control with manual reset.

7. _____" stack thermometer.
8. Feedwater regulating valve with 3 valve bypass
9. Low fire hold controller (optional).
10. 1 Slow Opening Blowdown Valve, Size _____", Class 200#
11. 2 Quick Opening Blowdown Valves, Size _____", Class 490#
12. Feedwater Globe Valve, Size _____", Class 240# m.
13. 1 Feedwater Check Valve, Size _____", Class 240# n.
14. 1 ASME Spool Piece, Inlet Size _____", Outlet Size _____", Length _____"
15. 1 Stop Valve (Steam Header Valve), Size _____", Flanged, Cast Iron, Class 250"
16. 1 Stop Check Valve (Non-Return Valve), Size _____", Flanged, Cast Iron, Class 250", Straight Pattern, with Free Blow Drain Valve
17. Factory mounted, installed, tested, and certified piping (by A, S, or PP ASME stamp holder) and valves per ASME Code, including:
 - Water Column piping
 - Bottom Blowdown (from boiler to last code valve)
 - Feedwater assembly (shipped loose)
 - Surface Blowdown piping with stop valve and metering valve.
18. JHB Modulating Feedwater Control Valve, including 3-Valve Bypass
19. Oil Pump, Mounted and Wired
20. Air Atomizing Compressor, Mounted and Wired
21. Platforms and ladder to access safety relief valves. Built to OSHA requirements.

2.07 BOILER CONTROLS

- A. BOILER MANAGEMENT CONTROL SYSTEM CONTROL PANEL: Boiler mounted NEMA 1 enclosure(s) with key lock; fusing, magnetic starters; step-down control transformer; flame safeguard and burner management system as indicated; annunciator lights for load demand, fuel on, low water and flame failure; selector switches, required by dry contacts, relays and terminal strips. Oil, heat and moisture resistant wire with circuit number corresponding to electrical wiring diagrams. In accordance with UL and National Electric Code.
- B. (OPTION 1) BURNER MANAGEMENT SYSTEM (CB 780-Standard): Boiler mounted in control panel enclosure. Microprocessor-based control to monitor all critical boiler and burner interlocks control and supervise burner light off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. Dynamic self checking. System to provide pre-post purge status, fault history, and diagnostic information by means of a two-line alpha-numeric display with alarm/status LEDs.
- C. (OPTION 2) CB-HAWK ICS Boiler Control System (Optional upgrade): Burner Management System (CB HAWK ICS - optional upgrade): Integrated Boiler Control and Management System: Boiler shall be factory equipped with a Boiler Control System combining a Digital Burner Management System for flame safety, and a Programmable Logic Controller for boiler modulation and operator interface functions. The factory pre-configured Boiler Control System shall integrate the Burner Management functions and the PLC based modulation and operator interface functions. The logic of the Burner Management System and the modulating controls will not be run in the same processor or powered by the same DC supply. The PLC and Operator Interface Hardware shall be as manufactured by Allen Bradley.

Major system components shall include:

1. Programmable Logic Controller
2. Touch Screen HMI
3. One Burner Management Controller with Wiring Sub-Base
4. One Flame Scanner and amplifier
5. Various Temperature and Pressure Sensors

D. Major functions provided by the Boiler Control System shall be:

1. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout and post-purge
2. Full modulating control of fuel and air
3. Utilize solid state controls and sensors to provide various control functions, such as:
 - a. Modulating control (algorithm shall be Proportional-Integral-Derivative (PID) type)
 - b. Thermal shock protection
 - c. High and Low limit alarms and shutdowns
4. Touch Screen graphical operator interface and monitoring
 - a. Manual control of the boiler firing rate using control screens on the HMI to increment or decrement the firing rate
 - b. On screen indication of burner management controller status and diagnostics
 - c. On screen display of system alarms and faults
 - d. On screen history of alarms and faults
 - e. On screen recommendations for troubleshooting of fault conditions
 - f. On screen water level indication and alarm(s)
5. Stack Flue Gas, Combustion Air and Shell (water) temperature indication
6. Boiler efficiency calculation
7. Low Fire Hold with Minimum Temperature Control
8. Assured Low Fire Cut-Off (ALFCO)

E. The Boiler Control System shall incorporate the following safety provisions:

1. Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the Burner Management System shall lockout on safety shutdown.
2. Closed-loop logic test of critical loads (ignition, pilot and main fuel valves) and must be able to lockout on safety.
3. Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
4. Dynamic checking of the flame signal amplifier.
5. Safe start check and expand check to include monitoring flame signal during standby.

6. High and Low fire switches checked for proper sequencing.
7. The Boiler Control System shall provide the ability to communicate with external digital via Ethernet as a standard. It shall be possible to communicate with any OPC compliant Internet communications shall be supported, with the Boiler Control System supplied with its own IP address.

2.08 SHOP TEST

- A. Shop test: The complete packaged boiler shall receive factory tests to check construction and function of all controls. All shop tests may be witnessed by the purchaser at his own c upon sufficient notice to the company.

2.9 ACCESSORIES - BOILER FLUE VENT

2.10 ACCESSORIES - FEEDWATER SYSTEM (BOILER FEEDSET OR DEAERATOR)

2.11 ACCESSORIES - FEEDWATER HEATER OR ECONOMIZER

2.12 ACCESSORIES - BLOWDOWN SEPARATOR AND/OR BLOWDOWN HEAT RECOVERY

2.13 ACCESSORIES - O₂ TRIM SYSTEM AND/OR

2.14 ACCESSORIES - CHEMICAL FEED SYSTEM AND/OR WATER TREATMENT

2.15 MANUFACTURES FIELD SERVICES

- A. General: The boiler and accessories supplier shall be responsible for performance of insp up and testing of the package boiler and accessory equipment and materials furnished un~ Section. A detailed written record of the start up performance, including burner setting dat entire load range shall be furnished to the test engineer before test personnel leave the sit equipment and test apparatus shall be furnished by the supplier. All equipment defects discovered by the tests shall be rectified. The minimum time for two (2) boilers is five (5) days.
- B. Equipment inspection: Boiler representative to provide _____ hours of job site assistance to i boilers and other equipment upon arrival, verifying completeness of equipment supplied ar damages. Responsibility of making freight claims to be performed by contractor or owner personnel.
- C. Pre start-up walk through: Boiler representative shall spend _____ hours at job site reviewing with mechanical contractor to be conducted approximately 1 week prior to startup.
- D. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the boiler supplier, and shall include:
 1. Demonstrate that boiler, burner, controls and accessories comply with requirement Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 2. Readings at different firing rates (25, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the test engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NOx and overall boiler efficiency.
 3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non compliance with referenced standards or overloading as applicable.

4. Commissioning Requirements:
 - a. Fireside inspection
 - b. Waterside inspection
 - c. Closing and resealing of doors, manways and hand holes
 - d. Set up fuel train and combustion air system
 - e. Set up operating set points
 - f. Check all safeties, including: Flame safeguard, LWCO, ALWCO, Air flow, Fuel pressures, High limits
 - g. Set up and verify efficiencies at 25%, 50%, 75%, and 100%
 - h. Set up and verify burner turndown.
 - i. Set up and verify feedwater/level controls
 - j. Set up and verify Emissions Compliance
5. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single-hour continuous session to accommodate operator's availability on site.
6. Special tool / safety equipment:
 - a. Boiler/burner supplier to include in their proposal safety equipment required to perform annual inspections and maintenance per OSHA requirements, Section 29CFR, 1910.146, date 4115193, Paragraphs 5.6.4.2 through 5.6.6.6 confined space requirements on rear furnace and flue gas turnaround area. Items to include respirator, tag out devices, atmospheric tester, acid suit, harness, wrist straps, life wire, and safety belt
 - b. Special Safety Training on safety procedures by a qualified trainer to be provided per OSHA Section 1910.146, Paragraph 5.6.5.2, to all owners and employees who are operating specified equipment. The cost of training to be included in boiler supplier's proposal

2.16 OPERATING & MAINTENANCE MANUALS

- A. Provide two (2) Operating and Maintenance manuals including cut-away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures. Operating and maintenance manuals shall be provided including cut-away views of boiler and burner schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.
- B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

2.17 WARRANTY DATA

- A. The entire boiler/burner package shall be guaranteed and warranted by the boiler manufacturer. Warranty shall include all parts for a period of (12) months from the date of start-up or beneficial use or 18 months from shipment, whichever comes first.

PART 3 EXECUTION

3.01 GENERAL

- A. Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced workman previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.02 INSTALLATION

- A. Install equipment in strict compliance with manufacturer's installation instructions.
- B. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
- C. Maintain manufacturer's recommended clearances around sides and over top of equipment.
- D. Install components that were removed from equipment for shipping purposes.
- E. Install components that were furnished loose with equipment for field installation.
- F. Provide all interconnecting electrical control and power wiring.
- G. Provide all fuel gas vent and service piping.
- H. Provide all piping for boiler pipe connections.

3.03 FIELD TESTING

- A. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced.
- B. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

3.04 START-UP, INSTRUCTION AND WARRANTY SERVICE

The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

Notes

MODEL CBLE

100 - 800 HP
Steam and Hot Water
Dryback Integral Burner



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Available as an option to the Model CB Firetube Dryback Boiler (125 - 800 hp), the Low Emission Option provides NO_x control, top performance, and reliable Cleaver-Brooks efficiency. The Low Emission Option combines the packaging of induced flue gas recirculation with the Cleaver-Brooks integral front head. The front head routes the flue gases from the fourth pass to the fan and burner assembly for reliable low NO_x performance. The enhanced burner design assures maximum NO_x reduction at all firing rates while maintaining top of the line boiler performance.

Standard Low Emission Options include 60, 30, 25, or 20 ppm packages (all NO_x emission levels are given on a dry volume basis and corrected to 3% O₂):

- NO_x performance for 60 ppm (natural gas corrected to 3% O₂) uses a standard size combustion air fan for induced flue gas recirculation.
- NO_x performance for 30, 25, or 20 ppm (natural gas corrected to 3% O₂) includes a larger combustion air fan/motor assembly and a larger internal NO_x reduction system.

Cleaver-Brooks' commitment to lowering emissions is based on more than 400 low NO_x installations - all passing guaranteed emission performance levels.

FEATURES AND BENEFITS

The Cleaver-Brooks Model CB Boiler - the premium firetube on the market today - includes the four-pass dryback design, five square feet of heating surface per boiler horsepower, and maximum boiler efficiency. In addition to the features of the Model CB Boiler, the Low Emission Option provides the following

Integral Front Head Design

- Single-piece front door.
- Fan cassette assembly for easy access to fan and motor.
- Guaranteed low nitrogen oxide (NOx) performance.
- Enhanced burner performance.
- Improved flame stability and combustion control.
- Intimate mixing of air and fuel assures minimum CO levels at low NOx levels.

True Boiler/Burner/Low NOx Package.

- UL/ULC approved package.
- Assures highest fuel-to-steam efficiency.
- Eliminates the need for field installation of burner, controls, or NOx equipment.
- Single point positioning of fuel and air ensures ease of startup and provides reliable operation.

PRODUCT OFFERING

The Low Emission Option currently is available on:

- 125 - 800 hp Model CB Firetube Dryback Boilers.
- High-pressure and low-pressure steam and hot water designs.
- Natural Gas, No. 2 oil, or combination fired.
- Retrofit capability.

Standard Equipment

- Model CB Firetube Boiler.
- New integral front head with internal low NOx system.
- Enhanced burner design.

Available Options

For option details, contact your local Cleaver-Brooks authorized representative.

- Full line of Model CB Firetube options.
- Additional NOx reduction packages.

DIMENSIONS AND RATINGS

The Model CB-LE dimensions and ratings are provided in Table A1-1 through Table A1-8, and in Figure A1-1 through Figure A1-6.

Table A1-1. Model CB-LE Steam Boiler Ratings

BOILER HP	125	150	200	250	300	350	400	500	600	700	750	800
RATINGS SEA LEVEL TO 700 FT												
Rated Steam Cap. (lbs/hr from and @ 212 °F)	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	25875	27600
Btu Output (1000 Btu/hr)	4184	5021	6695	8369	10043	11716	13390	16738	20085	23432	25106	26779
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY												
Light Oil (gph) ^A	36.4	43.7	58.3	72.9	87.5	102.1	116.6	145.8	175.0	204.1	218.7	233.3
Natural Gas (cfh) MBtu	5103	6124	8165	10206	12247	14288	16329	20412	24494	28576	30618	32659
Gas (Therm/hr)	51.0	61.2	81.7	102.1	122.5	142.8	163.3	204.2	245.0	285.8	306.2	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT, 60 HZ												
Blower Motor hp	Refer to Tables A1-9 and A1-10											
Oil Pump Motor, hp No. 2 Oil	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1	1
Air Compressor Motor hp (Oil firing Only)	3	3	3	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2

NOTES:

A. Based on 140,000 Btu/gal.

Table A1-2. Model CB-LE Hot Water Boiler Ratings

BOILER HP	125	150	200	250	300	350	400	500	600	700	750	800
POWER REQUIREMENTS - SEA LEVEL TO 700 FT, 60 HZ												
Rated Cap. Btu Output (1000 Btu/hr)	4184	5021	6695	8369	10043	11716	13390	16738	20085	23432	25106	26779
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY												
Light Oil (gph) ^A	36.4	43.7	58.3	72.9	87.5	102.1	116.6	145.8	175.0	204.1	218.7	233.3
Natural Gas (cfh) MBtu	5103	6124	8165	10206	12247	14288	16329	20415	24494	28576	30618	32659
Gas (Therm/hr)	51.0	61.2	81.7	102.1	122.5	142.9	163.3	204.2	245.0	285.8	306.2	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT, 60 HZ												
Blower Motor hp	Refer to Tables A1-9 and A1-10											
Oil Pump Motor, hp No. 2 Oil	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1	1
Air Compressor Motor hp (Oil firing Only)	3	3	3	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2

NOTES:

A. Based on 140,000 Btu/gal.

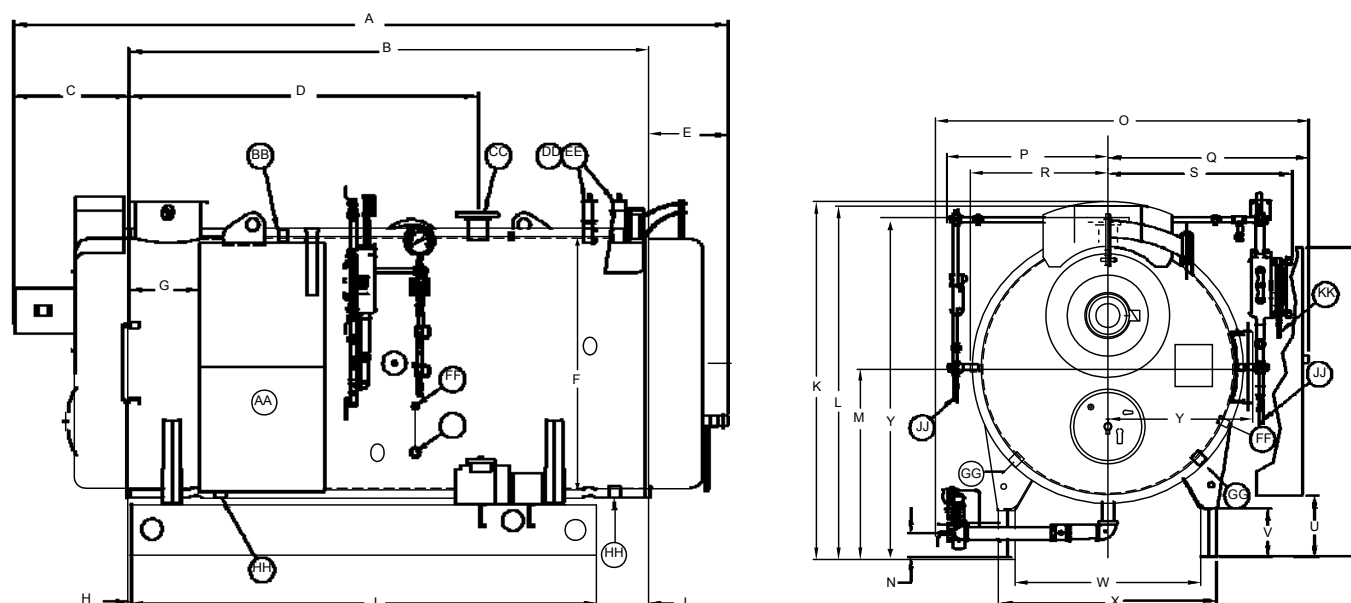


Figure A1-1. CB-LE Steam - 125-200 HP

Table A1-3. Model CB-LE Steam Boiler Dimensions, 60" (15 - 150 psig Design Pressure) - Sheet 1 of 2
(measurements shown in inches)

Measurements shown in inches

Description	DIM	Boiler HP		
		125	150	200
LENGTHS				
Length Overall	A	173	196.5	228.5
Shell	B	125	149	180
Front Head Extension	C	28	28	29
Front Ring Flange to Nozzle - 15#	D	88	90	96
Front Ring Flange to Nozzle - 150#	D	84	84	96
Rear Head Extension	E	19.5	19.5	19.5
Front Ring Flange to Panel	G	17	17	17
Ring Flange to Base	H	0.5	0.5	0.5
Base Frame	I	112	136	167
Rear Flange Ring to Base	J	12.5	12.5	12.5
HEIGHTS				
Ht Overall	K	86	86	86
Base to Vent Outlet	L	85	85	85
Base to Boiler Centerline	M	46	46	46
Base to Gas Train	N	6	8.5	8.5

Table A1-3. Model CB-LE Steam Boiler Dimensions, 60" (15 - 150 psig Design Pressure) - Sheet 2 of 2

Description	DIM	Boiler HP		
		125	150	200
HEIGHTS (continued)				
Base to Panel Top	T	75	75	77
Base to Panel Bottom	U	15	15	17
Height of Base	V	12	12	12
Base to Steam Nozzle	Y	82.38	82.38	82.38
WIDTHS				
Width Overall	O	89.88	89.875	90.5
Center to ALWCO	P	38.75	38.75	38.75
Center to Outside Control Panel	Q	48.5	48.5	48.5
Center to Lagging	R	33	33	33
Center to WC	S	44.5	45	45
Base Inside	W	44.5	44.5	44.5
Base Outside	X	52.5	52.5	52.5
Boiler I.D.	F	60	60	60
CONNECTIONS				
Electric - Main Power Supply	AA	460 / 3 / 60	460 / 3 / 60	460 / 3 / 60
Surface Blowoff (with collector pipe)	BB	1	1	1
Steam Outlet 15# (150# Flange)	CC	8	8	10
Steam Outlet 150# (300# Flange)	CC	4	4	4
Chemical Feed	FF	1	1	1
Feed Water (2)	GG	1.5	1.5	2
Blowdown/Drain (2)	HH	1.5	1.5	1.5
Water Column Blowdown	JJ	0.75	0.75	0.75
Gauge Glass Blowdown	KK	.025	0.25	0.25
VENT STACK				
Diameter (OD) (flgd. connection)		16	16	16
CLEARANCES				
Rear Door Swing (Davited)		32	32	32
Front Door Swing		67	67	67
Tube Removal, Rear		115	139	170
Tube Removal, Front		103	127	158
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL:				
From Rear of Boiler		307	355	417
From Front of Boiler		260	308	370
Through Window or Doorway		224	248	279
WEIGHT IN LBS				
Normal Water Capacity		5750	7250	8625
Approx. Ship Wt. 15 psig		11300	12600	14600
Approx. Ship Wt. 150 psig		12400	13500	15600
Approx. Ship Wt. 200 psig		13000	14200	16400

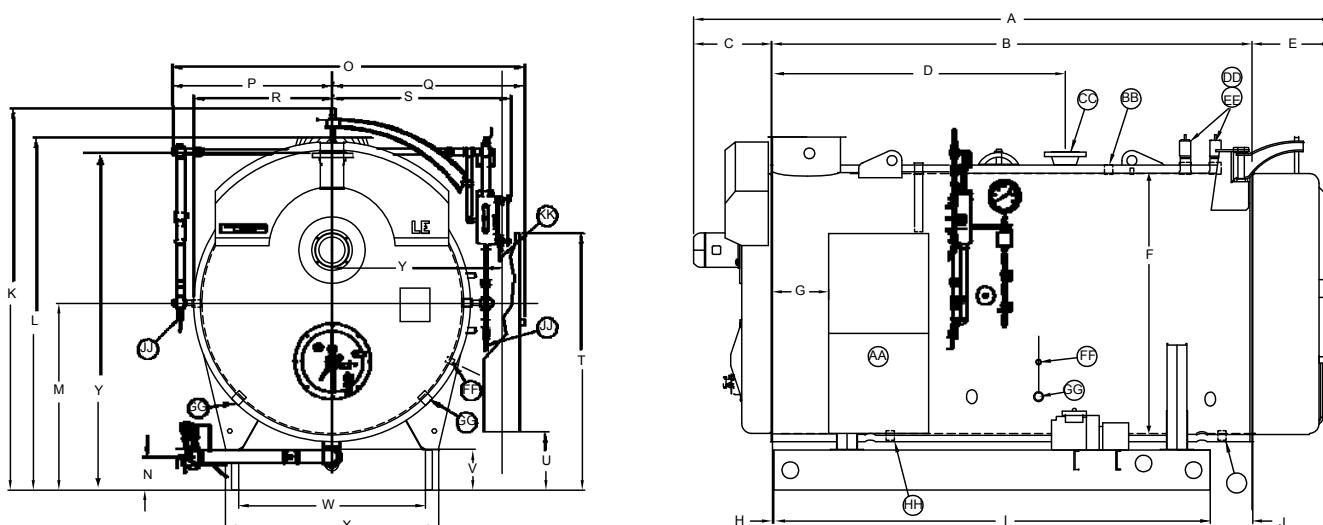


Figure A1-2. CB-LE Steam - 250-350 HP

Table A1-4. Model CB-LE Steam Boiler Dimensions, 78" (15 - 150 psig Design Pressure) - Sheet 1 of 2
(measurements shown in inches)

(Measurements shown in inches)

Description	DIM	Boiler HP		
		250	300	350
LENGTHS				
Length Overall	A	191.5	220	250
Shell	B	144	171	201
Front Head Extension	C	23.5	25	25
Front Ring Flange to Nozzle - 15#	D	90	98	112
Front Ring Flange to Nozzle - 150#	D	88	98	112
Rear Head Extension	E	24	24	24
Front Ring Flange to Panel	G	17	23	23
Ring Flange to Base	H	0.5	0.5	0.5
Base Frame	I	131	158	188
Rear Flange Ring to Base	J	12.5	12.5	12.5
HEIGHTS				
Ht Overall	K	115	115	115
Base to Vent Outlet	L	106	106	106
Base to Boiler Centerline	M	56	56	56
Base to Gas Train	N	10	10	10
Base to Panel Top	T	77	77	77
Base to Panel Bottom	U	17	17	17
Height of Base	V	12	12	12
Base to Steam Nozzle	Y	101.50	101.50	101.50

Table A1-4. Model CB-LE Steam Boiler Dimensions, 78" (15 - 150 psig Design Pressure) - Sheet 2 of 2

Description	DIM	Boiler HP		
		250	300	350
WIDTHS				
Width Overall	O	106.5	106.5	108.75
Center to ALWCO	P	48.5	48.5	48.5
Center to Outside Control Panel	Q	58	58	58
Center to Lagging	R	42	42	42
Center to WC	S	53.75	53.75	53.75
Base Inside	W	56	56	56
Base Outside	X	64	64	64
Boiler I.D.	F	78	78	78
CONNECTIONS				
Electric - Main Power Supply	AA	460 / 3 / 60	460 / 3 / 60	460 / 3 / 60
Surface Blowoff (with collector pipe)	BB	1	1	1
Steam Outlet 15# (150# Flange)	CC	10	12	12
Steam Outlet 150# (300# Flange)	CC	6	6	6
Chemical Feed	FF	1	1	1
Feed Water (2)	GG	2	2	2.5
Blowdown/Drain (2)	HH	1.5	1.5	1.5
Water Column Blowdown	JJ	0.75	0.75	0.75
Gauge Glass Blowdown	KK	0.25	0.25	0.25
VENT STACK				
Diameter (OD) (flgd. connection)		20	20	20
CLEARANCES				
Rear Door Swing		43	43	43
Front Door Swing		89	89	89
Tube Removal, Rear		131	157	187
Tube Removal, Front		116	142	172
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL				
From Rear of Boiler		364	417	477
From Front of Boiler		303	356	416
Through Window or Doorway		275	302	332
WEIGHT IN LBS				
Normal Water Capacity		10670	13000	15465
Approx. Ship Wt. 15 psig		21500	23600	26800
Approx. Ship Wt. 150 psig		22800	25200	27800
Approx. Ship Wt. 200 psig		24600	27200	29300

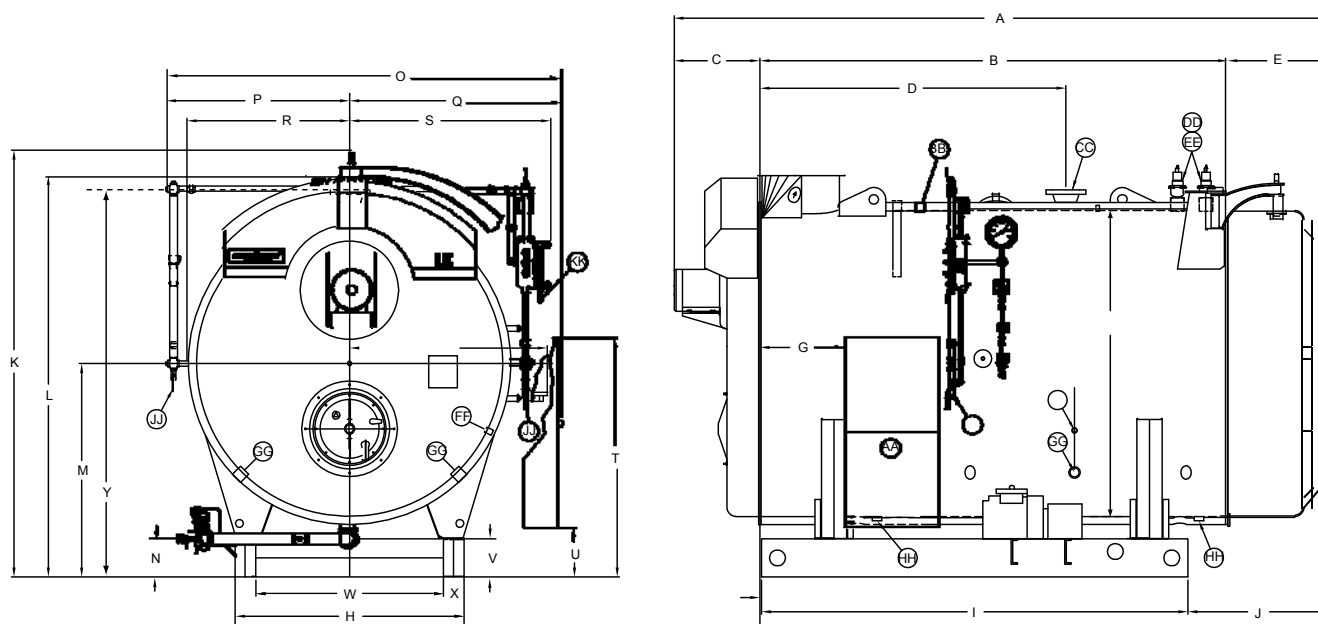


Figure A1-3. CB-LE Steam - 400-800 HP

Table A1-5. Model CB-LE Steam Boiler Dimensions, 96" (15 - 150 psig Design Pressure) - Sheet 1 of 2
(measurements shown in inches)

(measurements shown in inches)

Description	DIM	Boiler HP					
		400	500	600	700	750	800
LENGTHS							
Length Overall	A	205.75	227.75	259.75	298.75	298.75	298.75
Shell	B	146.75	167.5	199.75	232.75	232.75	232.75
Front Head Extension	C	27	28	28	34	34	34
Front Ring Flange to Nozzle - 15#	D	98	101	96	112	112	112
Front Ring Flange to Nozzle - 150#	D	96	100	96	112	112	112
Rear Head Extension	E	32	32	32	32	32	32
Front Ring Flange to Panel	G	26	26	26	26	26	26
Ring Flange to Base	H	0.5	0.5	0.5	0.5	0.5	0.5
Base Frame	I	133.75	154.75	186.75	219.75	219.75	219.75
Rear Flange Ring to Base	J	12.5	12.5	12.5	12.5	12.5	12.5
HEIGHTS							
Ht Overall	K	134	134	134	134	134	134
Base to Vent Outlet	L	126	126	126	126	126	126
Base to Boiler Centerline	M	67	67	67	67	67	67
Base to Gas Train	N	12	12	12	12	12	12
Base to Panel Top	T	75	75	75	75	75	75
Base to Panel Bottom	U	15	15	15	15	15	15
Height of Base	V	12	12	12	12	12	12
Base to Steam Nozzle	Y	121.5	123.5	121.5	121	121	121

Table A1-5 Model CB-LE Steam Boiler Dimensions, 96" (15 - 150 psig Design Pressure) - Sheet 2 of 2

Description	DIM	Boiler HP					
		400	500	600	700	750	800
WIDTHS							
Width Overall	O	124	124.25	124	124	124	124
Center to ALWCO	P	57.5	57.5	57.5	57.5	57.5	57.5
Center to Outside Control Panel	Q	66.5	66.5	66.5	66.5	66.5	66.5
Center to Lagging	R	51	51	51	51	51	51
Center to WC	S	63	63	63	63	63	63
Base Inside	W	58.88	58.88	58.88	58.88	58.88	58.88
Base Outside	X	71.88	71.88	71.88	71.88	71.88	71.88
Boiler I.D.	F	96	96	96	96	96	96
CONNECTIONS							
Electric - Main Power Supply	AA	460 / 3 / 60	460 / 3 / 60	460 / 3 / 60	460 / 3 / 60	460 / 3 / 60	460 / 3 / 60
Surface Blowoff (with collector pipe)	BB	1	1	1	1	1	1
Steam Outlet 15# (150# Flange)	CC	12	12	12	12	12	12
Steam Outlet 150# (300# Flange)	CC	6	8	8	8	8	8
Chemical Feed	FF	1	1 1		1	1 1	
Feed Water (2)	GG	2.5	2.5	2.5	2.5	2.5	2.5
Blowdown/Drain (2)	HH	2	2 2		2	2 2	
Water Column Blowdown	JJ	0.75	0.75	0.75	0.75	0.75	0.75
Gauge Glass Blowdown	KK	0.25	0.25	0.25	0.25	0.25	0.25
VENT STACK							
Diameter (OD) (flgd. connection)		24	24	24	24	24	24
CLEARANCES							
Rear Door Swing		53	53	53	53	53	53
Front Door Swing		108	108	108	108	108	108
Tube Removal, Rear		131	152	184	217	217	217
Tube Removal, Front		114	135	167	200	200	200
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL							
From Rear of Boiler		386	428	492	558	558	558
From Front of Boiler		314	356	420	486	486	486
Through Window or Doorway		308	329	361	394	394	394
WEIGHT IN LBS							
Normal Water Capacity		14810	15950	19270	23000	23000	23000
Approx. Ship Wt. 15 psig		33500	37110	42300	49500	49600	49600
Approx. Ship Wt. 150 psig		36570	39970	45025	52050	52150	52150
Approx. Ship Wt. 200 psig		39680	43580	49400	57315	57415	57415



BOILER HP	DIM	125	150	200
LENGTHS				
Overall (60 ppm System)	A	171-1/2	196-1/2	228-1/2
Shell	B	125	149	180
Base Frame	C	112	136	167
Front Head Extension (60 ppm System)	D	27	28	29
Rear Head Extension	E	19-1/2	19-1/2	19-1/2
Front Ring Flange to Outlet	HH	114	136	167
Front Ring Flange to Return	H	89	102	131
Ring Flange to Base	F	1/2	1/2	1/2
Over Tubesheets	V	113	137	168
Shell Extension	P	12	12	12
Rear Flange Ring to Base	G	12-1/2	12-1/2	12-1/2

Table A1-6. Model CB-LE Hot Water Boiler Dimensions, 60" (30 and 125 psig Design Pressure) - Sheet 2 of 2

BOILER HP	DIM	125	150	200
WIDTHS				
Overall	I	75-1/2	75-1/2	75-1/2
I.D. Boiler	J	60	60	60
Center to Entrance Box	K	42-1/2	42-1/2	42-1/2
Center to Outside Hinge	KK	35	35	35
Center to Lagging	L	33	33	33
Base, Outside	M	52-1/2	52-1/2	52-1/2
Base, Inside	N	44-1/2	44-1/2	44-1/2
HEIGHTS				
Overall	OO	86	86	86
Base to Vent Outlet	O	85	85	85
Base to Return and Outlet	X	82-3/8	82-3/8	82-3/8
Height of Base	Q	12	12	12
Base to Bottom of Boiler	R	16	16	16
BOILER CONNECTION				
Waterfill Conn. Right & Left	S	1-1/2	1-1/2	2
Auxiliary Connection	Z	1	1	1
Water Return Flange	T	6 ^A	6 ^A	6 ^A
Water Outlet Flange (2" Dip Tube Included)	U	6 ^A	6 ^A	6 ^A
Drain, Front and Rear	W	1-1/2	1-1/2	2
Air Vent	Y	1-1/2	1-1/2	1-1/2
VENT STACK				
Diameter (flgd. connection)	BB	16	16	16
MINIMUM CLEARANCES				
Rear Door Swing	DD	32	32	32
Front Door Swing	EE	67	67	67
Tube Removal, Rear	FF	115	139	170
Tube, Removal, Front	GG	103	127	158
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:				
Rear of Boiler	RR	307	355	417
Front of Boiler	RF	260	308	370
Thru Window or Doorway	RD	224	248	279
WEIGHT IN LBS				
Water Capacity Flooded		7670	9295	11130
Approx. Ship. Wgt. – 30 psig		11400	12500	14500
Approx. Ship. Wgt. – 125 psig		11800	12900	14900

NOTES: All connections are threaded unless indicated.

A. ANSI 150 psig flange.

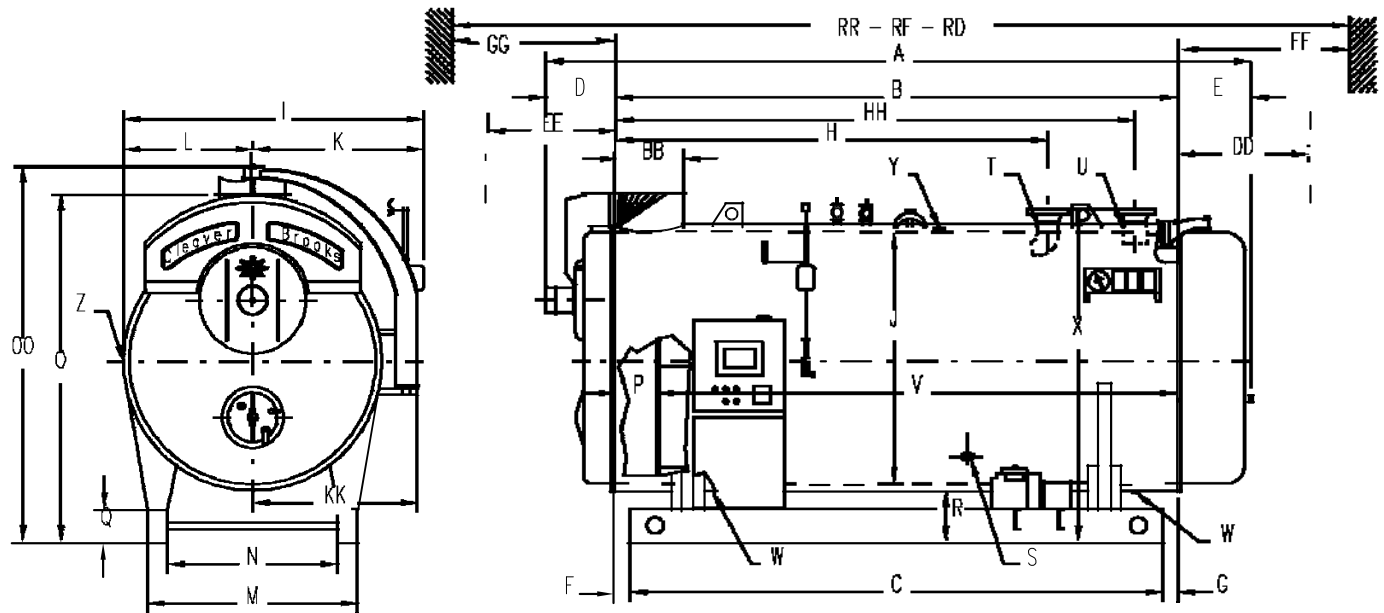


Figure A1-5. CB-LE Hot Water 250-350 HP

Table A1-7. Model CB-LE Hot Water Boiler Dimensions, 78" (30 and 125 psig Design Pressure) - Sheet 1 of 2

BOILER HP	DIM	250	300	350
LENGTHS				
Overall (60 ppm System)	A	191-1/2	220	252
Shell	B	144	171	201
Base Frame	C	131	158	188
Front Head Extension (60 ppm System)	D	23-1/2	25	27
Rear Head Extension	E	24	24	24
Front Ring Flange to Return	H	103-1/2	130	160
Front Ring Flange to Outlet	HH	131	158	188
Ring Flange to Base	F	1/2	1/2	1/2
Over Tubesheets	V	129	156	186
Shell Extension	P	15	15	15
Rear Flange Ring to Base	G	12-1/2	12-1/2	12-1/2

Table A1-7. Model CB-LE Hot Water Boiler Dimensions, 78" (30 and 125 psig Design Pressure) - Sheet 2 of 2

BOILER HP	DIM	250	300	350
WIDTHS				
Overall	I	93	93	93
I.D. Boiler	J	78	78	78
Center to Entrance Box	K	51	51	51
Center to Outside Hinge	KK	51	51	51
Center to Lagging	L	42	42	42
Base, Outside	M	64	64	64
Base, Inside	N	52	52	52
HEIGHTS				
Overall	OO	115	115	115
Base to Vent Outlet	O	106	106	106
Base to Return and Outlet	X	101-1/2	101-1/2	101-1/2
Height of Base	Q	10	10	10
Base to Bottom of Boiler	R	17	17	17
BOILER CONNECTION				
Waterfill Conn. Right & Left	S	2	2	2-1/2
Auxiliary Connection	Z	1-1/4	1-1/4	1-1/4
Water Return Flange (2" Dip Tube included)	T	8 ^A	8 ^A	8 ^A
Water Outlet Flange (2" Dip Tube Included)	U	8 ^A	8 ^A	8 ^A
Air Vent	Y	1-1/2	1-1/2	1-1/2
Drain, Front and Rear	W	2	2	2
VENT STACK				
Diameter (flgd. connection)	BB	20	20	20
MINIMUM CLEARANCES				
Rear Door Swing	DD	43	43	43
Front Door Swing	EE	89	89	89
Tube Removal, Rear	FF	131	157	187
Tube, Removal, Front	GG	116	142	172
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:				
Rear of Boiler	RR	364	417	477
Front of Boiler	RF	303	356	416
Thru Window or Doorway	RD	275	302	332
WEIGHT IN LBS				
Water Capacity Flooded		13880	16840	20090
Approx. Ship. Wgt. – 30 psig		21400	23500	26700
Approx. Ship. Wgt. – 125 psig		22200	24300	27500

NOTES: All connections are threaded unless indicated.

A. ANSI 150 psig flange.

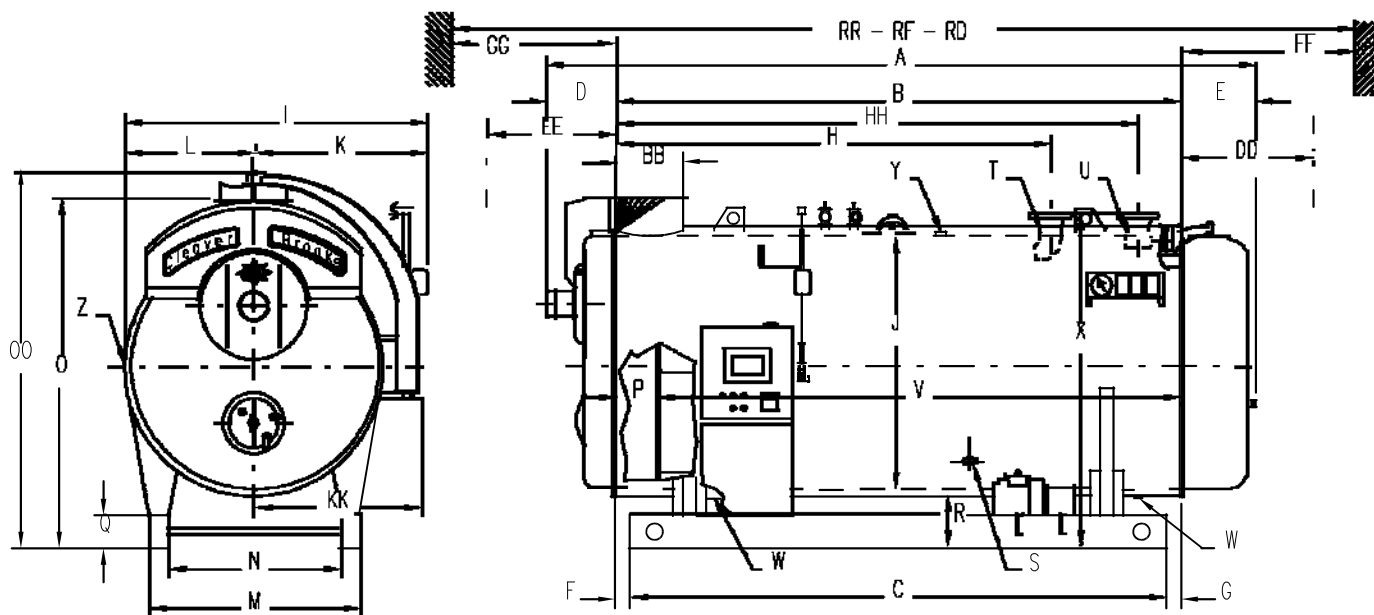


Figure A1-6. CB-LE Hot Water 400-800 HP

Table A1-8. Model CB-LE Hot Water Boiler Dimensions, 96" (30 and 125 psig Design Pressure) - Sheet 1 of 2

BOILER HP	DIM	400	500	600	700	750	800
LENGTHS							
Overall (60 ppm System)	A	206	228	262	299	300	300
Shell	B	147	168	200	233	233	233
Base Frame	C	134	155	187	220	220	220
Front Head Extension (60 ppm System)	D	27	28	30	34	35	35
Rear Head Extension	E	32	32	32	32	32	32
Shell Ring Flange to Base	F	1/2	1/2	1/2	1/2	1/2	1/2
Rear Ring Flange to Base	G	12-1/2	12-1/2	12-1/2	12-1/2	12-1/2	12-1/2
Shell Flange to Outlet	HH	139-1/2	156-1/2	182-1/2	216-1/2	216-1/2	216-1/2
Shell Flange to Return	H	107	125	151-1/2	185	185	185
Over Tubesheets	V	130	151	183	216	216	216
Shell Extension	P	17	17	17	17	17	17

Table A1-8. Model CB-LE Hot Water Boiler Dimensions, 96" (30 and 125 psig Design Pressure) - Sheet 2 of 2

BOILER HP	DIM	400	500	600	700	750	800
WIDTHS							
Overall	I	113	113	113	113	115	115
I.D. Boiler	J	96	96	96	96	96	96
Center to Entrance Box	K	62	62	62	62	64	64
Center to Outside Hinge	KK	62	62	62	62	62	62
Center to Lagging	L	51	51	51	51	51	51
Base, Outside	M	72	72	72	72	72	72
Base, Inside	N	56	56	56	56	56	56
HEIGHTS							
Overall	OO	134	134	134	134	134	134
Base to Vent Outlet	O	126	126	126	126	126	126
Height of Base	Q	12	12	12	12	12	12
Base to Bottom of Boiler	R	19	19	19	19	19	19
Base to Return and Outlet	X	121-9/16	121-9/16	121-9/16	121-9/16	121-9/16	121-9/16
BOILER CONNECTIONS							
Waterfill Connection, Right and Left	S	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2
Auxiliary Connection	Z	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Drain, Front and Rear	W	2	2	2	2	2	2
Water Return	T	10 ^A	10 ^A	12 ^A	12 ^A	12 ^A	12 ^A
Water Outlet (2" Dip Tube Included)	U	10 ^A	10 ^A	12 ^A	12 ^A	12 ^A	12 ^A
Air Vent	Y	2	2	2	2	2 2	
VENT STACK							
Diameter (Flanged Connection)	BB	24	24	24	24	24	24
MINIMUM CLEARANCES							
Rear Door Swing	DD	53	53	53	53	53	53
Front Door Swing	EE	108	108	108	108	108	108
Tube Removal, Rear	FF	131	152	184	217	217	217
Tube Removal, Front	GG	114	135	167	200	200	200
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:							
Rear of Boiler	RR	386	428	492	558	558	558
Front of Boiler	RF	314	356	420	486	486	486
Thru Window or Doorway	RD	308	329	361	394	394	394
WEIGHT IN LBS							
Normal Water Capacity		20015	23300	28260	33360	33360	33360
Approx. Ship. Wgt. – 30 psig		33300	36900	42150	49650	49750	49750
Approx. Ship. Wgt. – 125 psig		37270	40780	46005	53300	53400	53400

NOTES: All connections are threaded unless indicated:

A. ANSI 150 psig flange.

Table A1-9. Model CB-LE Blower Motor Selection - Operating Pressures 150 psig and Less, and All Hot Water Boilers

BOILER HP	MOTOR HP			
	60 PPM	30 PPM	25 PPM	20 PPM
125	5	10	5	10
150	7.5	10	10	10
200	15	15	20	NA
250	7.5	10	15	15
300	10	15	20	25
350	15	25	40	40
400	10	15	20	20
500	15	20	25	30
600	25	30	50	60
700	30	50	75	75
750	50	60	75	NA
800	50	75	NA	NA

NOTES: For elevations above 700' - contact your local Cleaver-Brooks authorized representative.

Table A1-10. Model CB-LE Blower Motor Selection - Operating Pressures Greater than 150 psig (Steam Boilers)

BOILER HP	MOTOR HP			
	60 PPM	30 PPM	25 PPM	20 PPM
125	5	10	10	10
150	10	10	10	15
200	15	20	20	NA
250	7.5	10	15	20
300	10	20	30	40
350	20	30	40	50
400	10	15	20	25
500	20	25	30	40
600	25	40	60	60
700	40	60	75 ^B	75 ^C
750	50	75	NA	NA
800	60	75 ^A	NA	NA

NOTES: For elevation above 700' - contact your local Cleaver-Brooks authorized representative.

A. Downrate to 770 hp.

B. Downrate to 675 hp.

C. Downrate to 660 hp.

Table A1-11. Blower Motor Selection CB-LE NTI Boilers

Nominal Boiler Size	15 ppm Blower Motor HP	9 ppm Blower Motor HP
125	5	5
150	7.5	10
200	15	20
250	10	10
300	20	20
350	20	25
400	20	20
500	25	30
600	40	50
700	60	75
800	75	75

* 800 HP - to be de-rated to 720 HP for 9 ppm and to 750 HP for 15 ppm.

Table A1-12. Turndown Guarantee for CB-LE NTI Boilers - Natural Gas & #2 Oil

Boiler Size	Turndown	
	9 ppm	15 ppm
125	4:1	4:1
150	4:1	5:1
200	4:1	5:1
250	5:1	5:1
300	5:1	5:1
350	5:1	5:1
400	5:1	6:1
500	5:1	6:1
600	6:1	6:1
700	7:1	7:1
800*	7:1	7:1

* 800 HP - to be de-rated to 720 HP for 9 ppm and to 750 HP for 15 ppm.

Table A1-13. Model CB-LE Boiler Weights

BOILER HP	FUEL SERIES	HOT WATER		STEAM		
		30 PSIG	125 PSIG	15 PSIG	150 PSIG	200 PSIG
125	100	11200	11600	11300	12000	12600
	200	11400	11800	11500	12400	13000
	700	11300	11700	11400	12300	12900
150	100	12300	12700	12400	13200	13900
	200	12500	12900	12600	13500	14200
	700	12300	12700	12400	13300	14000
200	100	14400	14800	14500	15500	16300
	200	14500	14900	14600	15600	16400
	700	14500	14900	14600	15600	16400
250	100	20700	21500	20800	22000	23800
	200	21400	22200	21500	22800	24600
	700	20900	21700	21000	22500	24300
300	100	23100	23900	23200	24800	26800
	200	23500	24300	23600	25200	27200
	700	23400	24200	23500	25000	27000
350	100	26200	27000	26300	27600	29100
	200	26700	27500	26800	27800	29300
	700	26400	27200	26500	27700	29200
400	100	33000	36970	33200	36270	39380
	200	33300	37270	33500	36570	39680
	700	33200	37170	33400	36470	39580
500	100	36600	40470	36810	39670	43480
	200	36900	40780	37110	39970	43580
	700	36800	40680	37010	39870	43280
600	100	41850	45905	42000	44725	49100
	200	42150	46005	42300	45025	49400
	700	42050	45915	42200	44925	49300
700 800	100	49450	53000	49300	51850	57015
	200	49750	53300	49600	52150	57315
	700	49650	53200	49500	52050	57215

NOTES:

1. Weights shown are based on standard product offering for current listed boilers. If units are of special design and construction, actual weight will be determined at time of shipment. Shipment will then be made on shipper's weight and count. All weights are in US pounds.

Table A1-14. Steam Boiler Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		100 PSIG STEAM		125 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM		300 PSIG STEAM	
BOILER HP	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)
125	1	3	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/4 (1) 1	2	1	2	1
150	1	3	2	(1) 2 (1) 1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1 (1) 1-1/4	2	1	2	1
200	2	2-1/2	2	2	2	(1) 2 (1) 1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4	2	(1) 1 (1) 1-1/4
250	2	(1) 2-1/2 (1) 3	2	(1) 2-1/2 (1) 2	2	2	2	(1) 2 (1) 1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4
300	2	3	2	(1) 2-1/2 (1) 2	2	(1) 2-1/2 (1) 2	2	(1) 2 (1) 1-1/2	2	1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
350	3	(1) 2 (2) 3	3	(1) 2-1/2 (2) 2	2	2-1/2	2	2	2	(1) 1-1/2 (1) 2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
400	3	(2) 3 (1) 2-1/2	3	(1) 2 (2) 2-1/2	2	2-1/2	2	(1) 2-1/2 (1) 2	2	(1) 1-1/2 (1) 2	2	(1) 2 (1) 1-1/2	2	1-1/2
500	3	(3) 3	3	2-1/2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	(2) 2	2	(1) 1-1/2 (1) 2
600	4	3	4	(3) 2-1/2 (1) 2	3	2-1/2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2	2	(1) 1-1/2 (1) 2
700	5	(3) 3 (2) 2-1/2	5	(3) 2-1/2 (2) 2	4	(3) 2-1/2 (1) 2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2
800	5	(3) 3 (2) 2-1/2	5	(3) 2-1/2 (2) 2	4	(3) 2-1/2 (1) 2	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2 (1) 2-1/2	2	(1) 2 (1) 2-1/2

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

Table A1-15. Hot Water Boiler Relief Valve Openings

VALVE SETTING	30 PSIG HW		60 PSIG HW		100 PSIG HW		125 PSIG HW	
BOILER HP	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)
125	1	2-1/2	1	2	1	2	1	1-1/4
150	1	2-1/2	1	2-1/2	1	2	1	2
200	2	(1) 2-1/2 (1) 1-1/4	1	2-1/2	1	2	1	2
250	2	(1) 2 (1) 2-1/2	1	2-1/2	1	2-1/2	1	2
300	2	2-1/2	2	(1) 1 (1) 2-1/2	1	2-1/2	1	2-1/2
350	3	(2) 2-1/2 (1) 1	2	(1) 2-1/2 (1) 2	1	2-1/2	1	2-1/2
400	3	(1) 2 (2) 2-1/2	2	(1) 2 (2) 2-1/2	2	(1) 1 (1) 2-1/2	1	2-1/2
500	4	(1) 1 (3) 2-1/2	2	2-1/2	2	(1) 2-1/2 (1) 1-1/4	2	(1) 1 (1) 2-1/2
600	4	(3) 2-1/2 (1) 2	3	(1) 1-1 (2) 2-1/2	2	(1) 2 (1) 2-1/2	2	(1) 2-1/2 (1) 1-1/4
700, 750 & 800	5	(1) 1 (4) 2-1/2	3	(1) 2 (2) 2-1/2	2	2-1/2	2	(1) 2-1/2 (1) 2

NOTES: Hot water relief valves are Kunkle #537.

BOILER HP	DIMENSION (INCHES)				
	A	B	C	D	E
CB-125 THRU CB-200	33	55	45	68	32
CB-250 THRU CB-350	42	69	58	86	43
CB-400 THRU CB-800	51	88	71	109	53

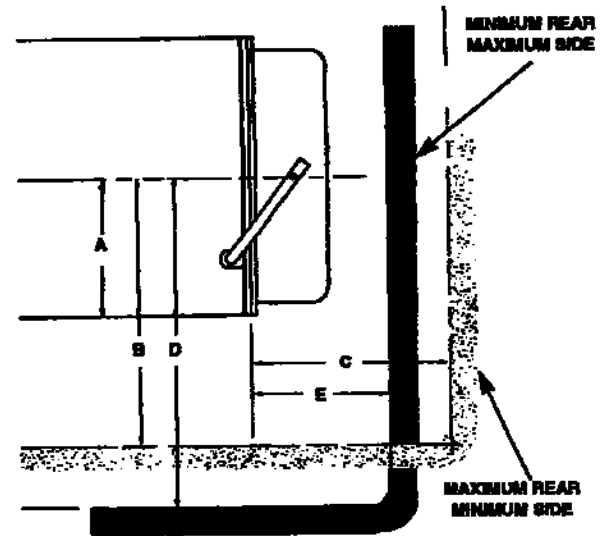
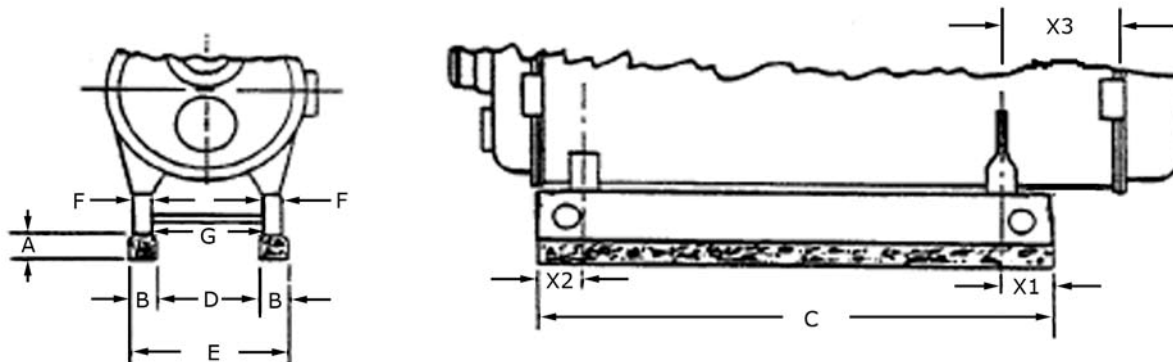


Figure A1-7. Space Required to Open Rear Head on Model CB-LE Boilers Equipped with Davits



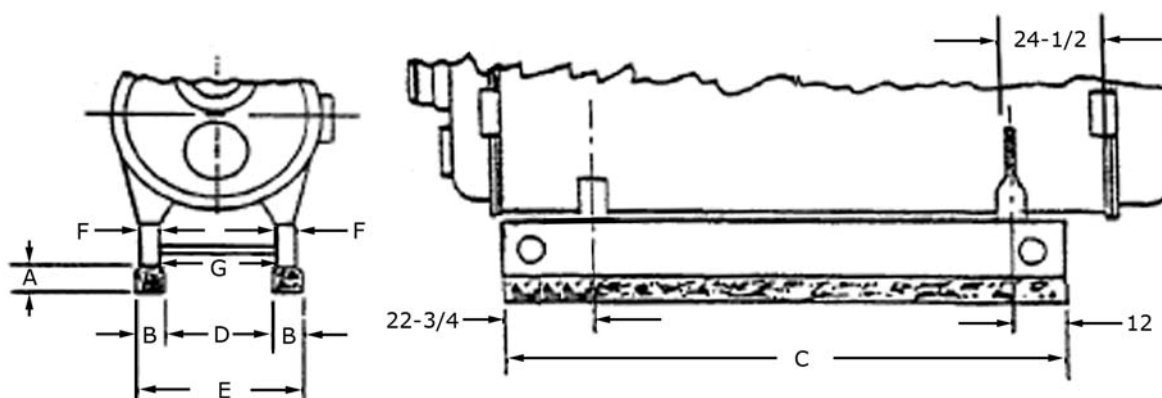
BOILER HP	A	B	C	D	E	F	G	X1	X2	X3
125	6	9	112	39-1/2	57-1/2	4	44-1/2	10	9-3/4	22-1/2
150	6	9	136	39-1/2	57-1/2	4	44-1/2	10	9-3/4	22-1/2
200	6	9	167	39-1/2	57-1/2	4	44-1/2	10	9-3/4	22-1/2
250	6	12	131	46	70	4	56	10	22	22-1/2
300	6	12	158	46	70	4	56	10	22	22-1/2
350	6	12	188	46	70	4	56	10	22	22-1/2

NOTE:

All numbers in table are in inches.

6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

Figure A1-8. Model CB-LE Boiler Mounting Piers (60" and 78")

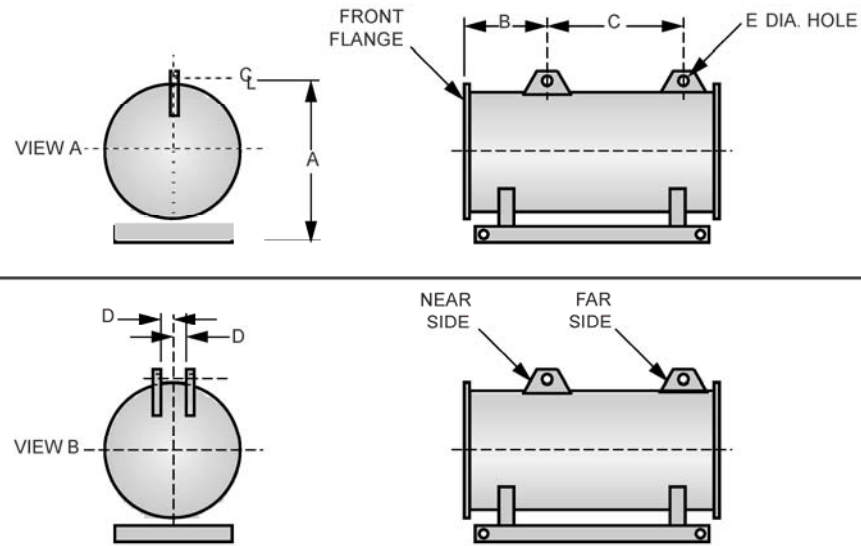


BOILER HP	A	B	C	D	E	F	G
400	6	14	134	50	78	6-1/2	58-7/8
500	6	14	155	50	78	6-1/2	58-7/8
600	6	14	187	50	78	6-1/2	58-7/8
700-750-800	6	14	220	50	78	6-1/2	58-7/8

NOTE:

1. All numbers in table are in inches.
2. 6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

Figure A1-9. Model CB-LE Boiler Mounting Piers (96")



BOILER HP		VIEW	ALL DIMENSIONS IN INCHES				
			A	B	C	D	E
125	All	B	80-1/4	29-3/4	70-1/2	10	3
150	All	B	80-1/4	29-3/4	83-1/2	10	3
200	All	B	80-1/4	29-3/4	114-1/2	10	3
250	Steam	B	99	36	72	10	3
	Hot Water	B	99	36	81	10	3
300	Steam	B	99	36	99	10	3
	Hot Water	B	99	36	108	10	3
350	Steam	B	99	36	129	10	3
	Hot Water	B	99	36	138	10	3
400	Steam	B	119	35-3/4	78	11	3
	Hot Water	B	119	35-3/4	78	11	3
500	Steam	B	119	35-3/4	99	11	3
	Hot Water	B	119	35-3/4	99	11	3
600	Steam	B	119	35-3/4	131	11	3
	Hot Water	B	119	35-3/4	131	11	3
700, 750 & 800	Steam	B	119	35-3/4	164	11	3
	Hot Water	B	119	35-3/4	164	11	3

NOTE: A, B and C dimensions may vary by 1/2 inch.

Figure A1-10. Lifting Lug Location, Model CB-LE Boilers

PERFORMANCE DATA

The Low Emission Option provides NO_x reduction at current published and predicted fuel-to-steam efficiencies.

Specifying Boiler Efficiency

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for Model CB-LE Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7768 for a detailed description of efficiency calculations).

When specifying the efficiencies in the tables, be sure to include the specific guarantee conditions to maximize the effectiveness of your efficiency specification. If you have any questions regarding the efficiency specifications, please contact your local Cleaver-Brooks authorized representative.

Efficiency Specification

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in Table A1-16 and Table A1-17) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, ten thousand dollars (\$10,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:
 - Natural Gas
Carbon,% (wt) = 69.98
Hydrogen,% (wt) = 22.31
Sulfur,% (wt) = 0.0
Heating value, Btu/lb. = 21,830
 - No. 2 Oil
Carbon,% (wt) = 85.8
Hydrogen,% (wt) = 12.7
Sulfur,% (wt) = 0.2
Heating value, Btu/lb. = 19,420
 - No. 6 Oil
Carbon,% (wt) = 86.6
Hydrogen,% (wt) = 10.9
Sulfur,% (wt) = 2.09
Heating value, Btu/lb. = 18,830
2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
3. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).
4. Any efficiency verification testing will be based on the stack loss method.

For efficiencies and stack temperatures at operating pressures not listed, follow these procedures:

When the operating steam pressure is between 10 psig and 125 psig, interpolate the values from the efficiency tables.

When the operating steam pressure is above 125 psig, estimated efficiency can be calculated as follows:

Example:

Boiler: 350 hp.

Fuel: natural gas.

Operating steam pressure: 200 psig.

Find the fuel-to-steam efficiency at 100% firing rate. From Table A1-16 for a 350 hp boiler operating at 100% firing rate and an operating steam pressure of 125 psig, the efficiency is 82.5%.

Using Figure A1-11, note that the stack temperature increases 36 °F at the higher operating pressure. To estimate boiler efficiency, use this rule of thumb: For every 40 °F increase in stack temperature, efficiency decreases by 1%. Since the stack temperature rise is 36 °F, the decrease in the boiler efficiency at 200 psig operating pressure is calculated as follows: $36/40 = .9\%$. Therefore, the boiler efficiency at 200 psig operating pressure is $82.5 - .9 = 81.6\%$

Emissions

The emission data included in this section consists of typical emission levels for Model CB boilers equipped with 60, 30, 25, and 20 ppm LE Options when firing natural gas and No. 2 oil.

Notice

The data in Table A1-18 and Table A1-19 represent typical emission levels only. Guaranteed emission levels are available from your local Cleaver-Brooks authorized representative.

Table A1-16. Predicted Fuel-to-Steam Efficiencies - Natural Gas

BOILER HP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
125	83.3	83.6	83.4	83.2	80.4	80.9	81.0	81.0
150	84.4	84.6	84.5	84.3	81.5	82.0	82.0	82.1
200	85.0	85.3	85.1	84.9	82.2	82.7	82.7	82.7
250	85.0	84.7	84.0	83.3	82.0	82.0	81.6	81.3
300	85.3	85.3	84.6	83.9	82.6	82.7	82.2	81.9
350	85.3	85.7	85.2	84.5	82.6	83.2	82.8	82.5
400	84.5	84.7	84.6	84.4	81.8	82.2	82.4	82.2
500	85.5	85.7	85.5	85.2	82.8	83.2	83.3	83.1
600	85.7	86.0	85.8	85.6	82.9	83.5	83.6	83.5
700	85.7	86.2	86.0	85.7	83.0	83.6	83.6	83.6
750, 800	85.8	86.1	85.9	85.6	83.1	83.6	83.7	83.5

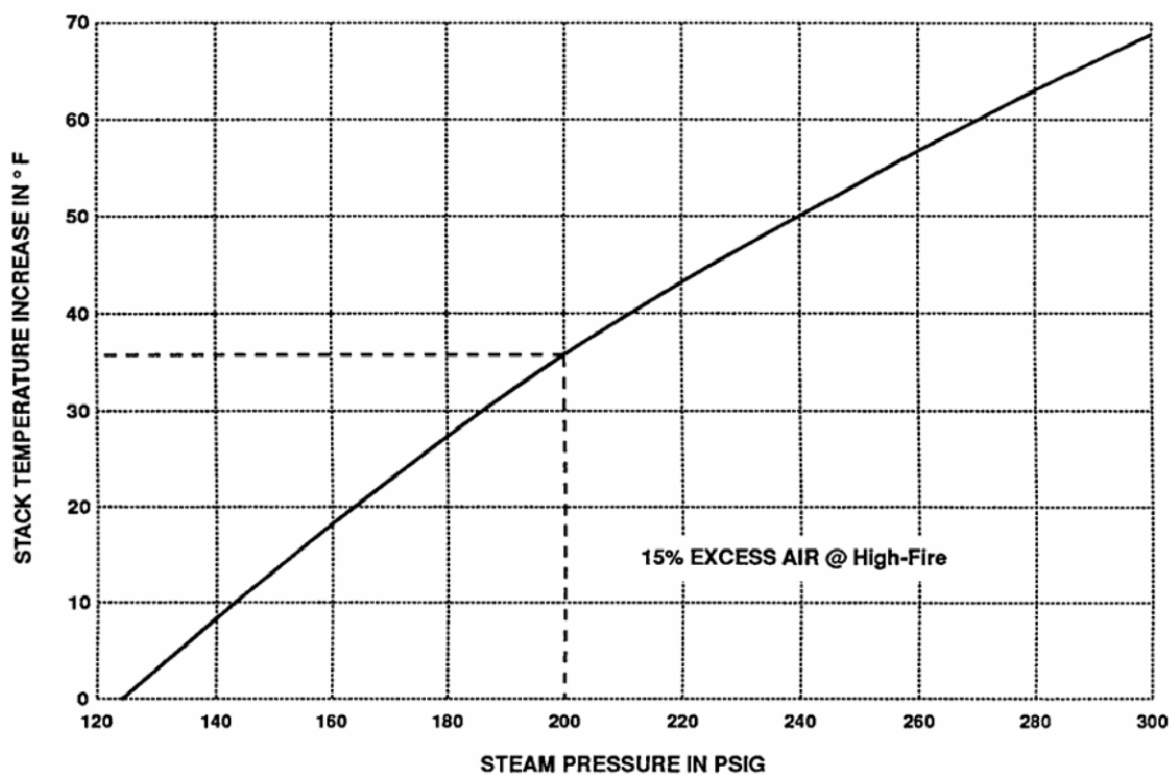


Figure A1-11. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig

Table A1-17. Predicted Fuel-to-Steam Efficiencies - No. 2 Oil

BOILER HP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
125	86.7	86.9	86.7	86.6	83.7	84.2	84.3	84.3
150	87.8	88.0	87.8	87.6	84.8	85.3	85.3	85.4
200	88.4	88.7	88.4	88.2	85.6	86.0	86.0	86.0
250	88.3	88.1	87.4	86.7	85.3	85.3	84.9	84.7
300	88.6	88.7	88.0	87.3	85.9	86.0	85.5	85.2
350	88.6	89.0	88.5	87.8	85.9	86.6	86.1	85.8
400	87.9	88.1	87.9	87.6	85.1	85.5	85.6	85.5
500	88.9	89.0	88.9	88.6	86.1	86.5	86.6	86.4
600	89.0	89.4	89.2	89.0	86.2	86.8	86.9	86.8
700	89.1	89.5	89.3	89.1	86.3	86.9	87.0	86.9
750, 800	89.2	89.5	89.3	89.0	86.4	86.9	87.0	86.8

Table A1-18. CB-LE Boilers - Natural Gas, Emission Levels

POLLUTANT		ESTIMATED LEVEL					
		60 ppm	30 ppm	25 ppm	20 ppm	15 ppm	9 ppm
CO	ppm ^A lb/MMBtu	50/150 ^B 0.04/0.11	50/150 ^B 0.04/0.11	50/150 ^B 0.04/0.11	50/150 ^B 0.04/0.11	50 0.04	50 0.04
NOx	ppm ^A lb/MMBtu	60 0.07	30 0.035	25 0.03	20 0.024	15 0.018	9 0.011
SOx	ppm ^A lb/MMBtu	1 0.001	1 0.001	1 0.001	1 0.001	1 0.001	1 0.001
HC/VOC ₅	ppm ^A lb/MMBtu	10 0.004	10 0.004	10 0.004	10 0.004	10 0.004	10 0.004
PM	ppm ^A lb/MMBtu	- 0.01	- 0.01	- 0.01	- 0.01	- 0.01	- 0.01

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

B. CO emission for 60, 30, 25 & 20 ppm system is 50 ppm (0.04 lb/MMBtu) when boiler is operating above 50% of rated capacity. CO emission is 150 ppm (0.11 lb/MMBtu) when boiler is operating below 50% of rated capacity.

Table A1-19. CB-LE Boilers - No. 2 Oil, Emission Levels

POLLUTANT		ESTIMATED LEVEL			
		60 ppm LE Option	30, 25, 20 ppm LE Option	15 ppm	9 ppm
CO	ppm ^A lb/MMBtu	50 0.039	50 0.039	50 0.039	50 0.039
NOx	ppm ^A lb/MMBtu	140 0.186	90 0.120	85 0.113	70 0.093
SOx	ppm ^A lb/MMBtu	278 0.52	278 0.52	278 0.52	278 0.52
HC/VOCs	ppm ^A lb/MMBtu	4 0.002	4 0.002	4 0.002	4 0.002
PM	ppm ^A lb/MMBtu	- 0.025	- 0.025	- 0.025	- 0.025

A. ppm levels are given on a dry volume basis and corrected to 3% oxygen (15% excess air). BASED ON THE FOLLOWING CONSTITUENT LEVELS:

Fuel-bound Nitrogen content = 0.015% by weight.

Sulfur content = 0.5% by weight.

Ash content = 0.01% by weight.

ENGINEERING DATA

Sound Level

Table A1-19 gives a summary of predicted sound pressure levels for Model CB boilers with 30 ppm LE Options. Contact your local Cleaver-Brooks authorized representative for sound levels or other LE Options.

Units

The units for the sound level tables are dbA (decibels, measured on the A-weighted scale) in reference to 0.0002 microbars (20 micro-Newtons per square meter). Their reference are standardly used in specifying and reporting sound pressure levels on industrial equipment.

Test Method

The sound pressure levels in the above tables were obtained from tests in accordance with the "ABMA Test Code for the Measurement of Sound from Packaged Boilers". In accordance with this code the sound pressure levels reported were measured on the boiler centerline 4-1/2 feet vertically above the bottom of the base rails and 3 feet horizontally in front of the end of the blower motor or front surface of the electrical cabinet.

Sound Level Meter

The sound level meter used complies with ANSI S1.4, Type 1 (Precision). The readings are taken with the meter set for slow response and corrected for background levels.

Sound Pressure

The large size boilers, the need for auxiliary equipment, and the necessary interconnecting piping make it impractical (and sometimes impossible) to provide a boiler testing environment which is suitable for taking the data needed to develop Sound Pressure Power levels.

Typical Values

Sound pressure levels (dbA) for the same boiler will vary between boiler rooms. Sound levels will vary with motor type, NOx levels, and altitudes. In addition, variations will occur between different people using different sound meters on the same boiler. And finally, no two boilers can be expected to give precisely the same sound levels. For these reasons, we can only predict, but not guarantee, sound levels (dbA).

Table A1-20. Model CB-LE Predicted Sound Levels 30 ppm NOx Systems

BOILER HP	125	150	200	250	300	350	400	500	600	700	750	800
HFO, dbA	84	84	84	83	84	85	84	85	85	88	89	90
LFO, dbA	82	82	83	81	82	83	82	83	83	84	87	89
HFG, dbA	82	82	83	82	83	84	83	83	85	87	89	90
LFG, dbA	81	81	82	81	82	83	81	81	82	84	86	88

NOTES

1. Sound pressure levels measured on boilers operating in various locations and expressed in dbA are as shown:
2. Based on standard altitude fans and fan motors, 60 Hz.
3. Contact your local Cleaver-Brooks authorized representative for sound levels of 60, 25, or 20 ppm LE Options.

ABBREVIATIONS: HF = High Fire LF = Low Fire O = Oil G = Gas

Gas-Fired Burners

Table A1-20 shows gas pressure with standard, over- and undersized gas trains.

Table A1-21 shows recommended NTI gas train sizes and pressure ranges.

Table A1-22 shows minimum required gas pressure altitude conversion.

Figure A1-12 shows standard gas train sizes and locations for Model CB Firetube Boilers.

Figure A1-13 shows typical gas train piping layouts for multiple boiler applications.

Figure A1-14 shows standard gas train components.

Table A1-21. Standard, Undersize, and Oversize Gas Trains

Boiler HP	CBLE 20 PPM		CBLE 30 PPM		CBLE 60 PPM	
	Gas Train Size, in	Pressure PSI	Gas Train Size, in	Pressure PSI	Gas Train Size, in	Pressure PSI
125	1.5	0.8 - 3.0	1.5	0.7 - 3.0	1.5	0.7 - 3.0
150	1.5	1.0 - 3.0	1.5	0.9 - 3.0	1.5	0.9 - 3.0
200	NA	NA	1.5 2	1.5 - 4.0 1.0 - 1.5	1.5 2	1.5 - 4.0 1.0 - 1.5
250	1.5 2	2.4 - 5.0 1.6 - 2.4	1.5 2	2.4 - 5.0 1.5 - 2.4	1.5 2	2.3 - 5.0 1.5 - 2.3
300	1.5-2 2 3	3.0 - 5.0 2.0 - 3.0 1.3 - 2.0	1.5-2 2 3	3.0 - 5.0 2.0 - 3.0 1.3 - 2.0	1.5-2 2 3	3.0 - 5.0 1.9 - 3.0 1.2 - 1.9
350	1.5-2 2 2.5 3	4.2 - 6.5 3.2 - 4.2 2.5-3.2 1.8 - 2.5	1.5-2 2 2.5 3	4.2 - 6.5 3.1 - 4.2 2.5-3.1 1.7 - 2.5	1.5-2 2 2.5 3	3.8 - 5.0 2.8 - 3.8 2.1 - 2.8 1.4 - 2.1
400	1.5-2 2 2.5 3	4.6 - 7.0 3.1 - 4.6 2.5 - 3.1 1.4 - 2.3	1.5-2 2 2.5 3	4.6 - 7.0 3.1 - 4.6 2.5 - 3.1 1.4 - 2.3	1.5-2 2 2.5 3	4.6 - 7.0 3.1 - 4.6 2.3 - 3.1 1.4 - 2.3
500	1.5-2.5 2-2.5 2.5 3	6.9 - 10.0 5.0 - 6.9 3.6 - 5.0 2.2 - 3.6	1.5-2.5 2-2.5 2.5 3	6.9 - 10.0 5.0 - 6.9 3.5 - 5.0 2.2 - 3.5	1.5-2.5 2-2.5 2.5 3	6.8 - 10.0 4.9 - 6.8 3.5 - 4.9 2.2 - 3.5
600	1.5-2.5 2-2.5 2.5 2.5-3 3	9.7 - 10.0 7.0 - 9.7 5.0 - 7.0 4.3 - 5.0 2.9 - 4.3	1.5-2.5 2-2.5 2.5 2.5-3 3	9.6 - 10.0 6.9 - 9.6 4.9 - 6.9 4.2 - 4.9 2.9 - 4.2	1.5-2.5 2-2.5 2.5 2.5-3 3	9.5 - 10.0 6.8 - 9.5 4.9 - 6.8 4.2 - 4.9 2.8 - 4.2
700	2-3 2.5-3 3 4	8.7 - 10.0 5.6 - 8.7 3.8 - 5.6 2.9 - 3.8	2-3 2.5-3 3 4	8.6 - 10.0 5.5 - 8.6 3.7 - 5.5 2.8 - 3.7	2-3 2.5-3 3 4	8.6 - 10.0 5.5 - 8.69 3.7 - 5.5 2.8 - 3.7
750	NA	NA	2.5-3 3 4	6.9 - 10.0 4.6 - 6.9 3.2 - 4.6	2.5-3 3 4	6.9 - 10.0 4.6 - 6.9 3.2 - 4.6
800	NA	NA	2.5-3 3 4	7.2 - 10.0 5.0 - 7.2 3.7 - 5.0	2.5-3 3 4	7.1 - 10.0 4.9 - 7.1 3.6 - 4.9

UNDERSIZE
STANDARD
OVERSIZE

Note: Some units list two diameters because the gas train increases in size after the regulating valve. The first number is the customer connection size.

Table is based on Siemens gas train, which includes a regulating actuator.

Table A1-22. Recommended NTI Gas Train Sizes and Pressure Ranges

Boiler HP	LE 15 PPM		LE 9 PPM	
	Gas Train Size, in	Pressure Range PSI	Gas Train Size, in	Pressure Range PSI
125	1.5	3.3 - 6.0	1.5	3.3 - 6.0
150	1.5	3.9 - 6.0	1.5	4.1 - 6.0
200	1.5	4.5 - 7.0	1.5	4.5 - 7.0
250	1.5 - 2	4.4 - 7.0	1.5 - 2	4.1 - 7.0
300	1.5 - 2	6.1 - 9.0	1.5 - 2	5.9 - 9.0
	2	4.8 - 6.1	2	4.6 - 5.9
350	1.5 - 2	5.1 - 7.5	1.5 - 2	6.2 - 9.0
	2	4.1 - 5.1	2	5.2 - 6.2
	2.5	3.4 - 4.1	2.5	4.5 - 5.2
400	1.5 - 2	7.3 - 10.0	1.5 - 2	7.2 - 10.0
	2	5.8 - 7.3	2	5.7 - 7.2
	2.5	5.0 - 5.8	2.5	4.9 - 5.7
	3	4.1 - 5.0	3	4.0 - 4.9
500	1.5 - 2	8.1 - 10.0	1.5 - 2	8.1 - 10.0
	2	6.1 - 8.1	2	6.1 - 8.1
	2.5	4.7 - 6.1	2.5	4.7 - 6.1
	3	3.4 - 4.7	3	3.4 - 4.7
600	2 - 2.5	7.8 - 10.0	2 - 2.5	7.8 - 10.0
	2.5	5.8 - 7.8	2.5	5.8 - 7.8
	3	4.4 - 5.8	3	4.4 - 5.8
700	2.5 - 3	7.7 - 10.0	2.5 - 3	8.0 - 10.0
	3	5.9 - 7.7	3	6.2 - 8.0
720			2.5 - 3	8.2 - 10.0
			3	6.3 - 8.2
750	2.5 - 3	8.6 - 10.0		
	3	6.7 - 8.6		
Note: Some units list two diameters because the gas train increases in size after the regulating valve. The first number is the customer connection size. Table is based on Siemens gas train, which includes a regulating actuator.			UNDERSIZE	
			STANDARD	
			OVERSIZE	

Table A1-23. Minimum Required Regulated Gas Pressure Altitude Conversion

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

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

Oz/sq-in x 1.732 = Inches WC

Inches WC x 0.0361 = psig.

Oz/sq-in x 0.0625 = psig.

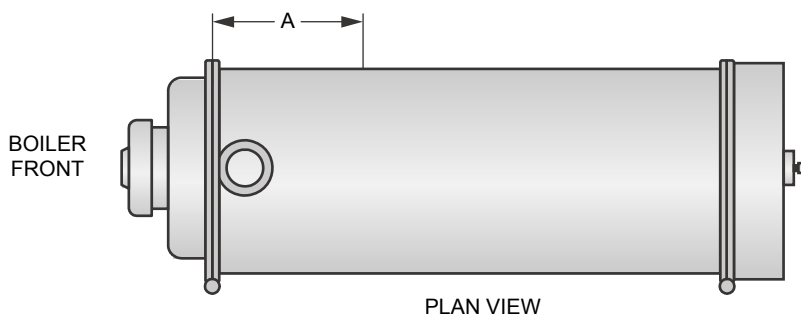
Psig x 27.71 = Inches WC

Psig x 16.0 = Oz/sq-in.

Table A1-24. Maximum Gas Consumption (CFH) for Natural Gas and Propane Vapor

BOILER HP	TYPE OF GAS AND HEAT CONTENT	
	NATURAL GAS 1000 (Btu/cu-ft)	PROPANE GAS 2550 (Btu/cu-ft)
125	5103	2000
150	6124	2402
200	8165	3202
250	10206	4002
300	12247	4802
350	14280	5600
400	16329	6404
500	20415	8006
600	24494	9605
700	28576	11206
750	30618	12007
800	32659	12807

BOILER HP	MODEL CB	
	CONNECTION SIZE (IN. NPT)	LOCATION DIMENSION "A" (IN.)
125-200	1-1/2	52
250-350	2	56
400	2	58
500	2-1/2	60
600	2-1/2 - 3	71
700-800	3	65

**Figure A1-12. Standard Gas Train Connection Size and Location**

Oil-Fired Burners

Fuel oil consumption information is shown on the boiler rating sheets in the Dimensions and Rating Section.

Figure A1-15 shows the oil connection sizes and locations for Model CB Boilers firing No. 2 oil.

Figure A1-16 through Figure A1-18 show typical oil systems and layouts.

Figure A1-19 and Figure A1-20 show the detail of an oil transfer tank (day tank) typically utilized to provide a storage reservoir between the oil system supply pump and the boiler oil pump.

General Boiler Information

Table A1-24 shows blowdown tank sizing information.

Table A1-25 provides heating surface information.

Table A1-26 provides steam volume and disengaging area information

Table A1-27 provides recommended steam nozzle sizes.

Table A1-28 provides recommended non-return valve sizes.

Boiler Room Information

Figure A1-21 shows typical boiler room length requirements.

Figure A1-22 shows typical boiler room width requirements.

Figure A1-23 shows typical breeching arrangements.

Stack Support Capabilities

All standard Cleaver-Brooks Firetube Boilers with an LE option can support up to 2,000 lbs without additional support.

LE Boilers 250 hp through 800 hp can be reinforced to support 3,000 lbs.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Model CB-LE is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.

- 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - E. Size the openings by using the formula: $\text{Area (sq-ft)} = \text{CFM/FPM}$
2. Amount of air required (cfm).
- A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp
 - C. Total recommended air = 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
- A. From floor to (7) foot height - 250 fpm
 - B. Above (7) foot height - 500 fpm

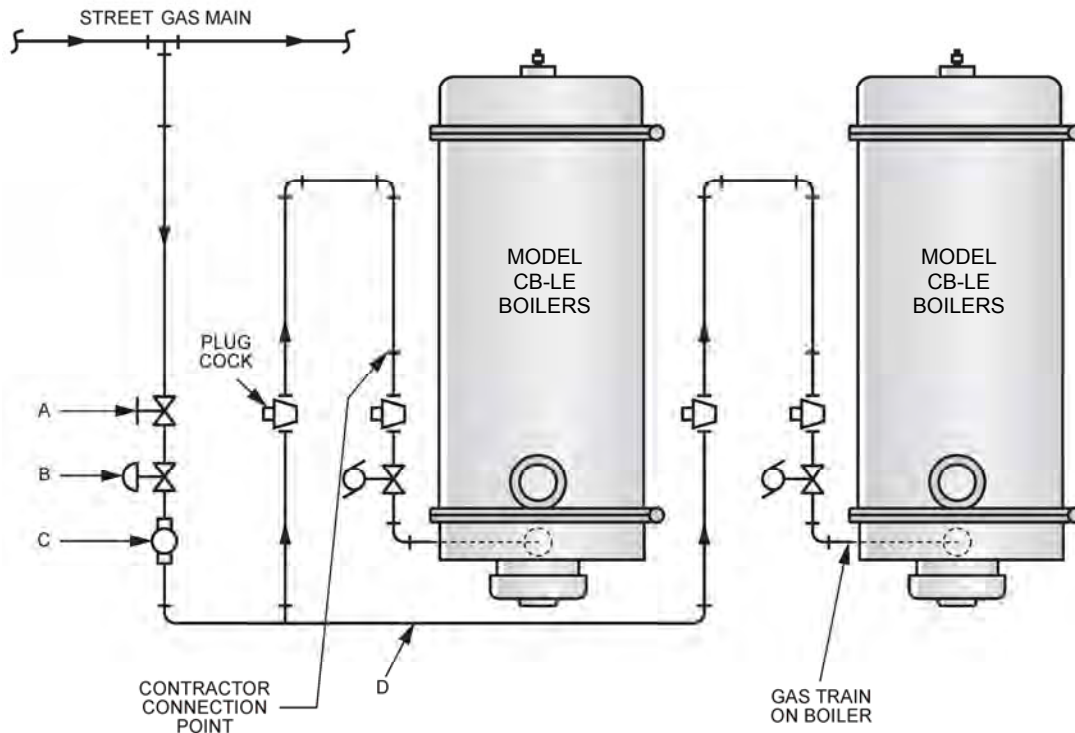
Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} = 3000/250 = 12$ sq-ft total.
- Area/Opening: $12/2 = 6$ sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

This figure illustrates the basic gas valve arrangement on Cleaver-Brooks Model CB boiler and shows the contractor's connection point. The valves and controls between the contractor connection point and the gas main in the street are representative of a typical installation. Actual requirements may vary depending on local codes or local gas company requirements which should be investigated prior to preparation of specifications and prior to construction.



- A. Utilities service valve.
- B. Utilities service regulator.
- C. Gas meter.
- D. Piping from meter to boiler.

The size of the gas line from the meter to the gas pressure regulator at the boiler can be very important if gas pressures are marginal. The gas line sizing is dependent on:

1. Gas pressure at outlet of gas meter (C)
2. Rate of gas flow required, CFH
3. Length of pipe run (D)
4. Pressure required at contractor connection point.

The local gas utility will advise the pressure that is available at the outlet of their meter.

Figure A1-13. Typical Gas Piping Layout

ITEM	DESCRIPTION	UL		FM		CSD-1	NFPA-85
		125 hp - 300 hp	350 hp - 800 hp	125 hp - 300 hp	350 hp - 800 hp	125 hp - 300 hp	350 hp - 800 hp
1	Pilot Shut Off Cock	X	X	X	X	X	X
2	Pilot Pressure Regulator	X	X	X	X	X	X
3	Pilot Pressure Gauge	X	X	X	X	X	X
4	Gas Pilot Valve	X	X	X	X	X	X
5	Pilot Vent Valve						X
6	Gas Pilot Valve						X
7	Manual Shut Off Valve	X	X	X	X	X	X
8	Low Gas Pressure Switch	X	X	X	X	X	X
9	Main Gas Valve w/o POC	X	X	X		X	
10	Main Gas Valve w/ POC				X		X
11	Vent Valve or Valve Proving Switch		X		X		X
12	Regulating Gas Valve w/ POC	X	X	X	X	X	X
13	High Gas Pressure Switch	X	X	X	X	X	X
14	Manual Shut Off Valve	X	X	X	X	X	X
15	Butterfly Valve	X	X	X	X	X	X

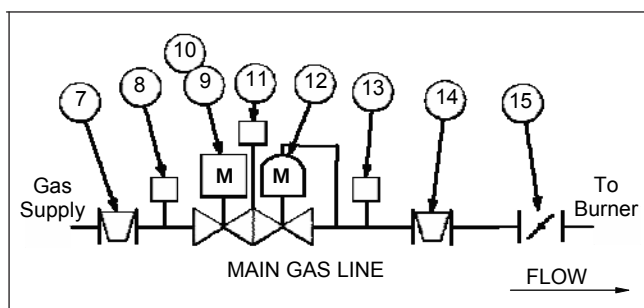
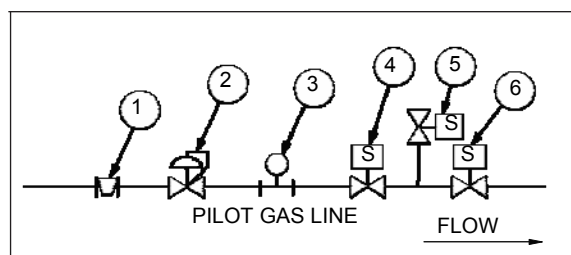
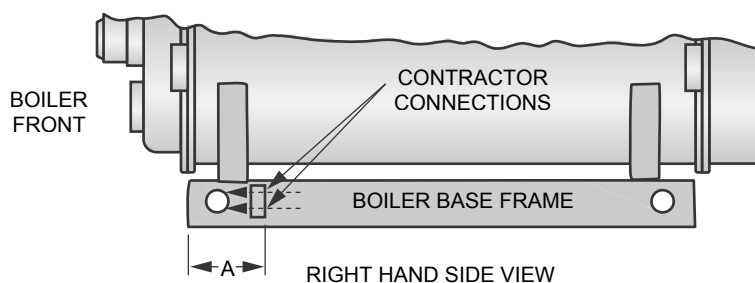


Figure A1-14. Model CB-LE Gas Train Components



BOILER HP	MODEL CB				
	SUPPLY AND RETURN CONN SIZES (IN.) (NPT)	A (IN.)	RECOMMENDED OIL LINE ^A SIZES (STANDARD PIPE) (IN. - IPS)		
			STORAGE TANK TO BOILER OR PUMP CONNECT	PUMP TO BOILER	RETURN LINE TO TANK
125 150 200	3/4	12-1/2	1	1	1
250 300 350	3/4	34	1	1	1
400 500 600	3/4	11-3/4	1	1	1
700 750 800	1	11-3/4	1	1	1

NOTE: See No. 2 Oil Line Sizing Instruction for systems with other conditions.

A. For suction line condition with a maximum of 10 Feet of lift and a total of 100 feet of suction line.

Figure A1-15. No. 2 Oil Connection Size, Location, and Recommended Line Sizes

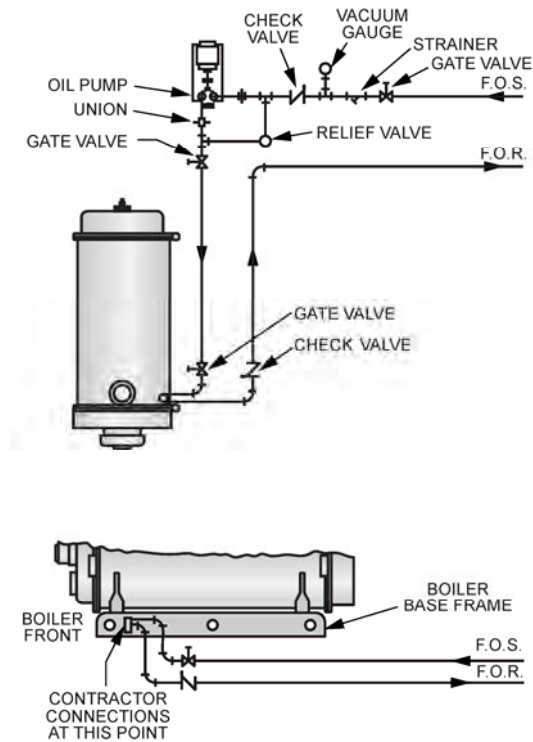


Figure A1-16. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump

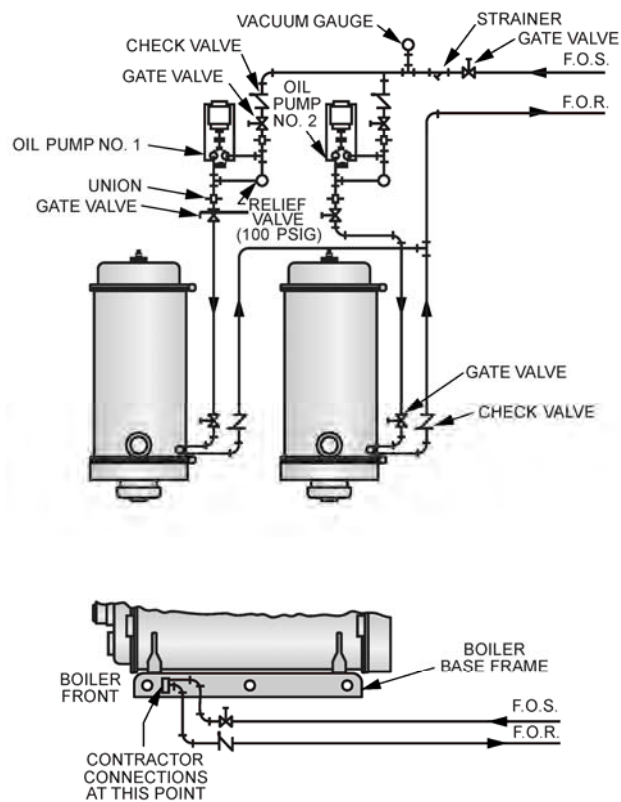


Figure A1-17. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

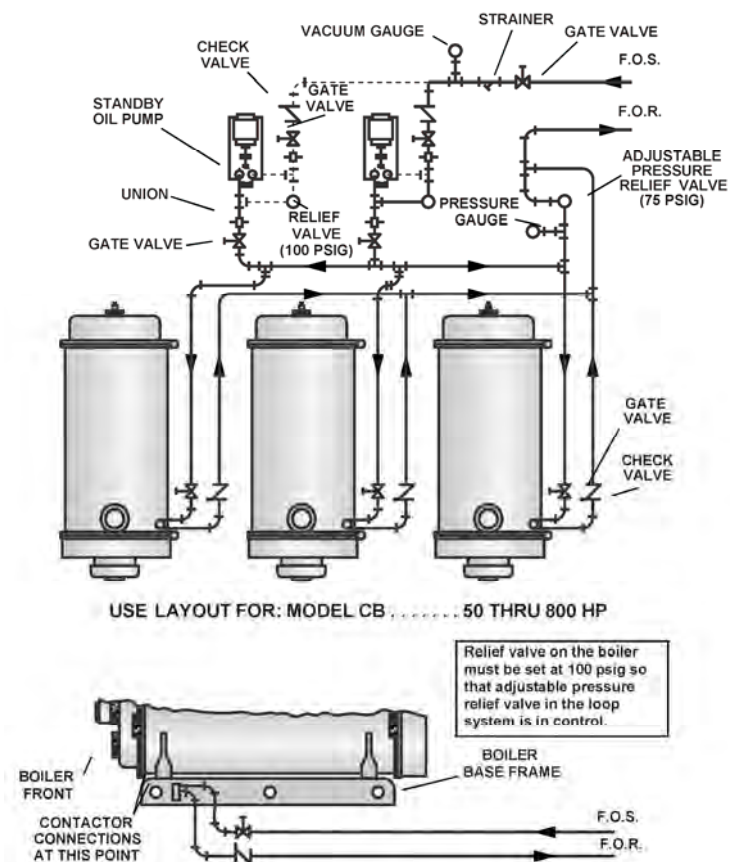


Figure A1-18. No. 2 Oil Piping, Multiple Boiler Installation

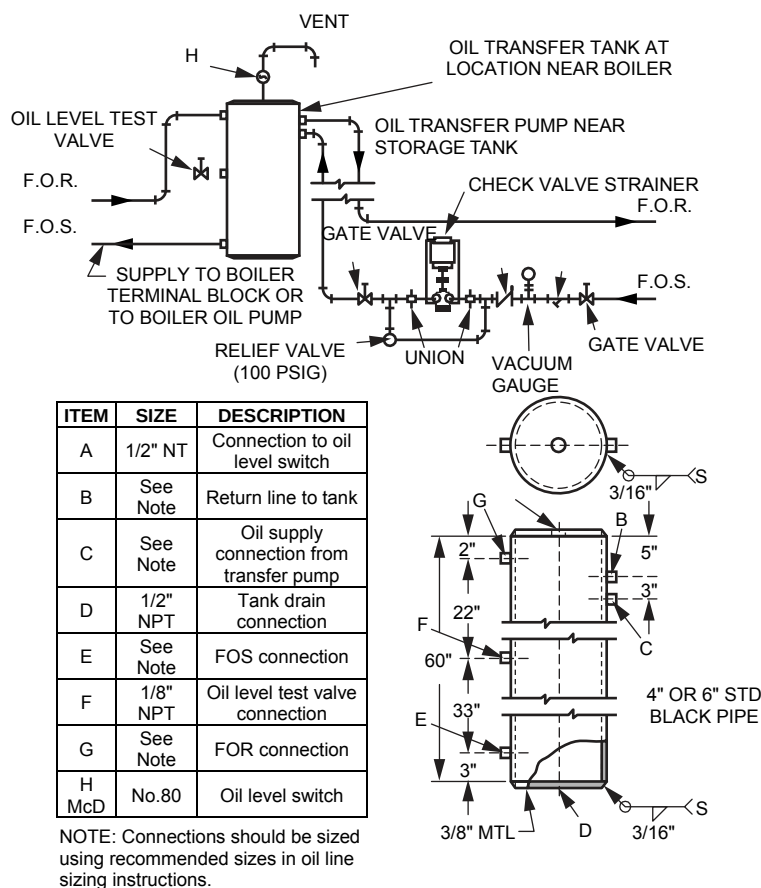


Figure A1-19. No. 2 Oil Piping

(For elevated boiler room locations sized using recommended sizes in oil line sizing instructions.)

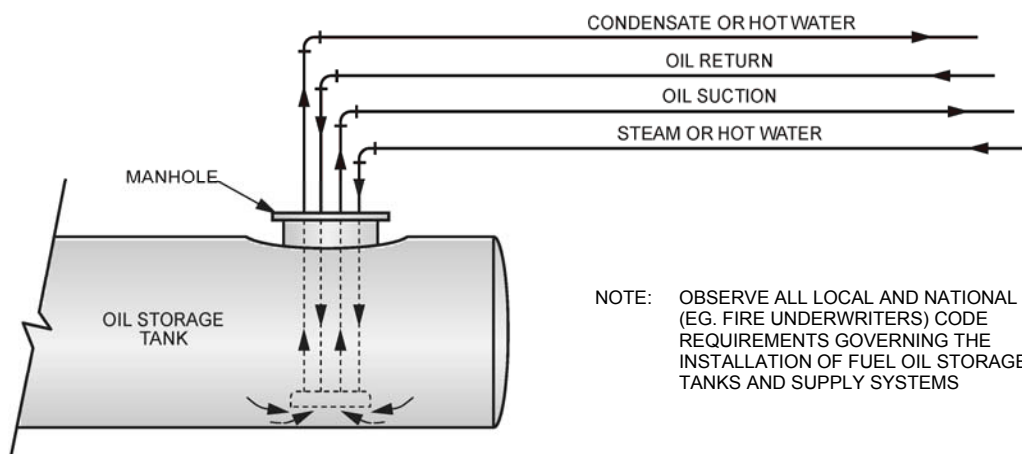


Figure A1-20. Typical Arrangement

Table A1-25. Model CB-LE Blowdown Tank Sizing

BOILER HP	WATER (GAL)
125	97
150	118
200	145
250	146
300	176
350	210
400	177
500	209
600	250
700, 750, 800	296

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Table A1-26. Heating Surface, Model CB-LE

BOILER HP	HEATING SURFACE (SQ-FT)	
	FIRESIDE	WATERSIDE
125	625	679
150	750	820
200	1000	1092
250	1250	1346
300	1500	1623
350	1750	1932
400	2000	2151
500	2500	2691
600	3000	3262
700, 750, 800	3500	3810

Table A1-27. Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM DISENGAGING AREA SQ-IN	
	HIGH PRESSURE ^A	LOW PRESSURE ^B	HIGH PRESSURE ^A	LOW PRESSURE ^B
125	25.4	36.6	5371	5887
150	30.7	44.3	6511	7138
200	37.7	54.4	7985	8752
250	49.2	70.6	7980	8695
300	59.5	85.3	9651	10516
350	70.9	101.7	11507	12538
400	72.1	97.9	9793	10593
500	83.7	113.7	11376	12303
600	101.5	137.8	13787	14911
700-800	119.8	162.7	16273	17600

NOTE: Based on normal water level.

A. Based on 150 psig design pressure.

B. Based on 15 psig design pressure.

Table A1-28. Recommended Steam Nozzle Size (for 4000 to 5000 fpm nozzle velocity)

OPERATING PRESSURE PSIG	Boiler HP											
	125	150	200	250	300	350	400	500	600	700	750	800
15	8	8	10	10	12	12	12	12	12	12	12	12
30	6	6	8	8	8	10	10	10	12	12	12	12
40	6	6	6	8	8	8	10	10	10	12	12	12
50	6	6	6	6	8	8	8	10	10	10	12	12
75	4	4	6	6	6	8	8	8	8	10	10	10
100	4	4	6	6	6	6	6	8	8	8	8	10
125	4	4	4	6	6	6	6	8	8	8	8	8
150	3	3	4	4	6	6	6	6	6	8	8	8
200	2.5	3	4	4	4	4	6	6	6	6	6	6
250	2.5	3	3	4	4	4	4	6	6	6	6	6

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.
3. All standard steam nozzle sizes for 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.
4. Shaded area denotes special surge load baffles must be installed to avoid possible water carry-over.
5. For incremental operating pressures, see Table I3-1 Steam Systems Fundamentals.

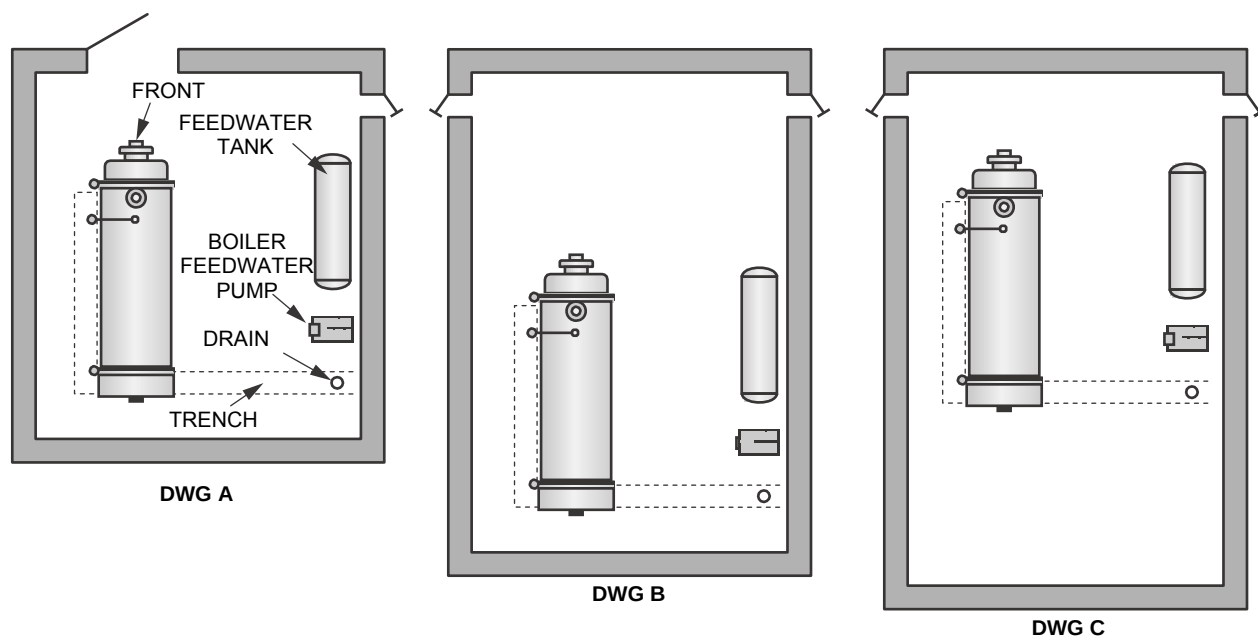
Table A1-29. Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURES (PSIG)							
		50	75	100	125	150	175	200	250
100	3450	2-1/2	2-1/2	NA	NA	NA	NA	NA	NA
125	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA	NA
150	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA	NA
200	6900	3*	3	3	3	3	2-1/2	2-1/2	2-1/2
250	8625	4	3*	3	3	3	3	3	3
300	10350	4	4	4	3*	3	3	3	3
350	12025	4	4	4	4	4	3*	3	3
400	13800	5	4	4	4	4	4	4	3*
500	17210	6	5	5	4	4	4	4	4
600	20700	6	6	5	5	5	4	4	4
700	24150	6	6	6	5	5	5	5	4
800	27600	6	6	6	6	6	5	5	5

NOTE: Valve sizes (300 # Flanges) given in inches.

Standard Non-Return valve selections limited to a maximum 2 to 1 turndown (50% of full load); selections based on typical non-return valve sizing recommendations. For final valve selection contact your C-B authorized representative. For high turndown applications see Boiler Book Section I3, Table I3-3.

* Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.

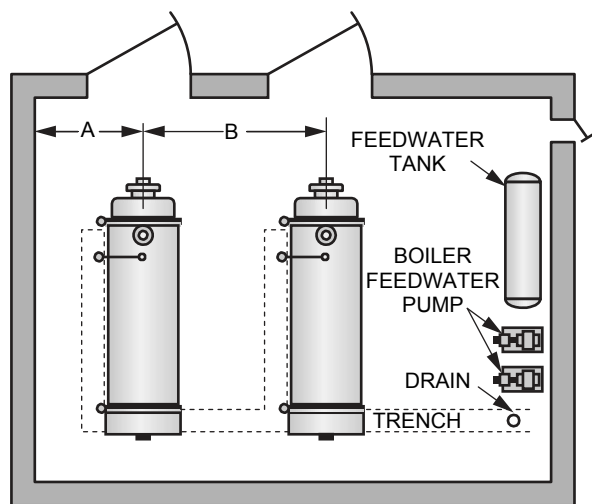
If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

3. A slightly longer boiler room (Dwg C) is obtained by allowing for possible future tube replacement from the rear of the boiler. Allowance for door swing at the front provides sufficient aisle and working space at the front.

Figure A1-21. Boiler Room Length (Typical Layouts)

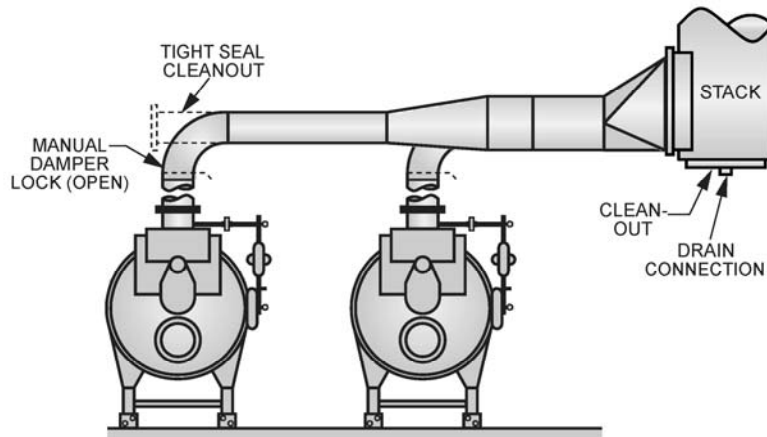


BOILER HP	125-200	250-350	400-800
Dimension A	82"	93"	102"
Dimension B	115"	141"	171"

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of:
42" - 125-200 hp
48" - 250-350 hp
60" - 400-800 hp
If space permits, this aisle should be widened.

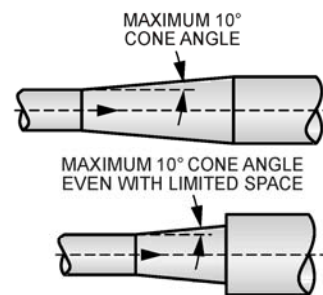
Figure A1-22. Boiler Room Width (Typical Layout)



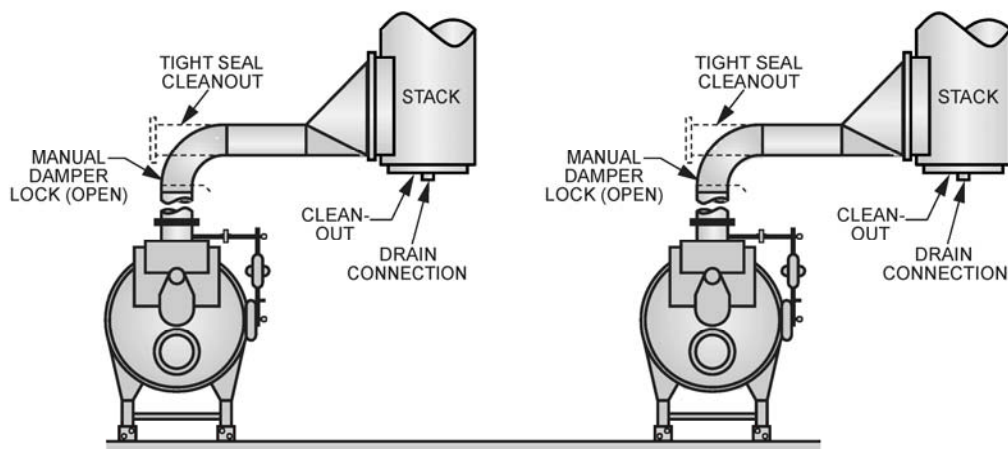
MULTIPLE BOILERS WITH A COMMON STACK

NOTE: These stack breaching arrangements for multiple boilers are typical and not intended for your specific design requirements. For additional information, review Section F, Stacks.

Stack and breaching sizes should always be provided by a reputable stack supplier who will design the stack and breaching system based on your specific criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of stack and breaching design.



DETAIL OF TRANSITION PIECES



MULTIPLE BOILERS WITH INDIVIDUAL STACKS

D

Figure A1-23. Breaching Arrangement

SECTION A1
MODEL CB-LE STEAM BOILER SPECIFICATIONS
(125-800 HP, STEAM 15-300 PSIG)

SAMPLE SPECIFICATIONS (STEAM)

CONTENTS

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 1.2 General Boiler Design.....A1-45

PART 2 PRODUCTS.....A1-45

 2.1 Boiler Shell (Steam).....A1-45

 2.2 Steam Boiler Trim A1-46

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 2.4 Boiler Controls and Control Panel A1-50

 2.5 Efficiency Guarantee A1-53

 2.6 Warranty A1-53

 2.7 Performance Criteria:.....A1-54

PART 3 EXECUTION.....A1-55

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 3.2 Start-up Service A1-55

MODEL CB-LE STEAM BOILER SPECIFICATIONS

(125-800 HP, STEAM 15-300 PSIG)

PART 1 GENERAL

The LE Option specification includes information on the base low emissions package for 60 or 30 ppm NO_x (dry volume basis and corrected to 3% O₂) when firing natural gas. For assistance in specifying, or for information on NO_x levels below 30 ppm, please contact your local Cleaver-Brooks authorized representative.

Model CB-LE Steam Boiler (125-800 hp, Steam 15-300 psig)

1.1 Boiler Characteristics (Steam)

- A. The Steam Boiler shall be Cleaver-Brooks Model CB, Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (15, 150, 200, or other psig steam). The maximum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 _____ oil and/or natural gas, _____ Btu/cu-ft. Electrical power available will be _____ Volt _____ Phase _____ Cycle.

1.2 General Boiler Design

- A. The boiler shall be a four pass horizontal firetube updraft boiler with five (5) square feet (except 750 or 800 hp) of heating surface per rated boiler horsepower. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls.
 - 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
 - 2. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, GE-GAP Insurance, ASME CSD-1).

PART 2 PRODUCTS

Notice

The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label, except in the case where 50 Hz has been selected.

2.1 Boiler Shell (Steam)

- A. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
- B. Two lifting eyes shall be located on top of the boiler.
- C. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.

- D. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
- E. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
- F. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The boiler shall be furnished with adequate handholes to facilitate boiler inspection and cleaning.
- G. For boilers 125 horsepower and over, a manhole shall be provided.
- H. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting:
 - 1. 15-100 hp. 1000 lbs and shall contain a stack thermometer
 - 2. 125-800 hp. 2000 lbs and shall contain a stack thermometer
- I. The boiler shell shall contain a chemical feed connection.
- J. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
- K. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
- L. The entire boiler base frame and other components shall be factory painted before shipment using a hard finish enamel coating.

2.2 Steam Boiler Trim

- A. Water Column

A water column shall be located on the right hand side of the boiler complete with gauge glass set and water column blowdown valves.

 - 1. Feedwater Pump Control

The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feed water pump maintaining the boiler water level within normal limits.
 - 2. WATER COLUMN/LOW WATER CUTOFF AND WATER LEVEL CONTROL SYSTEM (150-250 psig design):

Shall be a CB LEVEL MASTER Water level control system and shall be comprised of a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows: The electronic controller shall be mounted in the common control panel (see 2.4 below) and operate in ambient temperatures from 32 degrees F to 125 degrees F. The pressure chamber shall be boiler mounted and operate to pressures of 250 PSIG and the level sensor shall operate to pressures of 250 PSIG and temperatures to 400 degrees F. The pressure-containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase- 60 Hz. All wiring shall be in compliance with the National Electrical Code.

The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/ menu switch and the following features:

 - a. Continuous Level Indication

- b. Low Water Cutoff & Alarm
 - c. High Water Alarm
 - d. Low & High Water Warning
 - e. Full Modulating Control of Modulating Feedwater Control Valve
 - f. Continuous Monitoring of Float Operation
 - g. Column Blowdown Detection and Reminder
 - h. Auto or Manual Reset
 - i. Real Time Clock
 - j. Alarm Annunciation
 - k. Alarm History Files with Time Stamp
 - l. Water Column Blowdown Record
 - m. Auxiliary Low Water Cutoff Check
 - n. RS 232 Interface
 - o. Maximum Contacts Rating 15 amps Resistive Load
3. Low Water Cutoff (15 psig design)
The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.
- B. Auxiliary Low Water Cutoff
Auxiliary low water cutoff manual reset shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.
- C. Steam Pressure Gauge
The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- D. Safety Valves
Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- E. Steam Pressure Controls
The steam pressure controls to regulate burner operation shall be mounted near the water column. Controls shall be a high limit (manual reset), operating limit (auto reset), and firing rate control (30-800 hp).

2.3 Burner and Controls

- A. Mode of Operation
Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.
- B. Blower
- 1. Air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
 - 2. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
 - 3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

C. Combustion Air Control

Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor (remove this sentence when CB-HAWK flame safeguard is used).

D. Fuel Specification and Piping

Select one of the following fuel types:

Fuel series 700 - Gas fired (4.4.1).

Fuel series 100 - Light oil (No. 2) fired (4.4.2).

Fuel series 200 - Light oil or gas fired (4.4.3).

1. Fuel Series 700 - Gas Fired

- a. Burner Type - The burner shall be integral with the front head of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel and equipped with an LE option.
- b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
- c. Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock on butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 125-300 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 2) 350-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.
- d. Burner Turndown - Select one of the following:
 - 1) 125-200 hp. Turndown range of burner shall be 4:1 when firing natural gas.
 - 2) 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas with a 60 or 30 ppm LE option. (Consult with Cleaver- Brooks Representative regarding high turndown capability based on available gas pressure and 25 and 20 ppm LE options.)

2. Fuel Series 100 - Light Oil Fired

- a. Burner Type - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil and equipped with an LE option.
- b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
- c. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
- d. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
- e. Low Pressure Air Atomizing
Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
- f. Burner Turndown.
Select one of the following:
 - 1) 125 hp through 200 hp. Turndown range shall be 4:1 when firing No. 2 oil.
 - 2) 250 hp through 800 hp Turndown range shall be 8:1 when firing No. 2 oil. (Consult your local Cleaver-Brooks authorized representative regarding No. 2 oil turndown capabilities when utilizing LE Options to achieve NOx levels of 25 or 20 ppm when firing natural gas.)

3. Fuel Series 200 - Light Oil or Gas Fired

- a. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas. The burner shall be equipped with an LE option.
- b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
- c. Oil Burner
 - 1) Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.

- 2) Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
- 3) Low pressure air atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
- d. Gas Burner
Gas Burner Piping - gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 125-300 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 2) 350-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.
- e. Burner Turndown - Select one of the following:
 - 1) 125-200 hp. Turndown range of the burner shall be 4:1.
 - 2) 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas and 8:1 on No. 2 oil. (Consult your local Cleaver-Brooks authorized representative regarding high turndown capability based on available gas pressure and No. 2 oil turndown capabilities when utilizing LE Options to achieve NOx levels of 25 or 20 ppm when firing natural gas.)

2.4 Boiler Controls and Control Panel

A. Control/Entrance Panel

A common enclosure shall house the control panel and the entrance panel. Enclosure shall be NEMA 4 rated and shall be mounted at the side of the boiler in a location convenient to the operator. Enclosure shall consist of upper and lower sections divided by a partition with a separate hinged door for each section. Upper section (low voltage) will house boiler controls including flame safeguard, water level system controller, and Hawk ICS if so equipped. Lower panel section (high voltage) will house entrance panel.

B. CB780E Flame Safeguard

1. Boilers with CB780E Control - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

2. Lights

White - load demanded.

White - fuel valve open.

Red - low water.

Red - flame failure.

3. Control Switches

Burner On-Off.

Manual-Automatic.

Manual Firing Rate Control.

4. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
5. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
6. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

C. CB-HAWK ICS Integrated Boiler Control and Management System:

Boiler Control System combining a Digital Burner Management System for flame safety and a Programmable Logic Controller for boiler modulation and operator interface functions.

The factory pre-configured Boiler Control System shall integrate the Burner Management functions and the PLC based modulation and operator interface functions. The logic of the Burner Management System and the modulating controls will not be run in the same processor or powered by the same DC supply. The PLC and Operator Interface Hardware shall be as manufactured by Allen Bradley.

Major system components shall include:

- Programmable Logic Controller
- Touch Screen HMI
- One Burner Management Controller with Wiring Sub-Base

- One Flame Scanner and amplifier
- Various Temperature and Pressure Sensors

Major functions provided by the Boiler Control System shall be:

- Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout and post-purge
- Full modulating control of fuel and air
- Utilize solid state controls and sensors to provide various control functions, such as:
 - Modulating control (algorithm shall be Proportional-Integral-Derivative (PID) type)
 - Thermal shock protection
 - High and Low limit alarms and shutdowns
- Touch Screen graphical operator interface and monitoring
 - Manual control of the boiler firing rate using control screens on the HMI to increment or decrement the firing rate
 - On screen indication of burner management controller status and diagnostics
 - On screen display of system alarms and faults
 - On screen history of alarms and faults
 - On screen recommendations for troubleshooting of fault conditions
 - On screen water level indication and alarm(s)
- Stack Flue Gas, Combustion Air and Shell (water) temperature indication
- Boiler efficiency calculation
- Low Fire Hold with Minimum Temperature Control
- Assured Low Fire Cut-Off (ALFCO)

The Boiler Control System shall incorporate the following safety provisions:

- Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the Burner Management System shall lockout on safety shutdown.
- Closed-loop logic test of critical loads (ignition, pilot and main fuel valves) and must be able to lockout on safety.
- Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
- Dynamic checking of the flame signal amplifier.
- Safe start check and expand check to include monitoring flame signal during standby.
- High and Low fire switches checked for proper sequencing.

The Boiler Control System shall provide the ability to communicate with external digital devices via Ethernet as standard. OPC compliant Internet communications shall be supported, with the Boiler Control System supplied with its own IP address.

2.5 Efficiency Guarantee

- A. The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve _____ fuel-to-steam efficiency at 100% firing rate when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, ten thousand dollars (\$10,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

- B. Fuel specification used to determine boiler efficiency:
- Natural Gas
Carbon,% (wt) = 69.98
Hydrogen,% (wt) = 22.31
Sulfur,% (wt) = 0.0
Heating value, Btu/lb. = 21,830
 - No. 2 Oil
Carbon,% (wt) = 85.8
Hydrogen,% (wt) = 12.7
Sulfur,% (wt) = 0.2
Heating value, Btu/lb. = 19,420
 - No. 6 Oil
Carbon,% (wt) = 86.6
Hydrogen,% (wt) = 10.9
Sulfur,% (wt) = 2.09
Heating value, Btu/lb. = 18,830
- C. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
- D. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).
- E. Any efficiency verification testing will be based on the stack loss method.

2.6 Warranty

All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

2.7 Performance Criteria:

Performance Criteria	
Manufacturer:	CLEAVER-BROOKS
Model:	Prometeon Line
Horsepower:	_____ HP
Output:	_____ #/hr (from and at 212°F)
Gas Input:	_____ MBH
Oil Input:	_____ GPH
Design Pressure:	_____ PSIG
Operating Pressure	_____ PSIG
Steam Disengaging Area (minimum)	_____ Sq. Inches
Steam storage area (minimum)	_____ Cu. Ft.
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Heating Release (maximum):	_____ BTU/Cu. Ft.
Burner Turndown Ratio Natural Gas:	
Overall Efficiency (Fuel to Steam)	
Natural Gas (%):	_____ % at High Fire
No. 2 Oil (%):	_____ % at High Fire
NOX Emission (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
CO Emissions (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)

Performance Criteria	
Electrical:	_____ V / _____ H / _____ P
Fan Motor:	_____ HP
Air Compressor Motor:	_____ HP
Oil Pump Motor:	_____ HP
Noise Level (3' from burner):	_____ dBA
Available Gas Supply Pressure:	_____ PSIG
Weight	
Dry:	_____
Flooded:	_____
Seismic Zone:	_____
Altitude:	_____ ASL
Code Requirements:	ASME / NATIONAL BOARD CSD-1 NFPA 8501 Underwriter's Lab (UL) State Of _____ Factory Mutual (FM) Industrial Risk Insurers (IRI)

PART 3 EXECUTION

3.1 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

3.2 Start-up Service

- A. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - 1. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

SECTION A1
MODEL CB-LE HOT WATER SPECIFICATIONS
(125-800 HP, 30 PSIG, 125 PSIG)

SAMPLE SPECIFICATIONS (HOT WATER)

CONTENTS

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 3.2 Shop Tests.....A1-66

PART 1 GENERAL

1.1 Boiler Characteristics (Hot Water)

- A. The Hot Water Boiler shall be Cleaver-Brooks Model CB, Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (30, 125 psig, or other hot water). The maximum water temperature shall be _____ degree F, and the maximum system temperature drop shall be _____ degrees F.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 _____ oil and/or natural gas, _____ Btu/cu-ft. Electrical power available shall be _____ Volt _____ Phase _____ Cycle.

PART 2 PRODUCTS

2.1 General Boiler Design

- A. The boiler shall be a four pass horizontal firetube updraft boiler with five (5) square feet (except 750 or 800 hp) of heating surface per rated boiler horsepower. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls. The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label.
 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
 2. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, Industrial Risk Insurance, ASME CSD-1).
- B. Boiler Shell (Hot Water)
 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 2. The hot water return and outlet connections shall be located on the top center line of the boiler. The boiler shall be designated to rapidly mix the return water with the boiler water. Forced internal circulation shall be used.
 3. A dip tube shall be included as an integral part of the water outlet.
 4. Two lifting eyes shall be located on top of the boiler.
 5. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
 6. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
 7. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
 8. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The shell must be furnished with adequate handholes to facilitate boiler inspection and cleaning.
 9. A manhole shall be provided.

10. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 2000 lbs and shall contain a stack thermometer.
- C. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
- D. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
- E. The entire boiler based frame and other components shall be factory painted before shipment using a hand finish enamel coating.
- F. Emission Controls
 1. Boiler shall be equipped with a low emission (LE) option for guaranteed NOx performance at _____ ppm, dry volume basis and corrected to 3% O₂ when firing natural gas.
 2. The low emission option shall include an integral front head, burner, and boiler package, providing NOx reduction through an internal flue gas recirculation system using the combustion air fan, internal recirculation valve, and enhanced boiler design to achieve the guaranteed NOx levels. The emission control system shall not use an external fan, control valve, and piping. Boiler fuel-to-steam efficiency and rated boiler capacity shall be guaranteed while the boiler is operating at the low NOx performance levels.
 3. Burner, boiler, and low NOx system shall be manufactured as a package by a single manufacturer. The Low Emission Option to the CB Boiler shall included factory testing as a package, and shall bear the UL packaged label. The boiler nameplate shall include the approved UL low NOx boiler model designation. No field assembly of the burner or low NOx equipment shall be required.

2.2 Hot Water Boiler Trim

- A. Low Water Cutoff

A low water cutoff control (manual reset) shall be mounted on the top centerline of the boiler wired into the burner control circuit to prevent burner operation if boiler water falls below a safe level.
- B. Pressure and Temperature Gauges

Pressure and temperature gauges shall be mounted on the boiler with temperature sensing element located adjacent to the hot water outlet.
- C. Relief Valves

Water relief valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- D. Temperature Controls

Temperature controls to regulate burner operation shall be mounted on the unit with temperature sensing elements located adjacent to the hot water outlet. Controls shall be high limit (manual reset), operating limit (auto reset), and firing rate control.

2.3 Burner and Controls

- A. Mode of Operation

Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.
- B. Blower
 1. Air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.

2. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
 3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.
- C. Combustion Air Control
Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor (remove this sentence when CB-HAWK flame safeguard is used).
- D. Fuel Specification and Piping
Select one of the following fuel types:
- Fuel series 700 - Gas fired.
 - Fuel series 100 - Light oil (No. 2) fired.
 - Fuel series 200 - Light oil or gas fired.
1. Fuel Series 700 - Gas Fired
 - a. Burner Type - The burner shall be integral with the front head of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel and equipped with an LE option.
 - b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 - c. Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock on butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 125-300 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 2) 350-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.
 - d. Burner Turndown - Select one of the following:
 - 1) 125-200 hp. Turndown range of burner shall be 4:1 when firing natural gas.
 - 2) 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas when equipped with a 60 or 30 ppm LE option. (Consult with Cleaver-Brooks Representative regarding high turndown capability based on available gas pressure and 25 and 20 ppm LE options.)
 2. Fuel Series 100 - Light Oil Fired

- a. Burner Type - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil and equipped with an LE option.
 - b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 - c. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
 - d. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - e. Low Pressure Air Atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
 - f. Burner Turndown - Select one of the following:
 - 1) 125 hp through 200 hp. Turndown range shall be 4:1 when firing No. 2 oil.
 - 2) 250 hp through 800 hp. Turndown range shall be 8:1 when firing No. 2 oil. (Consult your local Cleaver-Brooks authorized representative regarding No. 2 oil turndown capabilities when utilizing LE Options to achieve NOx levels of 25 or 20 ppm when firing natural gas.)
3. Fuel Series 200 - Light Oil or Gas Fired
- a. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas. The burner shall be equipped with an LE option.
 - b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 - c. Oil Burner
 - 1) Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 - 2) Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A

single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.

- 3) Low pressure air atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

d. Gas Burner

- 1) Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 125-300 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 350-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.

e. Burner Turndown - Select one of the following:

- 125-200 hp. Turndown range of the burner shall be 4:1.
- 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas and 8:1 on No. 2 oil. (Consult your local Cleaver-Brooks authorized representative regarding high turndown capability based on available gas pressure and No. 2 oil turndown capabilities when utilizing LE Options to achieve NOx levels of 25 or 20 ppm when firing natural gas.)

E. Boiler Controls and Control Panel

1. CB780E Flame Safeguard

- a. Boilers with CB780E Control - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

- b. Control Panel - A common enclosure shall house the control panel and the entrance panel. Enclosure shall be NEMA 4 rated and shall be mounted at the side of the boiler in a location convenient to the operator. Enclosure shall consist of upper and lower sections divided by a partition with a separate hinged door for each section. Upper section (low voltage) will house boiler controls including flame safeguard and Hawk ICS if so equipped. Lower panel section (high voltage) will house entrance panel.
- c. The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.
- d. The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers the panel shall contain the fuel selector switch.

The panel shall contain the following lights and switches:

- e. Lights
 - White - load demanded.
 - White - fuel valve open.
 - Red - low water.
 - Red - flame failure.
- f. Control Switches
 - Burner On-Off.
 - Manual-Automatic.
 - Manual Firing Rate Control.
- g. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
- h. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
- i. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2. CB-HAWK ICS Integrated Boiler Control and Management System:

Boiler Control System combining a Digital Burner Management System for flame safety, and a Programmable Logic Controller for boiler modulation and operator interface functions.

The factory pre-configured Boiler Control System shall integrate the Burner Management functions and the PLC based modulation and operator interface functions. The logic of the Burner Management System and the modulating controls will not be run in the same processor or powered by the same DC supply. The PLC and Operator Interface Hardware shall be as manufactured by Allen Bradley.

Major system components shall include:

- Programmable Logic Controller
- Touch Screen HMI
- One Burner Management Controller with Wiring Sub-Base
- One Flame Scanner and amplifier

- Various Temperature and Pressure Sensors

Major functions provided by the Boiler Control System shall be:

- Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout and post-purge
- Full modulating control of fuel and air
- Utilize solid state controls and sensors to provide various control functions, such as:
 - Modulating control (algorithm shall be Proportional-Integral-Derivative (PID) type)
 - Thermal shock protection
 - High and Low limit alarms and shutdowns
- Touch Screen graphical operator interface and monitoring
 - Manual control of the boiler firing rate using control screens on the HMI to increment or decrement the firing rate
 - On screen indication of burner management controller status and diagnostics
 - On screen display of system alarms and faults
 - On screen history of alarms and faults
 - On screen recommendations for troubleshooting of fault conditions
 - On screen water level indication and alarm(s)
- Stack Flue Gas, Combustion Air and Shell (water) temperature indication
- Boiler efficiency calculation
- Low Fire Hold with Minimum Temperature Control
- Assured Low Fire Cut-Off (ALFCO)

The Boiler Control System shall incorporate the following safety provisions:

- Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the Burner Management System shall lockout on safety shutdown.
- Closed-loop logic test of critical loads (ignition, pilot and main fuel valves) and must be able to lockout on safety.
- Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
- Dynamic checking of the flame signal amplifier.
- Safe start check and expand check to include monitoring flame signal during standby.
- High and Low fire switches checked for proper sequencing.

The Boiler Control System shall provide the ability to communicate with external digital via Ethernet as a standard. OPC compliant Internet communications shall be supported, with the Boiler Control System supplied with its own IP address.

2.4 Efficiency Guarantee

- A. The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve _____ fuel-to-steam efficiency at 100% firing rate when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, ten thousand dollars (\$10,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

- B. Fuel specification used to determine boiler efficiency:
- Natural Gas
Carbon, % (wt) = 69.98
Hydrogen, % (wt) = 22.31
Sulfur, % (wt) = 0.0
Heating value, Btu/lb = 21,830
 - No. 2 Oil
Carbon, % (wt) = 85.8
Hydrogen, % (wt) = 12.7
Sulfur, % (wt) = 0.2
Heating value, Btu/lb = 19,420
 - No. 6 Oil
Carbon, % (wt) = 86.6
Hydrogen, % (wt) = 10.9
Sulfur, % (wt) = 2.09
Heating value, Btu/lb = 18,830
- C. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
- D. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).
- E. Any efficiency verification testing will be based on the stack loss method.

2.5 Performance Criteria

Performance Criteria	
Manufacturer:	CLEAVER-BROOKS
Model:	Promethean Line
Horsepower:	_____ HP
Output:	_____ #/hr (from and at 212°F)
Gas Input:	_____ MBH
Oil Input:	_____ GPH
Design Pressure:	_____ PSIG
Operating Pressure	_____ PSIG
Steam Disengaging Area (minimum)	_____ Sq. Inches
Steam storage area (minimum)	_____ Cu. Ft.
Operating Temperature	_____ degrees F
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Burner Turndown Ratio Natural Gas:	
Overall Efficiency (Fuel to Steam)	
Natural Gas (%):	_____ % at High Fire
No. 2 Oil (%):	_____ % at High Fire
NOX Emission (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)
CO Emissions (maximum)	
Gas (Natural):	_____ PPM (corrected to 3%O ₂)
Oil (No. 2):	_____ PPM (corrected to 3%O ₂)

Performance Criteria	
Electrical:	_____ V / _____ H / _____ P
Fan Motor:	_____ HP
Air Compressor Motor:	_____ HP
Oil Pump Motor:	_____ HP
Noise Level (3' from burner):	_____ dBA
Available Gas Supply Pressure:	_____ PSIG
Weight	
Dry:	_____
Flooded:	_____
Seismic Zone:	_____
Altitude:	_____ ASL
Code Requirements:	ASME / NATIONAL BOARD
	CSD-1 NFPA 8501
	Underwriter's Lab (UL)
	State Of _____
	Factory
	Mutual (FM) (optional)
	GE-GAP (optional)

PART 3 EXECUTION

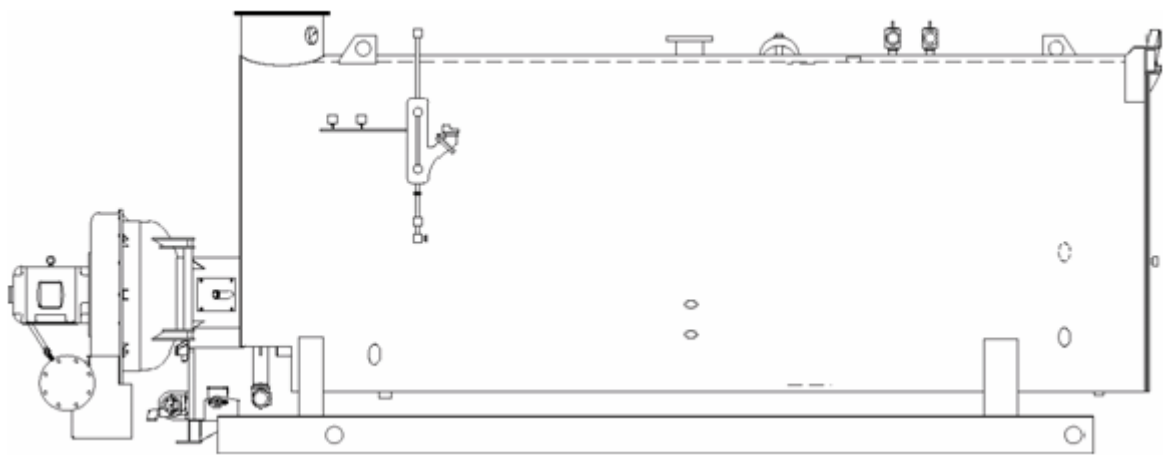
3.1 Warranty

All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

3.2 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.
- B. Start-up Service
 - 1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

MODEL ICB 100-800 HP



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The following information applies to the Cleaver-Brooks Model ICB Boiler.

FEATURES AND BENEFITS

The Cleaver-Brooks Model ICB Boiler line provides a quality product utilizing a baseline boiler/burner design. Additionally, the boiler/burner package is UL compliant. The following features apply:

Four-Pass Intercooled Design:

- Four-pass design provides high flue gas velocities and low stack temperatures to maximize efficiency.

Three-Pass Intercooled Design (optional):

- Versatile design offered with choice of three or four-pass construction to meet application needs.

Intercooled Rear Turnaround:

- Rear furnace turnaround area is fluid cooled and has a davited access opening for full accessibility to 2nd pass tubes and furnace. It eliminates confined space issues and provides for ease of maintenance. All tubes can be removed from either the front or rear of the boiler.

Front and Rear Doors:

- Davit, front and rear doors, all sizes.
- Provides access to front and rear tube sheet.
- Rear door completely covers and insulates rear tube sheet.

Natural Gas, No. 2 Oil, or Combination Burners Available:

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.
- Ultra low NOx emissions (<9ppm), consult factory.

PRODUCT OFFERING

Cleaver-Brooks Model ICB Boilers are available in low pressure steam, high pressure steam, and hot water designs. Burners are available to fire natural gas, No. 2 oil, or a combination of oil and gas. Standard product offering is:

- 100 – 800 hp.
- 30 and 125 psig hot water.
- 15 – 300 psig steam.
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks Authorized Representative for option details).

- Boiler Options:
 - Three-pass design.
 - Drain valves.
 - Additional screwed or flanged tappings.
 - Blowdown valves.
 - Non-return valves.
 - Feedwater valves and regulators.
 - Surface blowdown systems.
 - Blend pump.

- Surge load baffles.
- Seismic design.
- Burner/Control Options:
 - Flame safeguard controllers.
 - Lead/lag system.
 - High altitude design.
 - Special insurance and code requirements (e.g., IRI, FM, CSD-1).
 - Alarm bell/silence switch.
 - Special motor requirements (TEFC, high efficiency).
 - Special indicating lights.
 - Elapsed time meter.
 - Voltmeter/micro-ammeter.
 - NEMA enclosures.
 - Low-fire hold control.
 - Remote emergency shut-off (115V).
 - Circuit breakers.
 - Day/night controls.
 - Special power requirements.
 - Stack thermometer.
- Fuel Options
 - Air atomizing oil burner, 200 – 800 hp.
 - Pressure atomizing oil burner, 100 – 150 hp.
 - Gas strainer.
 - Gas pressure gauge.
 - Future gas conversion.
 - Oversized/undersized gas trains.

DIMENSIONS AND RATINGS

Dimensions and ratings for the Model ICB Boilers are shown in the following tables and illustrations. The information is subject to change without notice.

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- Figure A4-6 Model ICB Boilers Lifting Lug Location
- Figure A4-7 Model ICB Boiler Mounting Piers

Table A4-1. Model ICB Steam Boiler Ratings, 4-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL Model ICB	FP-3	FP-3	FP-3	FP-4	FP-4	D145P	D175P	D210P	D252P	D300P	D336P	D378P
RATINGS — SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr. from and at 212°F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr.)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.1	116.6	145.8	175.0	204.1	233.3
Gas CFH (1000 Btu)	4082	5103	6124	8165	10206	12247	14280	16329	20415	24494	28576	32659
Gas (Therm/hr.)	40.8	51.0	61.2	81.7	102.1	122.5	142.8	163.3	204.2	245.0	285.8	326.6
POWER REQUIREMENTS — SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	3	5	7-1/2	7-1/2	7-1/2	15	20	25	30	40	60	60
Separate Compressor Motor hp (Oil only)	**	**	**	3	3	—	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2	15
Integral Oil/Air Motor hp (Oil only)	—	—	—	—	—	2	—	—	—	—	—	—
Oil Metering Pump Motor hp (Oil only)	—	—	—	—	—	—	1/2	3/4	3/4	3/4	3/4	1
Circulating Oil Pump Motor hp (Oil only)	*	*	*	1/2	1/2	3/4 3/4		3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

* = Integral oil pump

** = No air compressor required (pressure atomized system)

NOTE: All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral motors will be 3-phase voltage.

Table A4-2. Model ICB Steam Boiler Ratings, 3-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL Model ICB	FP-3	FP-3	FP-3	FP-4	FP-4	FP-4	FP-4	D175P	D210P	D252P	D300P	D336P
RATINGS — SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr. from and at 212°F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr.)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.9	37.5	45.0	60.0	74.5	89.5	104.5	119.5	149.5	179.5	209	239
Gas CFH (1000 Btu)	4184	5230	6280	8370	10460	12555	14650	16750	20925	25100	29300	33500
Gas (Therm/hr.)	41.8	52.3	62.8	83.7	104.6	125.5	146.5	167.5	209.3	251.0	293.0	335.0
POWER REQUIREMENTS — SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	2	3	5	7-1/2	7-1/2	10	10	20	25	30	40	60
Separate Compressor Motor hp (Oil only)	**	**	**	3	3	3 3		5	5	7-1/2	7-1/2	7-1/2
Integral Oil/Air Motor hp (Oil only)	—	—	—	—	—	— —		—	—	—	—	—
Oil Metering Pump Motor hp (Oil only)	—	—	—	—	—	—	—	1/2	3/4	3/4	3/4	3/4
Circulating Oil Pump Motor hp (Oil only)	*	*	*	1/2	1/2	3/4 3/4		3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

* = Integral oil pump

** = No air compressor required (pressure atomized system)

NOTE: All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral motors will be 3-phase voltage.

Table A4-3. Model ICB Hot Water Boiler Ratings, 4-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL Model ICB	FP-3	FP-3	FP-3	FP-4	FP-4	D145P	D175P	D210P	D252P	D300P	D336P	D378P
RATINGS — SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr.)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.1	116.6	145.8	175.0	204.1	233.3
Gas CFH (1000 Btu)	4082	5103	6124	8165	10206	12247	14280	16329	20415	24494	28576	32659
Gas (Therm/hr.)	40.8	51.0	61.2	81.7	102.1	122.5	142.8	163.3	204.2	245.0	285.8	326.6
POWER REQUIREMENTS — SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	3	5	7-1/2	7-1/2	7-1/2	15	20	25	30	40	60	60
Separate Compressor Motor hp (Oil only)	**	**	**	3	3	—	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2	15
Integral Oil/Air Motor hp (Oil only)	—	—	—	—	—	2	—	—	—	—	—	—
Oil Metering Pump Motor hp (Oil only)	—	—	—	—	—	—	1/2	3/4	3/4	3/4	3/4	1
Circulating Oil Pump Motor hp (Oil only)	*	*	*	1/2	1/2	3/4 3/4		3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

* = Integral oil pump

** = No air compressor required (pressure atomized system)

NOTE: All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral motors will be 3-phase voltage.

Table A4-4. Model ICB Hot Water Boiler Ratings, 3-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL Model ICB	FP-3	FP-3	FP-3	FP-4	FP-4	FP-4	FP-4	D175P	D210P	D252P	D300P	D336P
RATINGS — SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr.)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.9	37.5	45.0	60.0	74.5	89.5	104.5	119.5	149.5	179.5	209	239
Gas CFH (1000 Btu)	4184	5230	6280	8370	10460	12555	14650	16750	20925	25100	29300	33500
Gas (Therm/hr.)	41.8	52.3	62.8	83.7	104.6	125.5	146.5	167.5	209.3	251.0	293.0	335.0
POWER REQUIREMENTS — SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	2	3	5	7-1/2	7-1/2	10	10	20	25 30	40 60		
Separate Compressor Motor hp (Oil only)	**	**	**	3	3	3 3		5	5	7-1/2	7-1/2	7-1/2
Integral Oil/Air Motor hp (Oil only)	—	—	—	—	—	—	—	—	— —	— —		
Oil Metering Pump Motor hp (Oil only)	—	—	—	—	—	—	—	1/2	3/4 3/4	3/4 3/4		
Circulating Oil Pump Motor hp (Oil only)	*	*	*	1/2	1/2	3/4 3/4		3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq.-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

* = Integral oil pump

** = No air compressor required (pressure atomized system)

NOTE: All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral motors will be 3-phase voltage.

Table A4-5. Model ICB-LE Steam Boiler Ratings, 4-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	LND54P	LND84P	LND105P	LND125P	LND145P	LND175P	LND210P	LND252P	LND300P	LND315P	LND378P	LND420P
RATINGS - SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr from and at 212 °F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.1	116.6	145.8	175.0	204.1	233.3
Gas CFH (1000 Btu)	4082	5103	6124	8165	10206	12247	14280	16329	20415	24494	28576	32659
Gas (Therm/hr)	40.8	51.0	61.2	81.7	102.1	122.5	142.8	163.3	204.2	245.0	285.8	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	5	7 1/2	10	15	15	20	25	30	40	60	60	60
Separate Compressor Motor hp (Oil only)	-	-	-	-	-	5	5	7 1/2	7 1/2	7 1/2	15	15
Integral Oil/Air Motor hp (Oil only)	1	1 1 1			2	-	-	-	-	-	-	-
Oil Metering Pump Motor hp (Oil only)	-	- - -			-	1/2	3/4	3/4	3/4	3/4	1	1
Circulating Oil Pump Motor hp (Oil only)	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

Table A4-6. Model ICB-LE Steam Boiler Ratings, 3-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	LND54P	LND63P	LND84P	LND105P	LND145S	LND145P	LND175P	LND210P	LND252P	LND300P	LND315P	LND378P
RATINGS - SEA LEVEL TO 700 FT.												
Rated Capacity (lbs-steam/hr from and at 212 °F)	3450	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.9	37.5	45.0	60.0	74.5	89.5	104.5	119.5	149.5	179.5	209	239
Gas CFH (1000 Btu)	4184	5230	6280	8370	10460	12555	14650	16750	20925	25100	29300	33500
Gas (Therm/hr)	41.8	52.3	62.8	83.7	104.6	125.5	146.5	167.5	209.3	251.0	293.0	335.0
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	5	5	7 1/2	10	15	15	20	25	30	40	60 60	
Separate Compressor Motor hp (Oil only)	-	-	-	-	- -		5	5	7 1/2	7 1/2	7 1/2	15
Integral Oil/Air Motor hp (Oil only)	1	1	1	1	2	2	-	- - - -				-
Oil Metering Pump Motor hp (Oil only)	-	-	-	-	- -		1/2	3/4	3/4	3/4	3/4	1
Circulating Oil Pump Motor hp (Oil only)	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

Table A4-7. Model ICB-LE Hot Water Ratings, 4-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	LND54P	LND84P	LND105P	LND125P	LND145P	LND175P	LND210P	LND252P	LND300P	LND315P	LND378P	LND420P
RATINGS - SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 82% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.2	36.4	43.7	58.3	72.9	87.5	102.1	116.6	145.8	175.0	204.1	233.3
Gas CFH (1000 Btu)	4082	5103	6124	8165	10206	12247	14280	16329	20415	24494	28576	32659
Gas (Therm/hr)	40.8	51.0	61.2	81.7	102.1	122.5	142.8	163.3	204.2	245.0	285.8	326.6
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	5	7 1/2	10	15	15	20	25	30	40	60	60	60
Separate Compressor Motor hp (Oil only)	-	-	-	-	-	5	5	7 1/2	7 1/2	7 1/2	15	15
Integral Oil/Air Motor hp (Oil only)	1	1	1	1 2		-	-	-	-	-	-	-
Oil Metering Pump Motor hp (Oil only)	-	-	-	-	-	1/2	3/4	3/4	3/4	3/4	1	1
Circulating Oil Pump Motor hp (Oil only)	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

NOTE: All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral motors will be 3-phase voltage.

Table A4-8. Model ICB-LE Hot Water Ratings, 3-Pass

BOILER H.P.	100	125	150	200	250	300	350	400	500	600	700	800
BURNER MODEL	LND54P	LND63P	LND84P	LND105P	LND145S	LND145P	LND175P	LND210P	LND252P	LND300P	LND315P	LND378P
RATINGS - SEA LEVEL TO 700 FT.												
Btu Output (1000 Btu/hr)	3348	4184	5021	6695	8369	10043	11716	13390	16738	20085	23433	26780
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY												
Light Oil gph (140,000 Btu/gal)	29.9	37.5	45.0	60.0	74.5	89.5	104.5	119.5	149.5	179.5	209	239
Gas CFH (1000 Btu)	4184	5230	6280	8370	10460	12555	14650	16750	20925	25100	29300	33500
Gas (Therm/hr)	41.8	52.3	62.8	83.7	104.6	125.5	146.5	167.5	209.3	251.0	293.0	335.0
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)												
Blower Motor hp	5	5	7 1/2	10	15	15	20	25	30	40	60	60
Separate Compressor Motor hp (Oil only)	-	-	-	-	-	-	5	5	7 1/2	7 1/2	7 1/2	15
Integral Oil/Air Motor hp (Oil only)	1	1	1	1	2	2	-	-	-	-	-	-
Oil Metering Pump Motor hp (Oil only)	-	-	-	-	-	-	1/2	3/4	3/4	3/4	3/4	1
Circulating Oil Pump Motor hp (Oil only)	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
BOILER DATA												
Heating Surface sq-ft. (Fireside)	353	438	555	729	885	1055	1384	1522	1734	2094	3244	3641

NOTE: All fractional hp motors will be single phase voltage except oil metering pump motor (3-phase); integral motors will be 3-phase voltage.

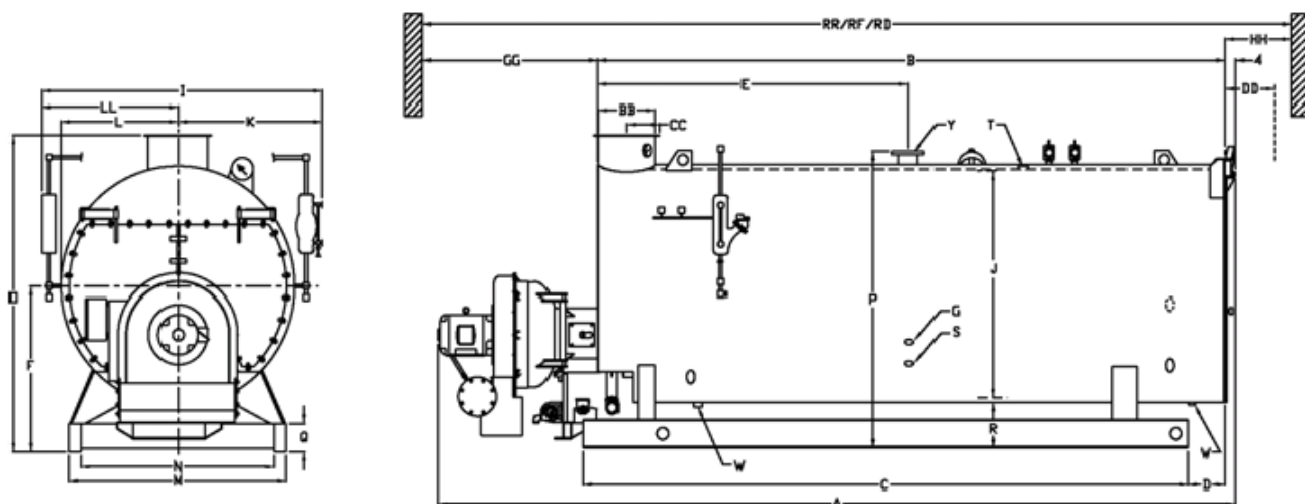
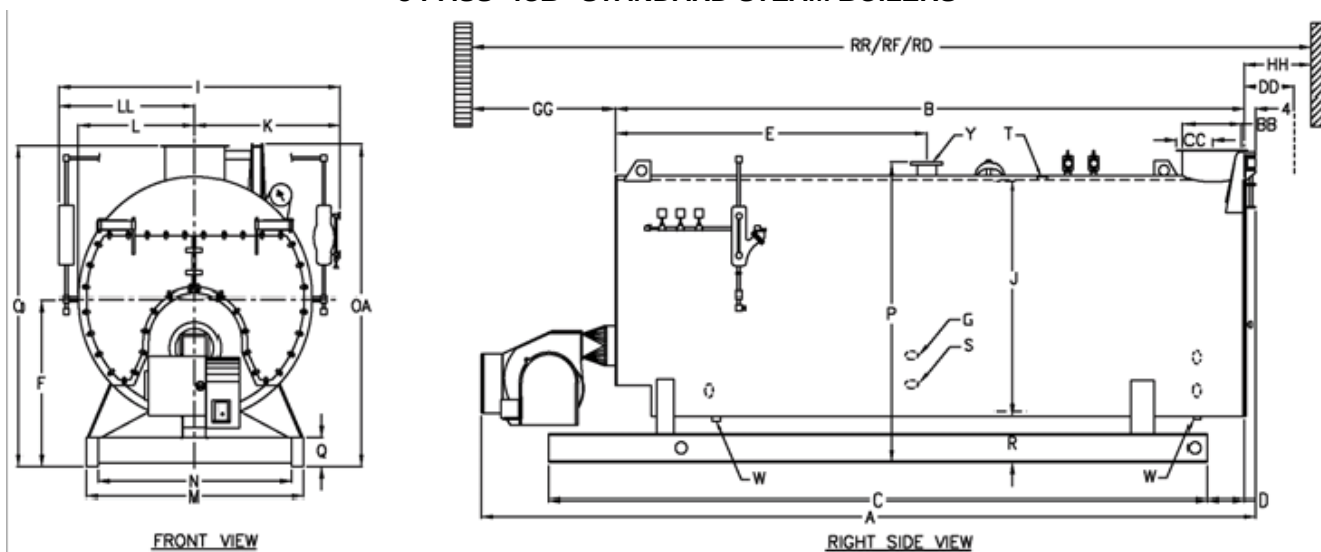
4-PASS "ICB" STANDARD STEAM BOILERS**3-PASS "ICB" STANDARD STEAM BOILERS**

Figure A4-1. Model ICB Steam Boiler Dimensions, 4-Pass and 3-Pass (Optional)

Table A4-9. Model ICB Steam Boiler Dimensions, 4-Pass and 3-Pass

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
LENGTHS													
Overall (3-Pass)	A	171"	197"	195"	243-1/2"	208-1/2"	234-1/2"	237-1/2"	263"	255"	290-1/2"	281-1/2"	306-1/2"
Overall (4-Pass)	A	171"	197"	195"	243-1/2"	208-1/2"	241"	247"	268"	257-1/2"	290-1/2"	284-1/2"	312"
Shell	B	127-7/8"	153-7/8"	151-7/8"	192-7/8"	160-7/8"	186-7/8"	189-7/8"	205-7/8"	195-3/4"	228-3/4"	219-7/8"	241-7/8"
Base Frame	C	124-3/8"	150-3/8"	148-3/8"	189-3/8"	157-3/8"	183-3/8"	184-3/8"	200-3/8"	187-1/4"	220-1/4"	211-3/8"	233-3/8"
Base Frame to Rear Flange	D	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	14-1/2"	14-1/2"	14-1/2"	14-1/2"
Flange to Steam Nozzle	E	55-7/8"	61-7/8"	65-7/8"	77-7/8"	68-7/8"	80-7/8"	78-7/8"	94-7/8"	82-3/4"	106-3/4"	98-7/8"	111-7/8"
WIDTHS													
Overall	I	80"	80"	85"	85"	97"	97"	103"	103"	117"	117"	131"	131"
I.D. Boiler	J	55"	55"	60"	60"	72"	72"	78"	78"	92"	92"	106"	106"
Center to Water Column	K	42-1/2"	42-1/2"	45"	45"	51"	51"	54"	54"	61"	61"	68"	68"
Center to Lagging	L	30-1/2"	30-1/2"	33"	33"	39"	39"	42"	42"	49"	49"	56"	56"
Center to Auxiliary LWCO	LL	37-1/2"	37-1/2"	40"	40"	46"	46"	49"	49"	56"	56"	63"	63"
Base Outside	M	47-1/2"	47-1/2"	52-1/2"	52-1/2"	58-1/2"	58-1/2"	64"	64"	68"	68"	74-3/4"	74-3/4"
Base Inside	N	39-1/2"	39-1/2"	44-1/2"	44-1/2"	50-1/2"	50-1/2"	56"	56"	55"	55"	61-3/4"	61-3/4"
HEIGHTS													
Base to Boiler Centerline	F	44-1/2"	44-1/2"	46"	46"	54"	54"	56"	56"	65-1/2"	65-1/2"	71"	71"
Base to Vent Outlet	O	80-3/4"	80-3/4"	85"	85"	101"	101"	106"	106"	122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to Rear Door Davit	OA	82-1/4"	82-1/4"	86-1/2"	86-1/2"	101"	101"	106"	106"	122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to Steam Outlet	P	78-3/8"	78-3/8"	82-3/8"	82-3/8"	96-1/4"	96-1/4"	101-1/2"	101-1/2"	118"	118"	130-5/8"	130-5/8"
Base Frame	Q	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
Base to Bottom Boiler	R	16"	16"	16"	16"	17"	17"	17"	17"	19"	19"	17-1/2"	17-1/2"
CONNECTIONS													
Chemical Feed	G	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
Feedwater Inlet (Both Sides)	S	1-1/4"	1-1/2"	1-1/2"	2"	2"	2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Steam Nozzle (15 psig) 150 LB. FLG.	Y	8"	8"	8"	10"	10"	12"	12"	12"	12"	12"	12"	12"
Steam Nozzle (150 psig) 300 LB. FLG.	Y	4"	4"	4"	4"	6"	6"	6"	6"	8"	8"	8"	8"
Drain — Front & Rear (15 psig)	W	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
Blowdown-Front & Rear(150 psig)	W	1-1/4"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"	2"
Surface Blowoff (150 psig only)	T	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
Vent Stack Diameter (Flanged)	BB	16"	16"	16"	16"	20"	20"	20"	20"	24"	24"	24"	24"
Flange to Center Vent	CC	9-1/8"	9-1/8"	9-1/8"	9-1/8"	10-5/8"	10-5/8"	10-5/8"	10-5/8"	12-5/8"	12-5/8"	12-5/8"	12-5/8"
MINIMUM CLEARANCES													
Rear Door Swing	DD	34"	34"	36"	36"	43"	43"	46"	46"	53"	53"	60"	60"
Tube Removal — Front	GG	95"	121"	119"	160"	122"	148"	149"	165"	146"	179"	170"	192"
Tube Removal — Rear	HH	96-1/2"	122-1/2"	120-1/2"	161-1/2"	126-1/2"	152-1/2"	150-1/2"	166-1/2"	148-1/2"	181-1/2"	172-1/2"	194-1/2"
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Front of Boiler	RF	257"	309"	307"	389"	326"	378"	385"	417"	395"	461"	450"	494"
Rear of Boiler (3-Pass)	RR	303-1/2"	355-1/2"	351-1/2"	441"	371"	423"	427"	468-1/2"	441-1/2"	510"	492"	539"
Rear of Boiler (4-Pass)	RR	303-1/2"	355-1/2"	351-1/2"	441"	371"	429-1/2"	436-1/2"	473-1/2"	444"	510"	495"	544-1/2"
Thru Window or Door (3-Pass)	RD	237"	263"	263"	311-1/2"	283-1/2"	309-1/2"	315-1/2"	341"	340"	375-1/2"	373-1/2"	398-1/2"
Thru Window or Door (4-Pass)	RD	237"	263"	263"	311-1/2"	283-1/2"	316"	325"	346"	342-1/2"	375-1/2"	376-1/2"	404"
WEIGHTS													
Normal Water Weight (lbs)	—	5,140	6,515	7,184	9,612	10,175	12,278	13,192	14,593	17,870	21,780	26,638	30,026
Shipping Weight — (15 psig) (lbs)	—	10,123	11,303	11,931	14,106	16,958	19,051	22,344	23,918	28,934	33,189	41,179	45,226
Shipping Weight — (150 psig) (lbs)	—	10,877	12,220	13,112	15,637	17,613	20,404	25,344	27,175	31,990	36,780	45,724	50,244
Shipping Weight — (200 psig) (lbs)	—	11,420	12,850	14,000	16,575	19,400	22,400	25,810	25,740	33,710	39,100	50,025	55,000

NOTE: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for actual option requirements.

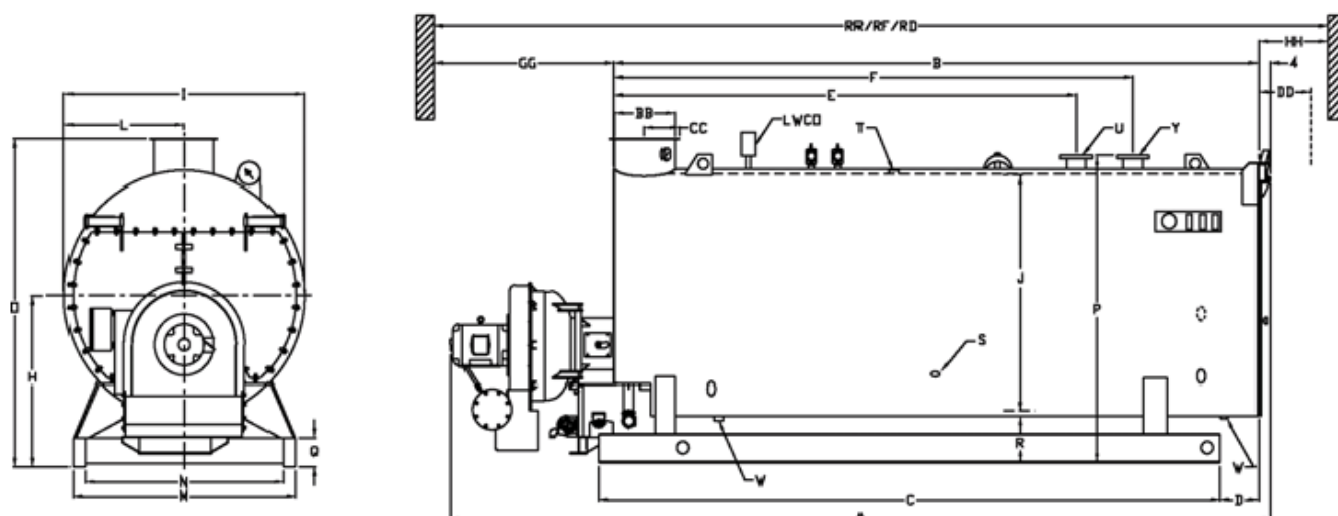
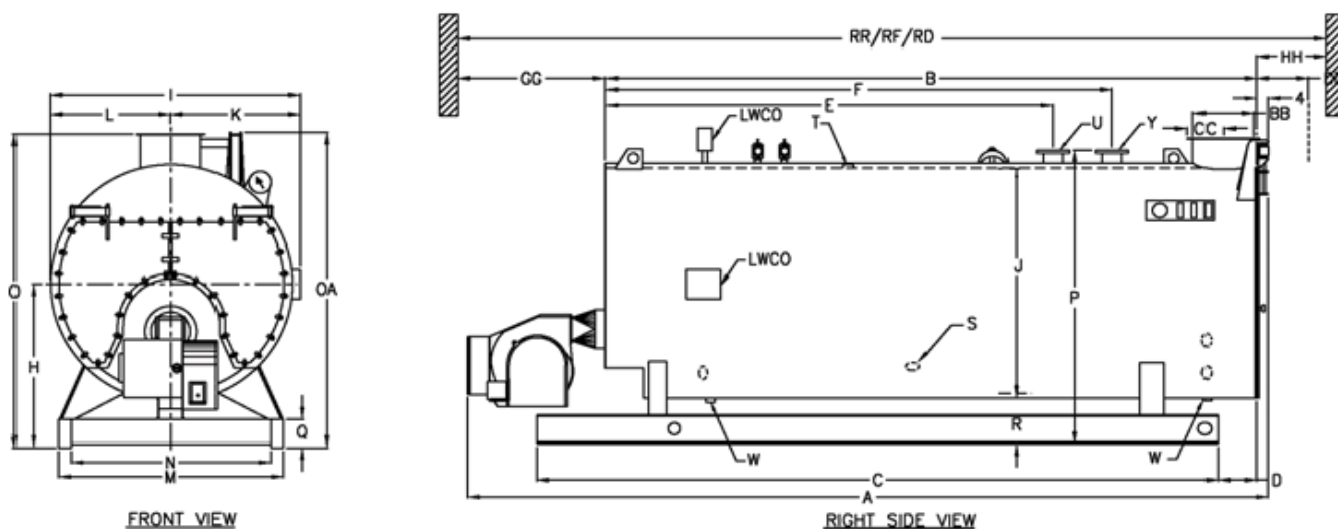
4-PASS "ICB" STANDARD HOT WATER BOILERS**3-PASS "ICB" STANDARD HOT WATER BOILERS**

Figure A4-2. Model ICB Hot Water Boiler Dimensions, 4-Pass and 3-Pass (Optional)

Table A4-10. Model ICB Hot Water Boiler Dimensions, 4-Pass and 3-Pass

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
LENGTHS													
Overall (3-Pass)	A	171"	197"	195"	243-1/2"	208-1/2"	234-1/2"	237-1/2"	263"	255"	290-1/2"	281-1/2"	306-1/2"
Overall (4-Pass)	A	171"	197"	195"	243-1/2"	208-1/2"	241"	247"	268"	257-1/2"	290-1/2"	284-1/2"	312"
Shell	B	127-7/8"	153-7/8"	151-7/8"	192-7/8"	160-7/8"	186-7/8"	189-7/8"	205-7/8"	195-3/4"	228-3/4"	219-7/8"	241-7/8"
Base Frame	C	124-3/8"	150-3/8"	148-3/8"	189-3/8"	157-3/8"	183-3/8"	184-3/8"	200-3/8"	187-1/4"	220-1/4"	211-3/8"	233-3/8"
Base Frame to Rear Flange	D	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	14-1/2"	14-1/2"	14-1/2"	14-1/2"
Flange to Return	E	82"	98"	95-5/8"	136-5/8"	101-5/8"	115-5/8"	117-5/8"	132-5/8"	125-1/2"	143-1/2"	139-1/2"	161-1/2"
Flange to Outlet	F	97-1/2"	123"	120-5/8"	161-5/8"	127-5/8"	141-5/8"	143-5/8"	158-5/8"	152-1/2"	175"	171"	193"
WIDTHS													
Overall	I	65"	65"	70"	70"	82"	82"	88"	88"	102"	102"	116"	116"
I.D. Boiler	J	55"	55"	60"	60"	72"	72"	78"	78"	92"	92"	106"	106"
Center to LWCO Controller	K	34-1/2"	34-1/2"	37"	37"	43"	43"	46"	46"	53"	53"	60"	60"
Base Outside	M	47-1/2"	47-1/2"	52-1/2"	52-1/2"	58-1/2"	58-1/2"	64"	64"	68"	68"	74-3/4"	74-3/4"
Base Inside	N	39-1/2"	39-1/2"	44-1/2"	44-1/2"	50-1/2"	50-1/2"	56"	56"	55"	55"	61-3/4"	61-3/4"
HEIGHTS													
Base to Boiler Centerline	H	44-1/2"	44-1/2"	46"	46"	54"	54"	56"	56"	65-1/2"	65-1/2"	71"	71"
Base to Vent Outlet	O	80-3/4"	80-3/4"	85"	85"	101"	101"	106"	106"	122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to Rear Door Davit	OA	82-1/4"	82-1/4"	86-1/2"	86-1/2"	101"	101"	106"	106"	122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to Return/Outlet	P	78-3/8"	78-3/8"	82-3/8"	82-3/8"	96-1/4"	96-1/4"	101-1/2"	101-1/2"	118"	118"	130-5/8"	130-5/8"
Base Frame	Q	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
Base to Bottom Boiler	R	16"	16"	16"	16"	17"	17"	17"	17"	19"	19"	17-1/2"	17-1/2"
CONNECTIONS													
Waterfill (Both Sides)	S	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Water Return (150 lb Flange)	U	4"	6"	6"	6"	8"	8"	8"	10"	10"	12"	12"	12"
Water Outlet (150 lb Flange)	Y	4"	6"	6"	6"	8"	8"	8"	10"	10"	12"	12"	12"
Drain — Front & Rear	W	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
Air Vent	T	1-1/4"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"
Vent Stack Diameter (Flanged)	BB	16"	16"	16"	16"	20"	20"	20"	20"	24"	24"	24"	24"
Flange to Center Vent	CC	9-1/8"	9-1/8"	9-1/8"	9-1/8"	10-5/8"	10-5/8"	10-5/8"	10-5/8"	12-5/8"	12-5/8"	12-5/8"	12-5/8"
MINIMUM CLEARANCES													
Rear Door Swing	DD	34"	34"	36"	36"	43"	43"	46"	46"	53"	53"	60"	60"
Tube Removal — Front	GG	95"	121"	119"	160"	122"	148"	149"	165"	146"	179"	170"	192"
Tube Removal — Rear	HH	96-1/2"	122-1/2"	120-1/2"	161-1/2"	126-1/2"	152-1/2"	150-1/2"	166-1/2"	148-1/2"	181-1/2"	172-1/2"	194-1/2"
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Front of Boiler	RF	257"	309"	307"	389"	326"	378"	385"	417"	395"	461"	450"	494"
Rear of Boiler (3-Pass)	RR	303-1/2"	355-1/2"	351-1/2"	441"	371"	423"	427"	468-1/2"	441-1/2"	510"	492"	539"
Rear of Boiler (4-Pass)	RR	303-1/2"	355-1/2"	351-1/2"	441"	371"	429-1/2"	436-1/2"	473-1/2"	444"	510"	495"	544-1/2"
Thru Window or Door (3-Pass)	RD	237"	263"	263"	311-1/2"	283-1/2"	309-1/2"	315-1/2"	341"	340"	375-1/2"	373-1/2"	398-1/2"
Thru Window or Door (4-Pass)	RD	237"	263"	263"	311-1/2"	283-1/2"	316"	325"	346"	342-1/2"	375-1/2"	376-1/2"	404"
WEIGHTS													
Normal Water Weight (lbs)	—	5,848	7,397	8,378	11,180	11,940	14,380	16,190	17,884	22,572	27,431	32,991	37,120
Shipping Weight — (30psig) (lbs)	—	10,123	11,303	11,931	14,106	16,958	19,051	22,344	23,918	28,934	33,189	41,179	45,226
Shipping Weight — (125psig) (lbs)	—	10,238	11,418	13,153	15,679	18,609	21,270	24,522	26,631	32,175	36,972	47,122	51,782

NOTE: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for actual option requirements.

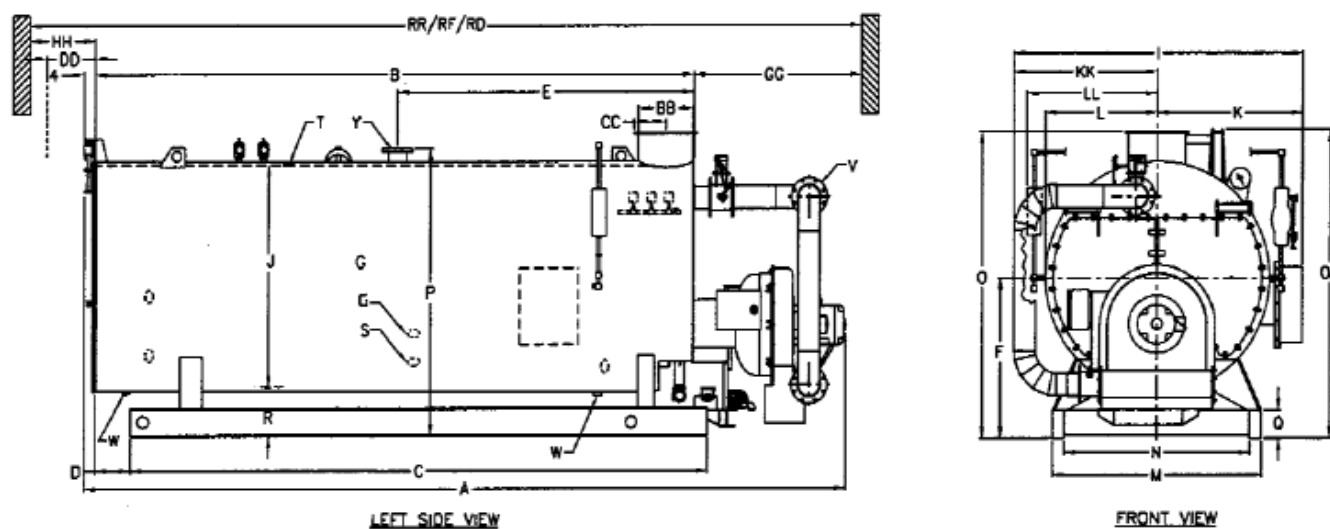
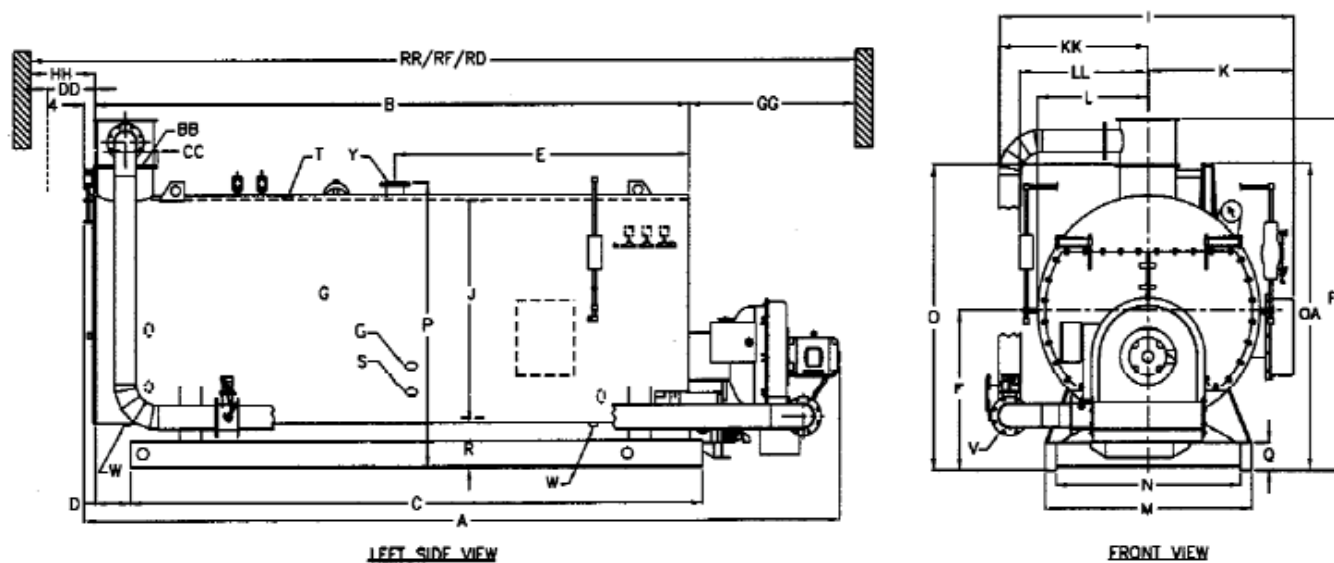
4-PASS "ICB" LOW NO_x STEAM BOILERS**3-PASS "ICB" LOW NO_x STEAM BOILERS**

Figure A4-3. Model ICB-LE Steam Boiler Dimensions, 4-Pass and 3-Pass (Optional)

Table A4-11. Model ICB-LE Steam Boiler Dimensions, 4-Pass and 3-Pass

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
LENGTHS													
Overall (3-Pass)	A	173"	199"	199"	240"	215"	241"	247"	268"	257-1/2"	290-1/2"	285-1/2"	312"
Overall (4-Pass)	A	173"	201"	199"	240"	215"	244"	252"	270-1/2"	257-1/2"	293-1/2"	290"	312"
Shell	B	127-7/8"	153-7/8"	151-7/8"	192-7/8"	160-7/8"	186-7/8"	189-7/8"	205-7/8"	195-3/4"	228-3/4"	219-7/8"	241-7/8"
Base Frame	C	124-3/8"	150-3/8"	148-3/8"	189-3/8"	157-3/8"	183-3/8"	184-3/8"	200-3/8"	187-1/4"	220-1/4"	211-3/8"	233-3/8"
Base Frame to Rear Flange	D	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	14-1/2"	14-1/2"	14-1/2"	14-1/2"
Flange to Steam Nozzle	E	55-7/8"	61-7/8"	65-7/8"	77-7/8"	68-7/8"	80-7/8"	78-7/8"	94-7/8"	82-3/4"	106-3/4"	98-7/8"	111-7/8"
WIDTHS													
Overall (3-Pass)	I	87"	87" 92"		92"	104"	106"	112" 112"		126"	128"	142"	142"
Overall (4-Pass)	I	82"	82" 87"		87"	100"	100"	109" 109"		122"	122"	133"	133"
I.D. Boiler	J	55"	55" 60"		60"	72"	72"	78" 78"	92"		92"	106"	106"
Center to Water Column	K	44-1/2"	44-1/2"	47"	47"	53"	53"	56"	56"	63"	63"	70"	70"
Center to Outside FGR Pipe (3-Pass)	KK	42-1/2"	42-1/2"	45"	45"	51"	53"	56" 56"	63"		65"	72"	72"
Center to Outside FGR Pipe (4-Pass)	KK	37"	37" 37"		37"	47"	47"	53"	53" 59"		59"	59"	59"
FGR Duct Size (3-Pass)	V	6"	6"	6"	6"	6"	8"	8" 8"		8"	10"	10"	10"
FGR Duct Size (4-Pass)	V	6"	6"	6"	6"	8"	8"	8" 8"		10"	10"	10"	10"
Center to Lagging	L	30-1/2"	30-1/2"	33"	33"	39"	39"	42" 42"		49"	49"	56"	56"
Center to Auxiliary LWCO	LL	37-1/2"	37-1/2"	40"	40"	46"	46"	49"	49"	56"	56"	63"	63"
Base Outside	M	47-1/2"	47-1/2"	52-1/2"	52-1/2"	58-1/2"	58-1/2"	64"	64"	68"	68"	74-3/4"	74-3/4"
Base Inside	N	39-1/2"	39-1/2"	44-1/2"	44-1/2"	50-1/2"	50-1/2"	56"	56"	55"	55"	61-3/4"	61-3/4"
HEIGHTS													
Base to Boiler Centerline	F	44-1/2"	44-1/2"	46"	46"	54"	54"	56" 56"		65-1/2"	65-1/2"	71"	71"
Base to Vent Outlet	O	80-3/4"	80-3/4"	85"	85"	101"	101"	106" 106"		122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to Rear Door Davit	OA	82-1/4"	82-1/4"	86-1/2"	86-1/2"	101"	101"	106" 106"		122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to FGR Stack Extension (3-Pass Only)	FF	94-3/4"	94-3/4"	99"	99"	118"	118"	123"	123"	142-1/2"	142-1/2"	155-5/8"	155-5/8"
Base to Steam Outlet	P	78-3/8"	78-3/8"	82-3/8"	82-3/8"	96-1/4"	96-1/4"	101-1/2"	101-1/2"	118"	118"	130-5/8"	130-5/8"
Base Frame	Q	12"	12" 12"		12"	10"	10"	10" 10"	12"		12"	12"	12"
Base to Bottom Boiler	R	16"	16" 16"		16"	17"	17"	17"	17"	19"	19"	17-1/2"	17-1/2"
CONNECTIONS													
Chemical Feed	G	1"	1"	1"	1"	1"	1"	1"	1" 1"		1"	1"	1"
Feedwater Inlet (Both Sides)	S	1-1/4"	1-1/2"	1-1/2"	2"	2"	2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Steam Nozzle (15 psig) 150 LB. FLG.	Y	8"	8"	8"	10"	10"	12"	12"	12" 12"		12"	12"	12"
Steam Nozzle (150 psig) 300 LB. FLG.	Y	4"	4"	4"	4"	6"	6"	6"	6" 8"		8"	8"	8"
Drain — Front & Rear (15 psig)	W	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"	2" 2"		2"	2"	2"
Blowdown-Front & Rear(150 psig)	W	1-1/4"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"	2"
Surface Blowoff (150 psig only)	T	1"	1"	1"	1"	1"	1"	1" 1" 1"			1"	1"	1"
Vent Stack Diameter (Flanged)	BB	16"	16"	16"	16"	20"	20"	20"	20"	24"	24"	24"	24"
Flange to Center Vent	CC	9-1/8"	9-1/8"	9-1/8"	9-1/8"	10-5/8"	10-5/8"	10-5/8"	10-5/8"	12-5/8"	12-5/8"	12-5/8"	12-5/8"
MINIMUM CLEARANCES													
Rear Door Swing	DD	34"	34" 36"		36"	43"	43"	46" 46"		53"	53"	60"	60"
Tube Removal — Front	GG	95"	121"	119"	160"	122"	148"	149" 165"		146"	179"	170"	192"
Tube Removal — Rear	HH	96-1/2"	122-1/2"	120-1/2"	161-1/2"	126-1/2"	152-1/2"	150-1/2"	166-1/2"	148-1/2"	181-1/2"	172-1/2"	194-1/2"
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Front of Boiler	RF	257"	309"	307"	389"	326"	378"	385" 417"		395"	461"	450"	494"
Rear of Boiler (3-Pass)	RR	305-1/2"	357-1/2"	355-1/2"	437-1/2"	377-1/2"	429-1/2"	436-1/2"	473-1/2"	444"	510"	496"	544-1/2"
Rear of Boiler (4-Pass)	RR	305-1/2"	359-1/2"	355-1/2"	437-1/2"	377-1/2"	432-1/2"	441-1/2"	476"	444"	513"	500-1/2"	544-1/2"
Thru Window or Door (3-Pass)	RD	239"	265"	267"	308"	290"	316"	325" 346"		342-1/2"	375-1/2"	376-1/2"	404"
Thru Window or Door (4-Pass)	RD	239"	267"	267"	308"	290"	319"	330"	348-1/2"	342-1/2"	378-1/2"	382"	404"
WEIGHTS													
Normal Water Weight	—	5,140	6,515	7,184	9,612	10,175	12,278	13,192	14,593	17,870	21,780	26,638	30,026
Shipping Weight — (15psig)	—	10,123	11,303	11,931	14,106	16,958	19,051	22,344	23,918	28,934	33,189	41,179	45,226
Shipping Weight — (150psig)	—	10,877	12,220	13,112	15,637	17,613	20,404	25,344	27,175	31,990	36,780	45,724	50,244

NOTE: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for actual option requirements.

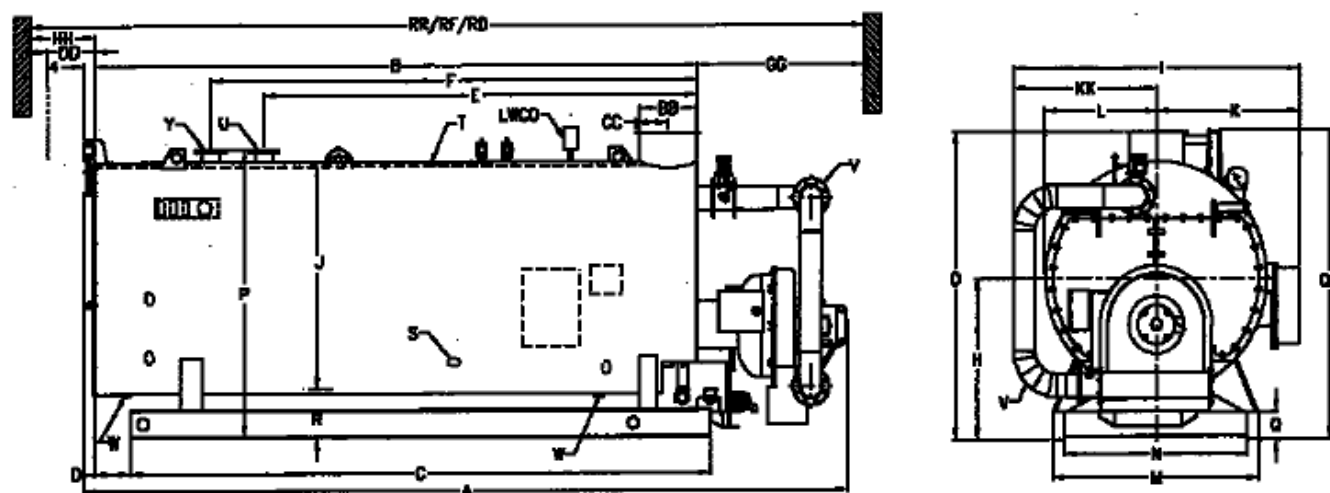
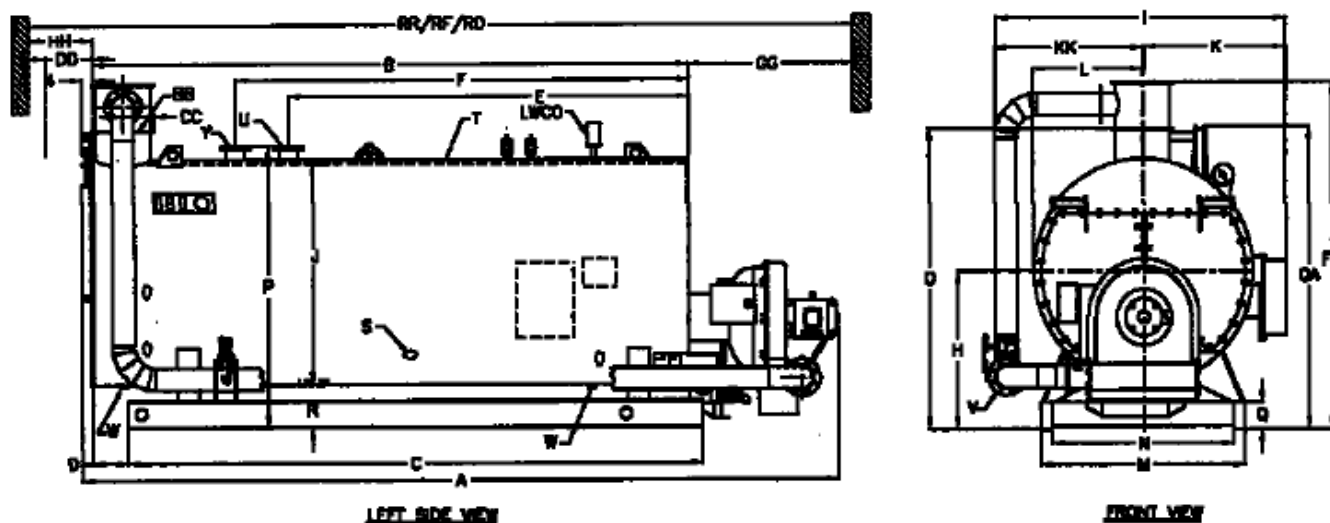
3-PASS "ICB" LOW NO_x HOT WATER BOILERS3-PASS "ICB" LOW NO_x HOT WATER BOILERS

Figure A4-4. Model ICB-LE Hot Water Boiler Dimensions, 4-Pass and 3-Pass (Optional)

Table A4-12. Model ICB-LE Hot Water Boiler Dimensions, 4-Pass and 3-Pass

BOILER H.P.	DIM	100	125	150	200	250	300	350	400	500	600	700	800
LENGTHS													
Overall (3-Pass)	A	173"	199"	199"	240"	215"	241"	247"	268"	257-1/2"	290-1/2"	285-1/2"	312"
Overall (4-Pass)	A	173"	201"	199"	240"	215"	244"	252"	270-1/2"	257-1/2"	293-1/2"	290"	312"
Shell	B	127-7/8"	153-7/8"	151-7/8"	192-7/8"	160-7/8"	186-7/8"	189-7/8"	205-7/8"	195-3/4"	228-3/4"	219-7/8"	241-7/8"
Base Frame	C	124-3/8"	150-3/8"	148-3/8"	189-3/8"	157-3/8"	183-3/8"	184-3/8"	200-3/8"	187-1/4"	220-1/4"	211-3/8"	233-3/8"
Base Frame to Rear Flange	D	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	14-1/2"	14-1/2"	14-1/2"	14-1/2"
Flange to Return	E	82"	98"	95-5/8"	136-5/8"	101-5/8"	115-5/8"	117-5/8"	132-5/8"	125-1/2"	143-1/2"	139-1/2"	161-1/2"
Flange to Outlet	F	97-1/2"	123"	120-5/8"	161-5/8"	127-5/8"	141-5/8"	143-5/8"	158-5/8"	152-1/2"	175"	171"	193"
WIDTHS													
Overall (3-Pass)	I	87"	87"	92"	92"	104"	106"	112"	112"	126"	128"	142"	142"
Overall (4-Pass)	I	81-1/2"	81-1/2"	84"	84"	100"	100"	109"	109"	122"	122"	129"	129"
I.D. Boiler	J	55"	55"	60"	60"	72"	72"	78"	78"	92"	92"	106"	106"
Center to Control Panel	K	44-1/2"	44-1/2"	47"	47"	53"	53"	56"	56"	63"	63"	70"	70"
Center to Outside FGR Pipe (3-Pass)	KK	42-1/2"	42-1/2"	45"	45"	51"	53"	56"	56"	63"	65"	72"	72"
Center to Outside FGR Pipe (4-Pass)	KK	37"	37"	37"	37"	47"	47"	53"	53"	59"	59"	59"	59"
FGR Duct Size (3-Pass)	V	6"	6"	6"	6"	6"	8"	8"	8"	8"	10"	10"	10"
FGR Duct Size (4-Pass)	V	6"	6"	6"	6"	8"	8"	8"	8"	10"	10"	10"	10"
Center to Lagging	L	30-1/2"	30-1/2"	33"	33"	39"	39"	42"	42"	49"	49"	56"	56"
Base Outside	M	47-1/2"	47-1/2"	52-1/2"	52-1/2"	58-1/2"	58-1/2"	64"	64"	68"	68"	74-3/4"	74-3/4"
Base Inside	N	39-1/2"	39-1/2"	44-1/2"	44-1/2"	50-1/2"	50-1/2"	56"	56"	55"	55"	61-3/4"	61-3/4"
HEIGHTS													
Base to Boiler Centerline	H	44-1/2"	44-1/2"	46"	46"	54"	54"	56"	56"	65-1/2"	65-1/2"	71"	71"
Base to Vent Outlet	O	80-3/4"	80-3/4"	85"	85"	101"	101"	106"	106"	122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to Rear Door Davit	OA	82-1/4"	82-1/4"	86-1/2"	86-1/2"	101"	101"	106"	106"	122-1/2"	122-1/2"	135-5/8"	135-5/8"
Base to FGR Stack Extension (3-Pass Only)	FF	94-3/4"	94-3/4"	99"	99"	118"	118"	123"	123"	142-1/2"	142-1/2"	155-5/8"	155-5/8"
Base to Return/Outlet	P	78-3/8"	78-3/8"	82-3/8"	82-3/8"	96-1/4"	96-1/4"	101-1/2"	101-1/2"	118"	118"	130-5/8"	130-5/8"
Base Frame	Q	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
Base to Bottom Boiler	R	16"	16"	16"	16"	17"	17"	17"	17"	19"	19"	17-1/2"	17-1/2"
CONNECTIONS													
Waterfill (Both Sides)	S	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Water Return (150 lb Flange)	U	4"	6"	6"	6"	8"	8"	8"	10"	10"	12"	12"	12"
Water Outlet (150 lb Flange)	Y	4"	6"	6"	6"	8"	8"	8"	10"	10"	12"	12"	12"
Drain — Front & Rear	W	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
Air Vent	T	1-1/4"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	2"	2"	2"	2"
Vent Stack Diameter (Flanged)	BB	16"	16"	16"	16"	20"	20"	20"	20"	24"	24"	24"	24"
Flange to Center Vent	CC	9-1/8"	9-1/8"	9-1/8"	9-1/8"	10-5/8"	10-5/8"	10-5/8"	10-5/8"	12-5/8"	12-5/8"	12-5/8"	12-5/8"
MINIMUM CLEARANCES													
Rear Door Swing	DD	34"	34"	36"	36"	43"	43"	46"	46"	53"	53"	60"	60"
Tube Removal — Front	GG	95"	121"	119"	160"	122"	148"	149"	165"	146"	179"	170"	192"
Tube Removal — Rear	HH	96-1/2"	122-1/2"	120-1/2"	161-1/2"	126-1/2"	152-1/2"	150-1/2"	166-1/2"	148-1/2"	181-1/2"	172-1/2"	194-1/2"
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:													
Front of Boiler	RF	257"	309"	307"	389"	326"	378"	385"	417"	395"	461"	450"	494"
Rear of Boiler (3-Pass)	RR	305-1/2"	357-1/2"	355-1/2"	437-1/2"	377-1/2"	429-1/2"	436-1/2"	473-1/2"	444"	510"	496"	544-1/2"
Rear of Boiler (4-Pass)	RR	305-1/2"	359-1/2"	355-1/2"	437-1/2"	377-1/2"	432-1/2"	441-1/2"	476"	444"	513"	500-1/2"	544-1/2"
Thru Window or Door (3-Pass)	RD	239"	265"	267"	308"	290"	316"	325"	346"	342-1/2"	375-1/2"	376-1/2"	404"
Thru Window or Door (4-Pass)	RD	239"	267"	267"	308"	290"	319"	330"	348-1/2"	342-1/2"	378-1/2"	382"	404"
WEIGHTS													
Normal Water Weight (lbs)	—	5,848	7,397	8,378	11,180	11,940	14,380	16,190	17,884	22,572	27,431	32,991	37,120
Shipping Weight — (30psig) (lbs)	—	10,123	11,303	11,931	14,106	16,958	19,051	22,344	23,918	28,934	33,189	41,179	45,226
Shipping Weight — (125psig) (lbs)	—	10,238	11,418	13,153	15,679	18,609	21,270	24,522	26,631	32,175	36,972	47,122	51,782

NOTE: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for actual option requirements.

BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
100 – 125	31	45	47	70	34
150 – 200	33	47	52	80	36
250 – 300	39	53	58	86	43
350 – 400	42	56	61	92	46
500 – 600	49	65	69	106	53
700 – 800	56	74	80	121	60

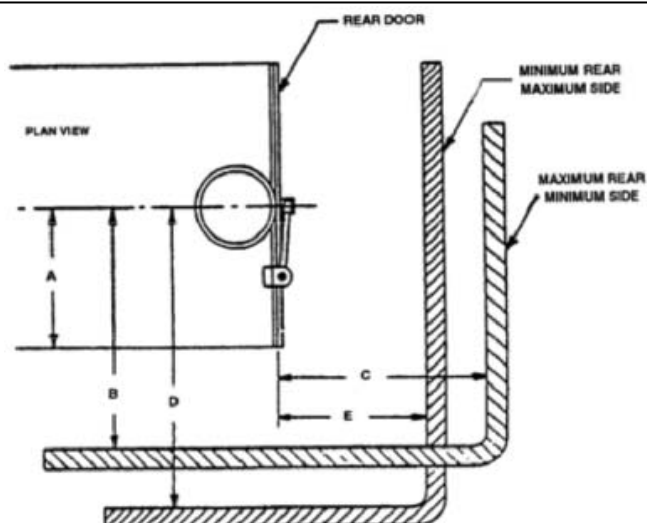
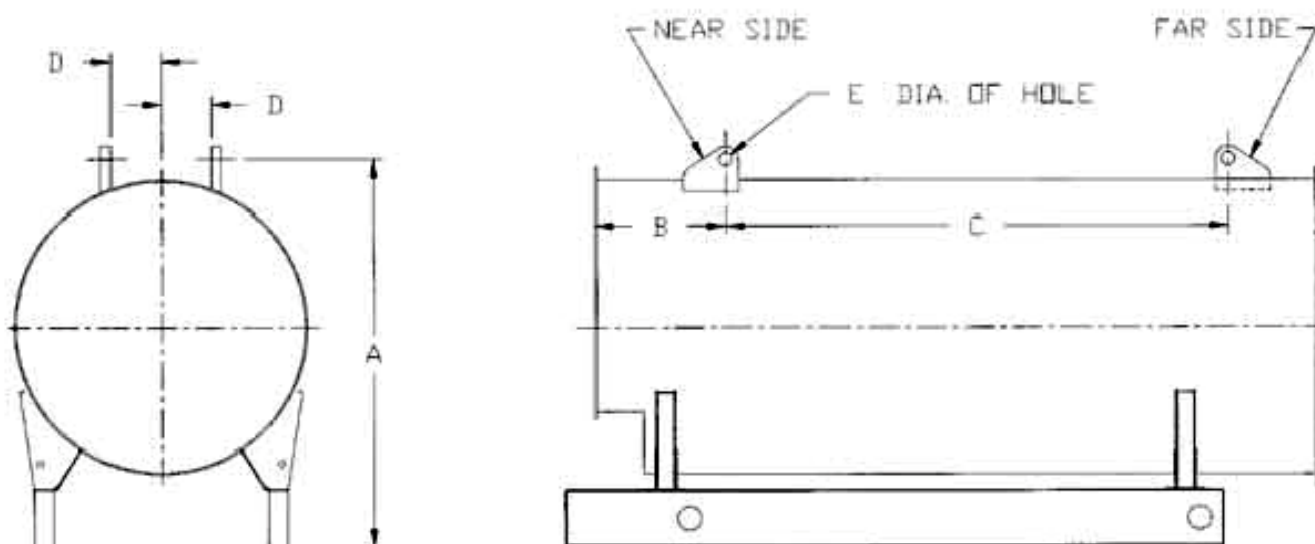


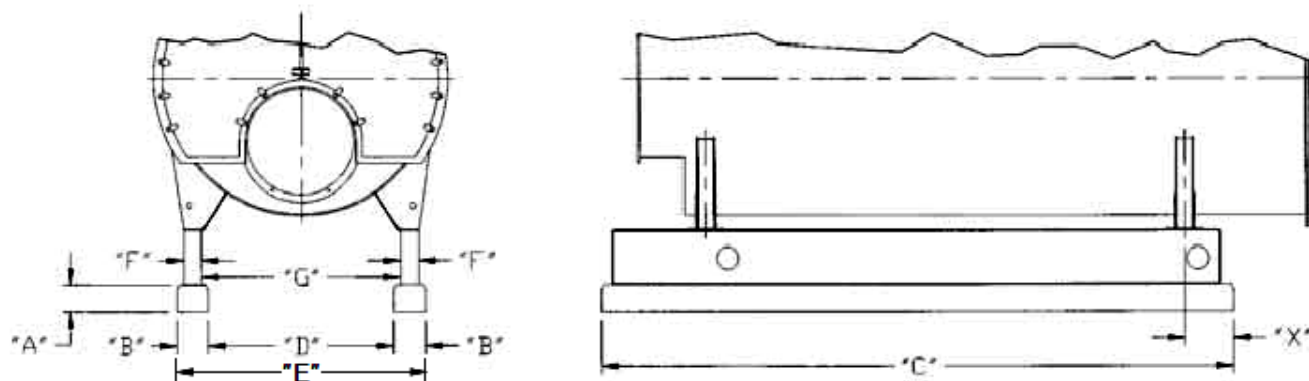
Figure A4-5. Space Required to Open Rear Head on Model ICB Boilers



BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
100	75-1/4	21-3/8	81-1/4	10	3
125	75-1/4	21-3/8	107-1/4	10	3
150	79-1/2	25-3/8	96-1/2	10	3
200	79-1/2	25-3/8	137-1/2	10	3
250	94	32	96-1/4	10	3
300	94	32	122-1/4	10	3
350	99	32	123-1/4	10	3
400	99	32	139-1/4	10	3
500	115-1/2	34	125-3/4	11	3
600	115-1/2	34	158-3/4	11	3
700	128-1/4	34	151	11	3
800	128-1/4	34	173	11	3

NOTE: A, B, and C dimensions may vary by 1 inch.

Figure A4-6. Model ICB Boilers Lifting Lug Location



BOILER HP	ALL DIMENSIONS IN INCHES							
	A	B	C	D	E	F	G	X
100	6	9	127-1/2	34-1/2	52-1/2	4	39-1/2	17-1/2
125	6	9	153-1/2	34-1/2	52-1/2	4	39-1/2	17-1/2
150	6	9	151-1/2	39-1/2	57-1/2	4	44-1/2	17-1/2
200	6	9	192-1/2	39-1/2	57-1/2	4	44-1/2	17-1/2
250	6	9	160-1/2	45-1/2	63-1/2	4	50-1/2	17-1/2
300	6	9	186-1/2	45-1/2	63-1/2	4	50-1/2	17-1/2
350	6	9	187-1/2	51	69	4	56	17-1/2
400	6	9	203-1/2	51	69	4	56	17-1/2
500	6	12	190-1/2	49-1/2	73-1/2	6-1/2	55	20-1/2
600	6	12	223-1/2	49-1/2	73-1/2	6-1/2	55	20-1/2
700	6	12	214-1/2	56-1/4	80-1/4	6-1/2	61-3/4	20-1/2
800	6	12	236-1/2	56-1/4	80-1/4	6-1/2	61-3/4	20-1/2

NOTE: 6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the boiler and added height for washing down the area beneath the boiler.

Figure A4-7. Model ICB Boiler Mounting Piers

PERFORMANCE DATA

Contact your local Cleaver-Brooks Authorized Representative for efficiencies or additional information.

Cleaver-Brooks ICB boilers are available with the standard burner package, or optional induced flue gas recirculation, refer to the Model ICB-LE for low NOx information.

ENGINEERING DATA

The following engineering information is provided for Model ICB Boilers. Additional detail is available from your local Cleaver-Brooks Authorized Representative.

Boiler Information

Table A4-13 shows steam volume and disengaging area for Model ICB Boilers.

Table A4-14 lists quantity and outlet size for safety valves supplied on Model ICB Steam Boilers.

Table A4-15 lists quantity and outlet size for relief valves supplied on Model ICB Hot Water Boilers.

Table A4-16 gives recommended steam nozzle sizes on Model ICB Boilers. Table A4-17 shows recommended non-return valve sizes for Model ICB Boilers.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table A4-18 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks Model ICB Boilers.

Burner/Control Information

Burner Characteristics

Maximum altitude for standard burners is 700 feet. Contact your local Cleaver- Brooks Authorized Representative for higher altitude availability. Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures.

Gas-Fired Burners

Table A4-19 lists minimum required gas pressure for altitude correction.

Table A4-21 shows minimum and maximum gas pressure requirements for Standard, FM and IRI ICB Boiler gas trains upstream of the gas pressure regulator.

Fuel Connections — Gas

For oversized or undersized gas trains or altitude above 700 feet, contact your local Cleaver-Brooks Authorized Representative.

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections — Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Figure A4-8 shows a typical fuel oil supply

arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Boiler Room Information

Figure A4-9 shows typical boiler room length requirements.

Figure A4-10 shows typical boiler room width requirements.

Stack Support Capabilities

100 – 800 hp Model ICB Boilers can support up to 2000 lbs without additional support.

100 – 800 hp Model ICB Boilers can be reinforced to support up to 3000 lbs.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance. Under no condition should the total area of the air supply openings be less than one (1) square foot.
 - D. Size the openings by using the formula:
$$\text{Area (sq.-ft.)} = \text{CFM/FPM}$$
2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp – up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.

3. Acceptable air velocity in Boiler Room (fpm).

A. From floor to (7) foot height – 250 fpm.

B. Above (7) foot height – 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm/fpm} = 3000/250 = 12$ sq.-ft. total.
- Area/Opening: $12/2 = 6$ sq.-ft./opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Model ICB is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks Authorized Representative is capable of assisting in your evaluation of the stack/breeching design.

Table A4-13. Model ICB Steam Volume and Disengaging Areas

BOILER HP	STEAM VOLUME CU-FT.		STEAM RELIEVING AREA SQ.-IN	
	HIGH PRESSURE (A)	LOW PRESSURE (B)	HIGH PRESSURE (A)	LOW PRESSURE (B)
100	11.2	16.5	3917	4363
125	14	20.5	4882	5443
150	19	26.3	5472	5990
200	25	34.6	7200	7891
250	27.8	41.4	6811	7618
300	33.2	49.4	8122	9072
350	47.9	66.3	9374	10238
400	52.6	72.9	10296	11246
500	74.5	94.9	11405	12168
600	89.6	114.2	13723	14630
700	100.8	127	14602	15538
800	112.7	142	16315	17381

NOTE:

1. Based on normal water level.

A. Based on 150 psig design pressure.

B. Based on 15 psig design pressure.

Table A4-14. Model ICB Steam Boiler Safety Valve Outlet Size

VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100	1	2-1/2	1	1-1/2	1	1-1/2	1	1-1/4
125	1	2-1/2	1	2	1	(1) 1-1/2	1	1 1/2
150	1	3	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4 (1) 1	2	1
200	2	(1) 2-1/2 (1) 2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	1-1/4
250	2	(2) 2-1/2	2	(1) 2 (1) 1-1/2	2	1-1/2 (1) 1-1/4	2	(1) 1-1/2 (1) 1-1/4
300	2	3 (1) 2-1/2	2	(1) 2 (1) 1-1/2	2	(2) 1-1/2	2	(1) 1-1/2 (1) 1-1/4
350	2	(2) 3	2	(1) 2-1/2 (1) 2	2	2 (1) 1-1/2	2	(1) 1-1/2 (1) 2
400	2	(2) 3	2	(1) 2-1/2 (1) 2	2	2 (1) 1-1/2	2	(2) 1-1/2
500	3	(2) 3 (1) 2-1/2	2	(1) 2-1/2 (1) 2	2	(1) 2-1/2 (1) 2	2	2 (1) 1-1/2
600	3	(3) 3	2	(2) 2-1/2	2	(1) 2-1/2 (1) 2	2	2
700	4	(4) 3	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2-1/2 (1) 2
800	5	(3) 3 (2) 2-1/2	3	2-1/2	3	(2) 2 (1) 2-1/2	2	2-1/2

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

Table A4-15. Model ICB Hot Water Boiler Relief Valve Outlet Size

VALVE SETTING	30 PSIG HW		125 PSIG HW		150 PSIG HW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100	1	2	1	1	1 2	
125	1	2-1/2	1	1-1/4	2	(1) 1-1/2 (1) 2
150	1	2-1/2	1	1-1/4	2	(1) 1-1/2 (1) 2
200	2	(1) 2-1/2 (1) 1	2	1	2 2	
250	2	(1) 1-1/4 (1) 2-1/2	1	2	2	(1) 2 (1) 2-1/2
300	2	(1) 2-1/2 (1) 2	1	2	2	(1) 1-1/2 (1) 2
350	2	2-1/2	1	2-1/2	2	(2) 2-1/2
400	3	(1) 1 (2) 2-1/2	1	2-1/2	2	(1) 2-1/2 (1) 3
500	4	(1) 2 (2) 2-1/2	1	2-1/2	2	(1) 3 (1) 2-1/2
600	3	2-1/2	2	(1) 1 (1) 2-1/2	2	3
700	4	(4) 2-1/2	2	(1) 2-1/2 (1) 1-1/4	3	(2) 3 (1) 2-1/2
800	5	(1) 1 (4) 2-1/2	2	(1) 2-1/2 (1) 2	3	3

NOTE: Relief valve is Kunkle #537 for 30# & 125#(Section IV) boiler and is Kunkle #927 for 150# HTHW (Section I) boiler.

Table A4-16. Model ICB Recommended Steam Nozzle Size

OPERATING PRESSURE	BOILER HP											
PSIG	100	125	150	200	250	300	350	400	500	600	700	800
15	8	8	8	10	10	12	12	12	12	12	12	12
30	6	6	6	8	8		10	10	10	12	12	12
40	6	6	6	8	8			10	10	10	12	12
50	4	6	6	6	8	8			10	10	10	12
75	4	4	4	6	6	8	8				10	10
100	4	4	4	6	6	6	8	8				10
125	4	4	4	4	6	6	6	8	8			
150	2.5	3	3	4	4	6	6	6	8	8		
200	2.5	2.5	3	4	4	4	6	6	6	6		
250	2	2.5	3	3	4	4	4	6	6	6		

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.
3. All standard steam nozzle sizes for 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.
4. Shaded area denotes special surge load baffles must be installed to avoid possible water carryover.
5. For incremental operating pressure, see Table I3-1 Steam System Fundamentals.

Table A4-17. Model ICB Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURE (PSIG)							
		50	75	100	125	150	175	200	250
100	3450	2-1/2	2-1/2	NA	NA	NA		NA	NA
125	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA	NA
150	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA	NA
200	6900	3*	3	3	3	3	2-1/2	2-1/2	2-1/2
250	8625	4	3*	3	3	3	3	3	3
300	10350	4	4	4	3*	3	3	3	3
350	12025	4	4	4	4	4	3*	3	3
400	13800	5	4	4	4	4	4	4	3*
500	17210	6	5	5	4	4	4	4	4
600	20700	6	6	5	5	5	4	4	4
700	24150	6	6	6	5	5	5	5	4
800	27600	6	6	6	6	6	5	5	5

NOTE:

Valve sizes (300# flanges) given in inches.

Standard non-return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output); selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative. For high turndown applications see Boiler Book Section I3, Table I3-3.

*Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table A4-18. Model ICB Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
100	75
125	94
150	102
200	135
250	125
300	150
350	174
400	191
500	206
600	248
700	266
800	297

NOTE: Quantity of water removed from boiler by lowering normal water line 4"

Table A4-19. Altitude Correction for Gas

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

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

Table A4-20. Sound Levels in dBA for 4-Pass ICB Boilers at High Fire

BHP	Sound Level — dBA
	ICB
100	80.0
125	84.5
150	84.5
200	84.5
250	84.5
300	91.0
350	94.0
400	91.5
500	93.5
600	93.5
700	93.7
800	93.7

Table A4-21. Model ICB, Standard Emissions, Minimum Required Gas Pressure at Entrance to Standard, FM & IRI Gas Trains (Upstream of Gas Pressure Regulator)

BOILER HP	STD PIPE SIZE (Inches)	PRESSURE REQUIRED, 3-PASS ("WC)			PRESSURE REQUIRED, 4-PASS ("WC)		
		GPR*	Minimum	Maximum	GPR*	Minimum	Maximum
100	2	RV91	8.5	27.7	RV91	10.5	27.7
125	2	RV91	13.5	27.7	RV91	16	27.7
150	2	RV91	17	27.7	RV91	21	27.7
200	2-1/2	RV111	20	27.7	210G	26	277
250	2-1/2	210G	32.5	277	210G	33	277
300	2-1/2	210G	45	277	210G	45.5	277
350	3	210G	46	277	210G	46.5	277
400	1.5-2	S	133	208	S	133	208
	2-2.5	S	91	133	S	94	133
	2.5	S	64	91	S	66	94
	3	S	39	64	S	42	66
500	1.5-2.5	S	191	277	S	183	277
	2-2.5	S	139	191	S	133	183
	2.5	S	94	139	S	89	133
	3	S	55	94	S	53	89
600	2-1.5-2.5	S	249	277	S	244	277
	2-2.5	S	191	249	S	188	244
	2.5	S	130	191	S	133	188
	2.5-3	S	108	130	S	111	133
	3	S	66	108	S	72	111
700	2-3	S	233	277	S	230	277
	2.5-3	S	141	233	S	141	230
	3	S	91	141	S	91	141
	4	S	58	91	S	64	91
800	2.5-3	S	177	277	S	175	277
	3	S	114	177	S	114	175
	4	S	72	114	S	72	114

NOTE: Where multiple gas train sizes are shown, the shaded row indicates standard size. For altitudes above 700 feet, contact your local Cleaver-Brooks authorized representative.

* GPR Gas Pressure Regulator

S-Siemens regulating actuator.

Table A4-22. Model ICB, Low NOx, Minimum Required Gas Pressure at Entrance to Standard, FM & IRI Gas Trains (Upstream of Gas Pressure Regulator)

BOILER HP	STD PIPE SIZE (Inches)	PRESSURE REQUIRED, 3-PASS ("WC)			PRESSURE REQUIRED, 4-PASS ("WC)		
		GPR*	Minimum	Maximum	GPR*	Minimum	Maximum
100	2	RV91	13	27.7	RV91	15	27.7
125	2	RV91	19.5	27.7	RV91	17.5	27.7
150	2	RV91	20	27.7	RV91	21.5	27.7
200	2-1/2	210G	27	277	210G	32.5	277
250	2-1/2	210G	30	277	210G	35.5	277
300	2-1/2	210G	43	277	210G	47.5	277
350	3	210G	45	277	210G	49.5	277
400	1.5-2	S	133	208	S	133	208
	2	S	91	133	S	91	133
	2.5	S	66	91	S	66	91
	3	S	39	66	S	42	66
500	1.5-2.5	S	188	277	S	186	277
	2-2.5	S	136	188	S	136	186
	2.5	S	91	136	S	94	136
	3	S	53	91	S	55	94
600	2-1.5-2.5	S	252	277	S	247	277
	2-2.5	S	194	252	S	191	247
	2.5	S	130	194	S	133	191
	2.5-3	S	108	130	S	111	133
	3	S	69	108	S	75	111
700	2-3	S	235	277	S	230	277
	2.5-3	S	144	235	S	141	230
	3	S	91	144	S	91	141
	4	S	61	91	S	61	91
800	2.5-3	S	175	277	S	175	277
	3	S	111	175	S	114	175
	4	S	69	111	S	3	114

NOTE: Where multiple gas train sizes are shown, the shaded row indicates standard size. For altitudes above 700 feet, contact your local Cleaver-Brooks authorized representative.

* GPR Gas Pressure Regulator

S-Siemens regulating actuator.

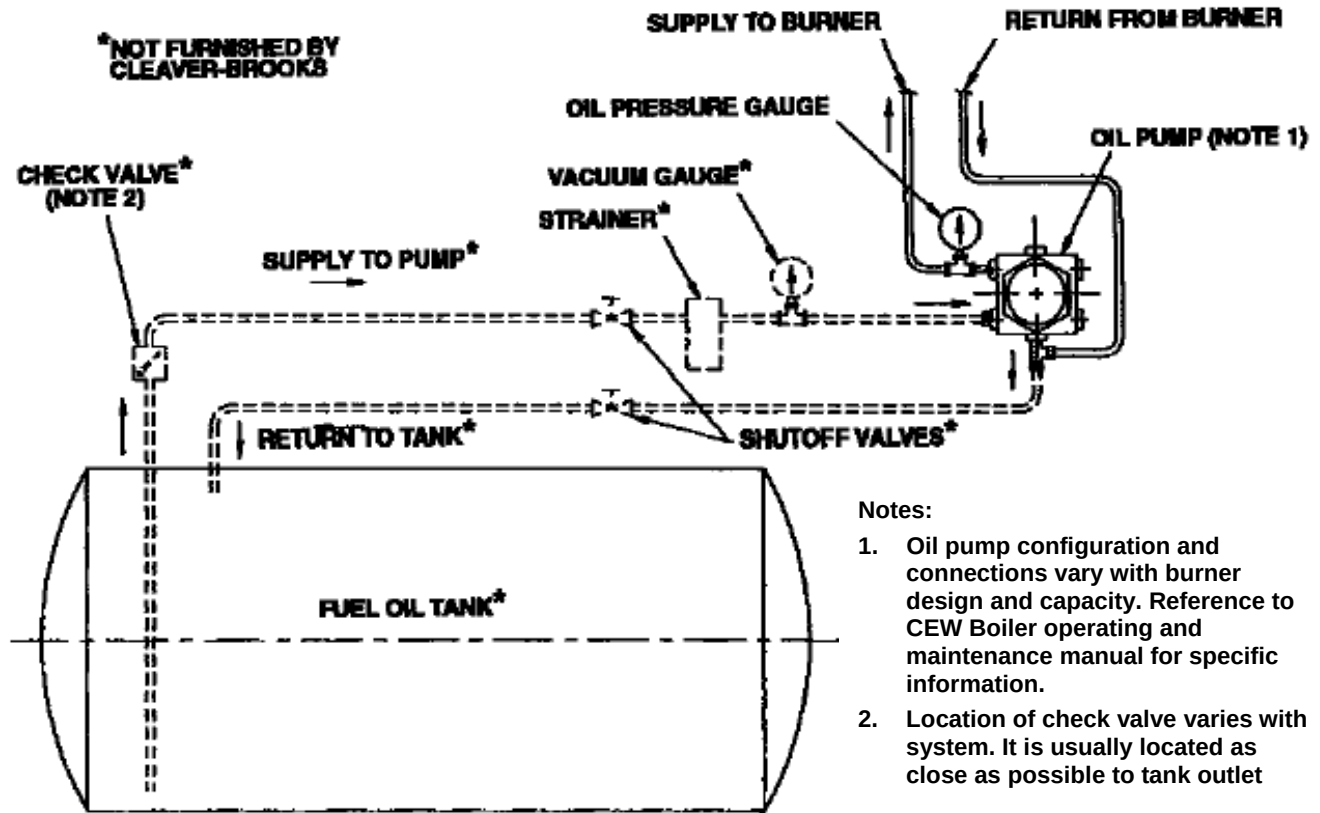
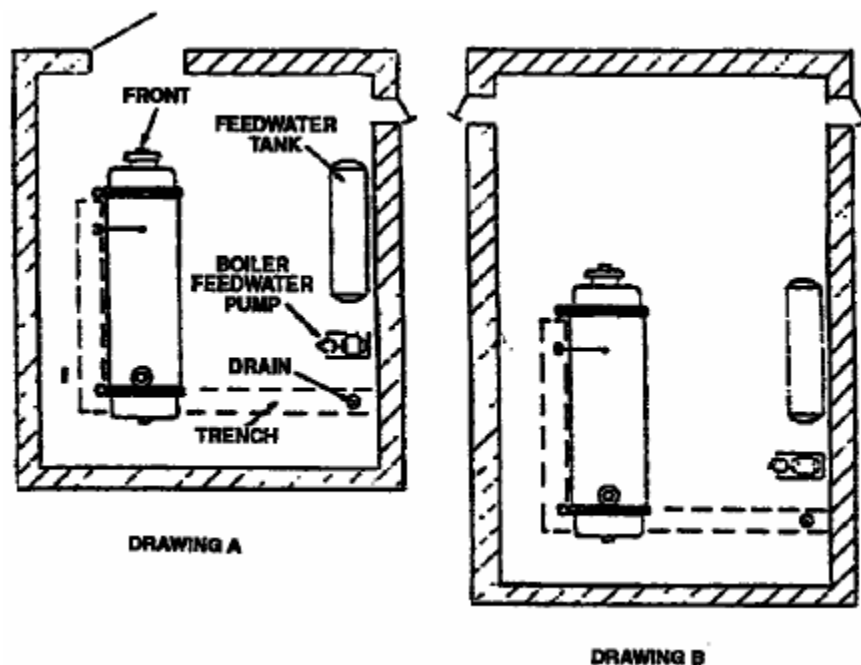


Figure A4-8. Typical Fuel Oil Supply Arrangement



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

Figure A4-9. Boiler Room Length (Typical Layouts) — Model ICB

BOILER HP	100 – 125	150 – 200	250 – 300	350 – 400	500 – 600	700 – 800
DIM. "A"	84-1/2	87	93 96		103	110
DIM. "B"	115-1/2	120	138 144		170	184

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.

2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of:

42" – 100-200 hp

48" – 250-400 hp

60" – 500-800 hp

If space permits, this aisle should be widened.

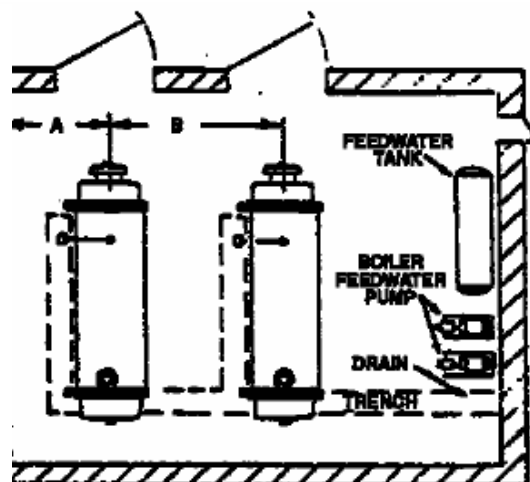


Figure A4-10. Boiler Room Width (Typical Layout) — Model ICB

SECTION A4

MODEL ICB

SAMPLE SPECIFICATIONS

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The following sample specification is provided by Cleaver-Brooks to assist you in meeting your customer's specific needs and application.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks Authorized Representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.

PART 1 GENERAL

Model ICB Steam Boiler (100 – 800 hp, 15 – 300 psig)

1.1 Boiler Characteristics (Steam)

- A. The Steam Boiler shall be Cleaver-Brooks Model ICB, Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (15, 150, 200, 250, 300 psig steam). The maximum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 No. 2 oil and/or natural gas, _____ Btu/cu-ft. Electrical power available will be _____ Volt _____ Phase _____ Cycle and 115/1/60 for the control circuit.

PART 2 PRODUCTS

2.1 General Boiler Design

- A. Number of Passes — Select one of the following:
 - (Four-Pass) The boiler shall be a four-pass intercooled horizontal firetube updraft boiler. It shall be mounted on a heavy steel frame with forced draft burner and burner controls.
 - (Three-Pass) The boiler shall be a three-pass intercooled horizontal firetube updraft boiler. It shall be mounted on a heavy steel frame with forced draft burner and burner controls.
- 1. Approvals: The complete burner/boiler package shall be approved as a unit by Underwriters Laboratories Inc. and bear the UL/cUL label.
- 2. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
- B. Boiler Shell (Steam)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 - 2. Two lifting eyes shall be located on top of the boiler.
 - 3. Front and rear doors on the boiler shall be davited.

4. The rear door shall be insulated with a blanket material and a steel covering to give the surface a hard durable finish.
5. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
6. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning.
7. Exhaust Vent — Select one of the following:
 - (Four-Pass) The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 2000 lbs.
 - (Three-Pass) The exhaust gas vent shall be located at the rear of the boiler on the top center line and shall be capable of supporting 2000 lbs.
8. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
9. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
10. The entire boiler based frame and other components shall be factory painted before shipment using a hard finish enamel coating.
11. An inner rear turnaround access opening shall swing on a davit, to allow full accessibility to the 2nd pass tubes and furnace.
12. Tubes shall be removable from either the front or rear of the boiler.

2.2 Steam Boiler Trim

A. 3.1 Water Column

A water column shall be located on the right hand side of the boiler complete with gauge glass set and water column blowdown valves.

1. Feedwater Pump Control

The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feedwater pump maintaining the boiler water level within normal limits.

2. Low Water Cutoff

The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.

B. Auxiliary Low Water Cutoff

The auxiliary low water cutoff shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used for this control.

C. Steam Pressure Gauge

The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.

D. Safety Relief Valves

Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.

E. Steam Pressure Controls

The steam pressure controls to regulate burner operation shall be mounted near the water column.

2.3 Burner and Controls

A. Mode of Operation

Burner operation shall be the full modulation principle. The burner shall always return to low fire position for ignition.

B. Blower

1. All air for combustion shall be supplied by a forced draft blower mounted on the burner, to eliminate vibration and reduce noise level.
2. Maximum sound level of the boiler/burner package shall not exceed _____ dBA (when measured in accordance with ABMA Sound Test Standards).
3. The impeller shall be fabricated aluminum with radial blade, carefully balanced, and directly connected to the blower motor shaft.

C. Combustion Air Control — Select one of the following:

- (Four-Pass) Combustion air damper and fuel control valve (100 – 250 hp) or cam operated fuel metering valve (300 – 800 hp) shall be operated by a single damper control motor that regulates the flame according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.
- (Three-Pass) Combustion air damper and fuel control valve (100 – 350 hp) or cam operated fuel metering valve (400 – 800 hp) shall be operated by a single damper control motor that regulates the flame according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.

D. Fuel Specification and Piping

Select one of the following fuel types:

- Fuel series 700 — Gas fired (para 4.4.1).
- Fuel series 100 — Light oil (No. 2) fired (para 4.4.2).
- Fuel series 200 — Light oil or gas fired (para 4.4.3).

1. FUEL SERIES 700 — GAS FIRED

- a. Burner Type — The burner shall be mounted at the front of the boiler and be of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel.
- b. Gas Pilot — The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one (1) shut-off valve, solenoid valve, pressure regulator, and one (1) plugged leakage test connection (Canada only).
- c. Gas Burner Piping — Select one of the following:
 - 1) 100 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 2) 125 – 250 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, two (2) motorized gas valves, one (1) valve with proof of closure switch, two (2) plugged leakage test

connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.

- 3) 300 – 350 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, two (2) motorized gas valves, one (1) valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
- 4) 400 – 800 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, two (2) motorized gas valves, one (1) valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.

2. FUEL SERIES 100 — LIGHT OIL FIRED

- a. Burner Type — The burner shall be mounted at the front of the boiler, and shall be approved for operation with CS12-48, Commercial No. 2 oil.
- b. Gas Pilot — The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one (1) shut-off valve, solenoid valve, pressure regulator, and one (1) plugged leakage test connection (Canada only).
- c. Oil Pump — An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Pump shall be motor driven and shipped loose to be field installed near the oil storage tank. Oil pump motor starter shall also be provided.
- d. Oil Burner Piping
 - 1) Four-Pass — Select one of the following:
 - 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - 200 – 250 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch, and pressure gauge all integrally mounted on the unit.
 - 300 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut-off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
 - 2) Three-Pass — Select one of the following:
 - 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - 200 – 350 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off

- valves, atomizing air proving switch, low oil pressure switch, and pressure gauge all integrally mounted on the unit.
- 400 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut-off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
- e. Oil Atomization Type — Select one of the following:
- 1) 100 – 150 hp. Burner shall include a complete mechanical oil atomizing system and be of the pressure atomizing type.
 - 2) 200 – 800 hp. Burner shall be a low pressure air atomizing type, including a “shipped loose” air compressor assembly.
3. FUEL SERIES 200 — LIGHT OIL OR GAS FIRED
- a. Burner Type — Select one of the following:
- 1) 100 – 150 hp. The burner, mounted at the front of the boiler, shall be a combination pressure atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 - 2) 200 – 800 hp. The burner, mounted at the front of the boiler, shall be a combination of low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
- b. Gas Pilot — The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include one (1) manual shut-off valve, solenoid valve, pressure regulator, and one (1) plugged leakage test connection (Canada only).
- c. Oil Burner
- 1) Oil Pump — An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Pump shall be motor driven and shipped loose to be field installed near the oil storage tank. Oil pump motor starter shall also be provided.
 - 2) Oil Burner Piping
 - Four-Pass — Select one of the following:
 - a. 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - b. 200 – 250 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch and pressure gauge all integrally mounted on the unit.
 - c. 300 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut-off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
 - Three-Pass — Select one of the following:

- a. 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - b. 200 – 350 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch and pressure gauge all integrally mounted on the unit.
 - c. 400 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut- off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
- 3) Oil Atomization Type — Select one of the following:
 - 100 – 150 hp. Burner shall include a complete mechanical oil atomizing system and be of the pressure atomizing type.
 - 200 – 800 hp. Burner shall be a low pressure air atomizing type, including a “shipped loose” air compressor assembly.
- d. Gas Burner Piping — Select one of the following:
 - 1) 100 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 2) 125 – 150 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid and one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 3) 300 – 350 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid and one (1) motorized gas valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 4) 400 – 800 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, two (2) motorized gas valves and one (1) valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water or any abnormal shutdown condition.
- E. Control Panel and Flame Safeguard Controller
 1. Control Panel

A factory prewired control panel shall be supplied with the boiler/burner package. Panel may be mounted on the burner or boiler.

2. The panel will have a NEMA 1A rating and contain the flame safeguard controller, burner motor starter, air compressor motor starter, oil metering pump motor starter, control circuit transformer and fuses, selector switches, indicating lights and terminal strips. Lights shall indicate load demand, flame failure, low water, and fuel valve open.
3. The panel shall contain fuse protection for the burner motor, air compressor motor, and oil metering pump.
4. The flame safeguard controller shall be a CB110 flame monitor with EPD170 program module. Flame detector shall be ultra-violet type.

2.4 Efficiency Guarantee

- A. The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of _____ percent at 100 percent of rating when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (Contact your local Cleaver-Brooks Authorized Representative for efficiency details).

2.5 Warranty

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

PART 3 EXECUTION

3.1 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.
- B. Start-Up Service
 1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

PART 1 GENERAL

Model ICB Hot Water Boiler (100 – 800 hp, 30 psig, 125 psig)

1.1 Boiler Characteristics (Hot Water)

- A. The Hot Water Boiler shall be Cleaver-Brooks Model ICB, Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (30, 125, or other psig hot water). The maximum water temperature will be _____ degree F, and the maximum system temperature drop will be _____ degree F.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 No. 2 oil and/or natural gas, _____ Btu/cu-ft. Electrical power available will be _____ Volt _____ Phase _____ Cycle and 115/1/60 for the control circuit.

PART 2 PRODUCTS

2.1 General Boiler Design

- A. Number of Passes — Select one of the following:
 - (Four-Pass) The boiler shall be a four-pass intercooled horizontal firetube updraft boiler. It shall be mounted on a heavy steel frame with forced draft burner and burner controls.
 - (Three-Pass) The boiler shall be a three-pass intercooled horizontal firetube updraft boiler. It shall be mounted on a heavy steel frame with forced draft burner and burner controls.
1. Approvals: The complete burner/boiler package shall be approved as a unit by Underwriters Laboratories Inc. and bear the UL/cUL label.
2. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
- B. Boiler Shell (Hot Water)
 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 2. The hot water return and outlet connections shall be located on the top center line of the boiler. The boiler shall be designed to rapidly mix the return water with the boiler water. Forced internal circulation shall be used.
 3. A dip tube shall be included as an integral part of the water outlet.
 4. Two lifting eyes shall be located on top of the boiler.
 5. Front and rear doors on the boiler shall be davited.
 6. The rear door shall be insulated with a blanket material and a steel covering to give the surface a hard durable finish.
 7. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.

8. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning.
9. Exhaust Vent — Select one of the following:
 - (Four-Pass) The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 2000 lbs.
 - (Three-Pass) The exhaust gas vent shall be located at the rear of the boiler on the top center line and shall be capable of supporting 2000 lbs.
10. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
11. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
12. The entire boiler based frame and other components shall be factory painted before shipment using a hard finish enamel coating.
13. An inner rear turnaround access opening shall swing on a davit, to allow full accessibility to the 2nd pass tubes and furnace.
14. Tubes shall be removable from either the front or rear of the boiler.

2.2 Hot Water Boiler Trim

- A. Hot Water Connections
The hot water outlet and return connections shall be located on the top center line of the boiler. The internal design of these connections shall provide forced internal circulation, mixing return water with the hot water within the boiler.
- B. Dip Tube
The dip tube, an integral part of the hot water outlet, and an air vent tapping in the boiler shell must be provided for removal of air.
- C. Low Water Cutoff
A low water cutoff control shall be mounted on the top centerline of the boiler wired into the burner control circuit to prevent burner operation if boiler water falls below a safe level. A manual reset device shall be used on this control.
- D. Pressure and Temperature Gauges
Pressure and temperature gauges shall be mounted on the boiler with temperature sensing element located adjacent to the hot water outlet.
- E. Relief Valves
Water relief valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- F. Temperature Controls
The temperature controls to regulate burner operation shall be mounted on the unit with temperature sensing elements located adjacent to the hot water outlet.

2.3 Burner and Controls

- A. Mode of Operation
Burner operation shall be the full modulation principle. The burner shall always return to low fire position for ignition.
- B. Blower
 1. All air for combustion shall be supplied by a forced draft blower mounted on the burner, to eliminate vibration and reduce noise level.

2. Maximum sound level of the boiler/burner package shall not exceed _____ dBA (when measured in accordance with ABMA Sound Test Standards).
 3. The impeller shall be fabricated aluminum with radial blade, carefully balanced, and directly connected to the blower motor shaft.
- C. Combustion Air Control — Select one of the following:
- (Four-Pass) Combustion air damper and fuel control valve (100 – 250 hp) or cam operated fuel metering valve (300 – 800 hp) shall be operated by a single damper control motor that regulates the flame according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.
 - (Three-Pass) Combustion air damper and fuel control valve (100 – 350 hp) or cam operated fuel metering valve (400 – 800 hp) shall be operated by a single damper control motor that regulates the flame according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.
- D. Fuel Specification and Piping
Select one of the following fuel types:
- Fuel series 700 — Gas fired (para 4.4.1).
 - Fuel series 100 — Light oil (No. 2) fired (para 4.4.2).
 - Fuel series 200 — Light oil or gas fired (para 4.4.3).
1. FUEL SERIES 700 — GAS FIRED
- a. Burner Type — The burner shall be mounted at the front of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel.
 - b. Gas Pilot — The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one (1) shut-off valve, solenoid valve, pressure regulator, and one (1) plugged leakage test connection (Canada only).
 - c. Gas Burner Piping — Select one of the following:
 - 1) 100 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 2) 125 – 250 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid and one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 3) 300 – 350 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid and one (1) motorized gas valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the

event of power failure, flame failure, low water, or any abnormal shutdown condition.

- 4) 400 – 800 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, two (2) motorized gas valves and one (1) valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.

2. FUEL SERIES 100 — LIGHT OIL FIRED

- a. Burner Type – The burner shall be mounted at the front of the boiler, and shall be approved for operation with CS12-48, Commercial No. 2 oil.
- b. Gas Pilot – The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include one (1) manual shut-off valve, solenoid valve, pressure regulator, and one (1) plugged leakage test connection (Canada only).
- c. Oil Pump – An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Pump shall be motor driven and shipped loose to be field installed near the oil storage tank. Oil pump motor starter shall also be provided.
- d. Oil Burner Piping
 - 1) Four-Pass — Select one of the following:
 - 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - 200 – 250 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch, and pressure gauge all integrally mounted on the unit.
 - 300 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut-off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
 - 2) Three-Pass — Select one of the following:
 - 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - 200 – 350 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch, and pressure gauge all integrally mounted on the unit.
 - 400 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut-off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.

- e. Oil Atomization Type — Select one of the following:
 - 1) 100 – 150 hp. Burner shall include a complete mechanical oil atomizing system and be of the pressure atomizing type.
 - 2) 200 – 800 hp. Burner shall be a low pressure air atomizing type, including a “shipped loose” air compressor assembly.
- 3. FUEL SERIES 200 — LIGHT OIL OR GAS FIRED
 - a. Burner Type — Select one of the following:
 - 1) 100 – 150 hp. The burner, mounted at the front of the boiler, shall be a combination pressure atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 - 2) 200 – 800 hp. The burner, mounted at the front of the boiler, shall be a combination of low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 - b. Gas Pilot – The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include one (1) manual shut-off valve, solenoid valve, pressure regulator, and one (1) plugged leakage test connection (Canada only).
 - c. Oil Burner
 - 1) Oil Pump – An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Pump shall be motor driven and shipped loose to be field installed near the oil storage tank. Oil pump motor starter shall also be provided.
 - 2) Oil Burner Piping
 - Four-Pass — Select one of the following:
 - a. 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - b. 200 – 250 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch and pressure gauge all integrally mounted on the unit.
 - c. 300 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut- off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
 - Three-Pass — Select one of the following:
 - a. 100 – 150 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, and pressure gauge all integrally mounted on the unit.
 - b. 200 – 350 hp. Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shut-off valves, atomizing air proving switch, low oil pressure switch and pressure gauge all integrally mounted on the unit.

- c. 400 – 800 hp. Fuel oil piping on the unit shall include oil metering system, one (1) solenoid oil shut- off valve, one (1) motorized oil valve with proof of closure switch, pressure relief valve, atomizing air proving switch, and low oil pressure switch all integrally mounted on the unit.
- 3) Oil Atomization Type — Select one of the following:
 - 100 – 150 hp. Burner shall include a complete mechanical oil atomizing system and be of the pressure atomizing type.
 - 200 – 800 hp. Burner shall be a low pressure air atomizing type, including a “shipped loose” air compressor assembly.
- d. Gas Burner Piping — Select one of the following:
 - 1) 100 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 2) 25 – 250 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid and one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 3) 300 – 350 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid and one (1) motorized gas valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 4) 400 – 800 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, two (2) motorized gas valves and one (1) valve with proof of closure switch, main gas vent valve, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water or any abnormal shutdown condition.
- E. Control Panel and Flame Safeguard Controller
 - 1. Control Panel

A factory prewired control panel shall be supplied with the boiler/burner package. Panel may be mounted on the burner or boiler.
 - 2. The panel will have a NEMA 1A rating and contain the flame safeguard controller, burner motor starter, air compressor starter, oil metering pump motor starter, control circuit transformer and fuses, selector switches, indicating lights and terminal strips. Lights shall indicate load demand, flame failure, low water, and fuel valve open.
 - 3. The panel shall contain fuse protection for the burner motor, air compressor motor, and the oil metering pump.

4. The flame safeguard controller shall be a CB110 flame monitor with EPD170 program module. Flame detector shall be ultra-violet type.

2.4 Efficiency Guarantee

- A. The boiler must be guaranteed to operate at a minimum fuel-to-water efficiency of _____ percent at 100 percent of rating when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (Contact your local Cleaver-Brooks Authorized Representative for efficiency details).

PART 3 EXECUTION

3.1 Warranty

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of

3.2 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

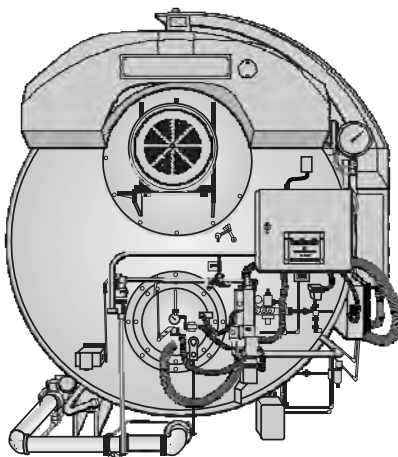
3.3 Start-Up Service

- A. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 1. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

Notes

MODEL CBR

125 - 800 HP
Steam and Hot Water
Dryback Integral Burner



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FEATURES AND BENEFITS

- 125-800hp.
- Steam and hot water.
- Same available pressures as equivalent Model CB/CBLE/CBW/4WI.
- Capable of firing natural gas, #2-#6 oil, bio-gas, digester gas or town gas.
- Low NOx capabilities—natural gas only.
- Containerization from 125-800 hp will reduce delivered to job site price for large boilers that would otherwise be shipped on flatracks.
- Enhanced heat transfer technology enables Cleaver-Brooks to reduce the number of tubes, thus reducing the overall weight and shell diameters while maintaining high fuel-to steam efficiency.
- Integral burner design.
- Allows interchangeability of burner spare parts for Models CB/CBLE/CBR.
- Enables us to offer 50/60Hz with no price surcharge.
- Corrugated furnace will be standard equipment.
- .095" tubes will be standard. (.105" tubes can be supplied at an additional cost.)
- Level master will be standard equipment.
- The CBR can be ordered with Hawk ICS as well as all other boiler extras which are available for Model CB/CBLE/4WI boilers.
- Same factory warranty as is applied to all other Cleaver-Brooks products.
- The CBR will be manufactured in the U.S. at our facility in Thomasville, Georgia.
- Locally available spare parts and after sales services through exclusive Cleaver-Brooks representatives around the world.

DIMENSIONS AND RATINGS

- Dimensions and ratings for the Model CBR boilers are shown in the following tables and illustrations:
- Table A10-1. Model CBR Steam Boiler Ratings
- Table A10-2. Model CBR Hot Water Boiler Ratings
- Table A10-3. Safety Valve Openings
- Table A10-4. Relief Valve Openings
- Figure A10-1. Model CBR Steam Boiler Dimensions
- Figure A10-2 Model CBR Hot Water Boiler Dimensions
- Figure A10-3. Space Required to Open Rear Head on Model CBR Boilers Equipped with Davits
- Figure A10-4. Model CBR Boiler Mounting Piers
- Figure A10-5. Lifting Lug Locations, Model CBR Boilers

Table A10-1. Model CBR Steam Boiler Ratings

BOILER H.P.	125	150	200	250	300	350	400	500	600	700	800
RATINGS - SEA LEVEL TO 700 FT.											
Rated Capacity (lbs-steam/hr from and at 212 °F)	4313	5175	6900	8625	10350	12075	13800	17250	20700	24150	27600
Btu Output (1000 Btu/hr)	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY											
Light Oil gph (140,000 Btu/gal)	37.4	44.8	59.8	74.7	89.7	104.6	119.5	149.4	179.3	209.2	239.1
Heavy Oil gph (150,000 Btu/gal)	34.9	41.8	55.8	69.7	83.7	97.6	111.6	139.5	167.4	195.3	223.1
Gas CFH (1000 Btu)	5230	6276	8368	10460	12552	14644	16736	20920	25104	29288	33472
Gas (Therm/hr)	52.3	62.8	83.7	104.6	125.5	146.4	167.4	209.2	251.0	292.9	334.7
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)											
Blower Motor hp (60 ppm)A	7 1/2	10	15	7 1/2	15	20	10	15	30	40	50
Blower Motor hp (30 ppm)A	10	15	20	15	20	30	15	25	40	60	75
Oil Pump Motor, hp, No. 2 Oil	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Oil Pump Motor, hp, No. 6 Oil	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	3/4
Air Compressor Motor hp	3	3	3	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2
Heavy Oil Heater kW B	5	5	5	7 1/2	7 1/2	7 1/2	7 1/2 ^C	7 1/2 ^C	7 1/2 ^C	7 1/2 ^C	7 1/2 ^C
BOILER DATA											
Heating Surface sq.-ft. (Fireside)	459	459	641	764	966	1238	1226	1374	1794	2535	2535

Notes:

A. Blower motor size for boiler operating pressures 125 psig and less, contact your local Cleaver-Brooks authorized representative for higher pressures and altitude.

B. Oil heater sized as a combination steam-electric heater. For straight electric heaters, contact your local Cleaver-Brooks authorized representative.

C. 10 KW Oil heater for low pressure.

Table A10-2. Model CBR Hot Water Boiler Ratings

BOILER H.P.	125	150	200	250	300	350	400	500	600	700	800
RATINGS - SEA LEVEL TO 700 FT.											
Btu Output (1000 Btu/hr)	4184	5021	6694	8368	10042	11715	13389	16736	20083	23430	26778
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY											
Light Oil gph (140,000 Btu/gal)	37.4	44.8	59.8	74.7	89.7	104.6	119.5	149.4	179.3	209.2	239.1
Heavy Oil gph (150,000 Btu/gal)	34.9	41.8	55.8	69.7	83.7	97.6	111.6	139.5	167.4	195.3	223.1
Gas CFH (1000 Btu)	5230	6276	8368	10460	12552	14644	16736	20920	25104	29288	33472
Gas (Therm/hr)	52.3	62.8	83.7	104.6	125.5	146.4	167.4	209.2	251.0	292.9	334.7
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)											
Blower Motor hp (60 ppm)	7 1/2	10	15	7 1/2	15	20	10	15	30	40	50
Blower Motor hp (30 ppm)	10	15	20	15	20	30	15	25	40	60	75
Oil Pump Motor, hp, No. 2 Oil	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	1	1
Oil Pump Motor, hp, No. 6 Oil	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4	3/4
Air Compressor Motor hp	3	3	3	5	5	5	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2
Heavy Oil Heater kW ^A	5	5	5	7 1/2	7 1/2	7 1/2	10	10	10	10	10
BOILER DATA											
Heating Surface sq.-ft. (Fireside)	459	459	644	764	966	1238	1226	1374	1794	2535	2535

Notes:

A. Oil heater sized as a straight electric heater.

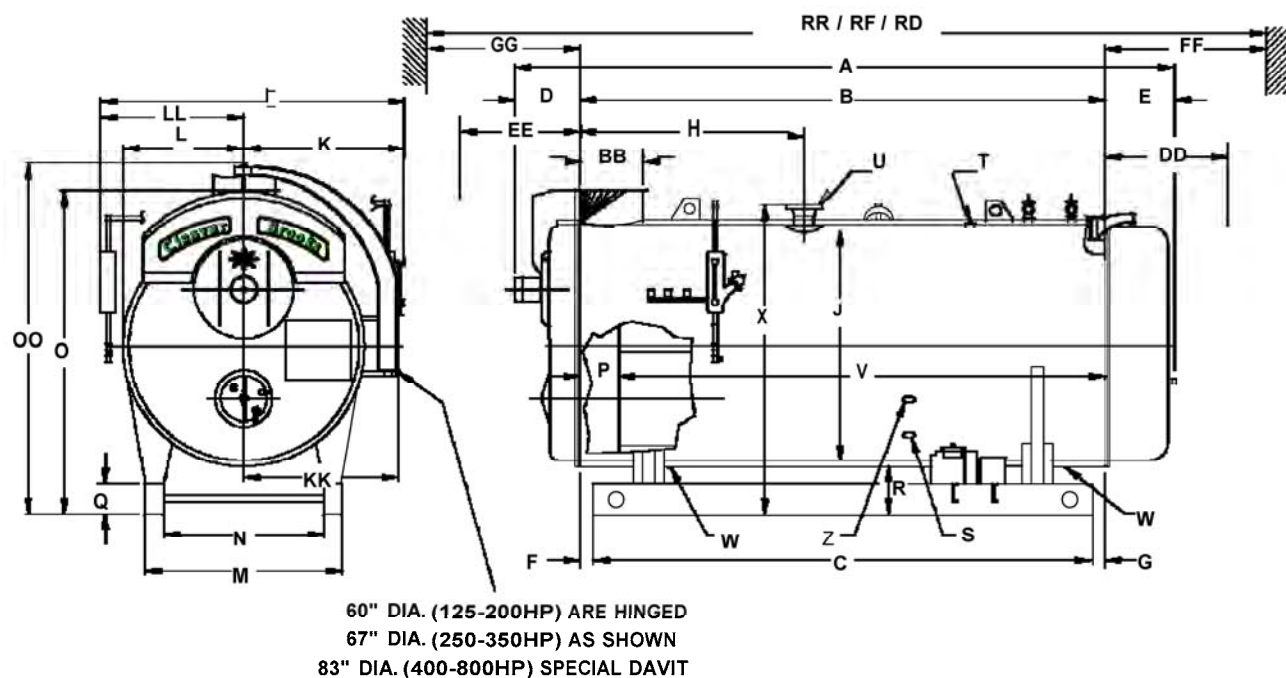


Figure A10-1. Model CBR Steam Boiler Dimensions and Weights - Sheet 1 of 2

BOILER H.P.	DIM	125	150	200	250	300	350	400	500	600	700	800
LENGTHS												
Overall Length (60 PPM system)	A	196.5	199.5	231.5	207	226	258	224	230	266	300	301
Overall Length (30 PPM system)	A	199.5	200.5	233.5	211	228	260	225	234	267	302	303
Shell	B	149	149	180	156 171	201 163			168	200	233	233
Base Frame	C	136	136	167	143 158	188 150			155	187	220	220
Front Head Extension (60 PPM system)	D	28	31	32	28	32	34	29	30	34	35	36
Front Head Extension (30 PPM system)	D	31	32	34	32	34	36	30	34	35	37	38
Rear Head Extension	E	19.5	19.5	19.5	23	23	23	32	32	32	32	32
Shell Ring Flange to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rear Ring Flange to Base	G	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Shell Flange to Steam Nozzle 15 psi	H	90	90	96	96	98	112	101	101	96	112	112
Shell Flange to Steam Nozzle 150 psi	H	84	84	96	96	98	112	100	100	96.25	112.75	112.75
Front Shell Extension	P	12	12	12	15 15	15 17			17	17	17	17
Over Tubesheets	V	137	137	168	141 156	186 146			151	183	216	216
WIDTHS												
Overall Width	I	85	85	85	92 92	92		109	109	109	109	109
I.D. Boiler	J	60	60	60	67 67	67 83			83	83	83	83
Center to Water Column	K	45	45	45	48.5	48.5	48.5	56.5	56.5	56.5	56.5	56.5
Center to Outside Davit/Hinge	KK	35	35	35	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5
Center to Lagging	L	33	33	33	36.5	36.5	36.5 44.5		44.5	44.5	44.5	44.5
Center to Auxiliary LWCO	LL	40	40	40	43.5	43.5	43.5	52.5	52.5	52.5	52.5	52.5
Base Outside	M	52.5	52.5 52.5		51	51	51	60	60	60	60	60
Base Inside	N	44.5	44.5 44.5		43	43	43	47	47	47	47	47
HEIGHTS												
Overall Height	OO	86	86	86	102.5	102.5	102.5	120.5	120.5	120.5	120.5	120.5
Base to Vent Outlet	O	85	85	85	94.5	94.5	94.5	112	112	112	112	112
Height of Base Frame	Q	12	12	12	12 12	12 12			12	12	12	12
Base to Bottom of Boiler	R	16	16	16	14	14	14	16	16	16	16	16
Base to Steam Outlet	X	82.375	82.375	82.375	90.25	90.25	90.25	108	108	108	108	108
BOILER CONNECTIONS												
Feedwater Inlet (Both Sides)	S	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Surface Blowoff (150 lb only)	T	1	1	1	1 1 1	1			1	1	1	1
Steam Nozzle 15 lb (See Note "A")	U	8	8	10	10	12	12	12	12	12	12	12
Steam Nozzle 150 lb (See Note "B")	U	4	4	4	6	6	6	6	8	8	8	8
Blowdown-Front & Rear (15 lb)	W	1.5	1.5	2	2 2 2	2			2	2	2	2
Blowdown-Front & Rear (150 lb)	W	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
Chemical Feed	Z	1	1	1	1 1 1	1			1	1	1	1
VENT STACK												
Vent Stack Diameter (Flanged)	BB	16	16	16	20 20	20 24			24	24	24	24
MINIMUM CLEARANCES												
Rear Door Swing	DD	32	32	32	36 36	36 45			45	45	45	45
Front Door Swing	EE	67	67	67	75 75	75 80			80	80	80	80
Tube Removal - Rear	FF	139	139	170	143 157	187 147			152	184	217	217
Tube Removal - Front	GG	127	127	158	128 142	172 130			135	167	200	200
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:												
Thru Window or Door	RD	248	248	279	267 282	312 288			293	325	358	358
Front of Boiler	RF	308	308	370	320 349	409 338			348	412	478	478
Rear of Boiler	RR	355	355	417	374 403	463 390			400	464	530	530
WEIGHTS IN LBS												
Normal Water Weight		6,950	6,950	8,350	8,400	9,050	10,550	11,650	11,900	14,150	15,700	15,700
Approx. Shipping Weight - (15 psig)		11,850	11,850	13,550	15,400	17,550	19,750	26,450	27,100	30,700	35,700	35,700
Approx. Shipping Weight - (150 psig)		13,000	13,000	14,850	18,100	19,300	20,750	29,050	29,750	32,400	37,600	37,600
Approx. Shipping Weight - (200 psig)		13,200	13,200	15,100	19,250	20,300	23,300	29,800	30,150	34,850	38,800	38,800

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension

All Connections are Threaded Unless Otherwise Indicated:

Note "A": ANSI 150 psig Flange

Note "B": ANSI 300 psig Flange

Figure A10-1. Model CBR Steam Boiler Dimensions and Weights - Sheet 2 of 2

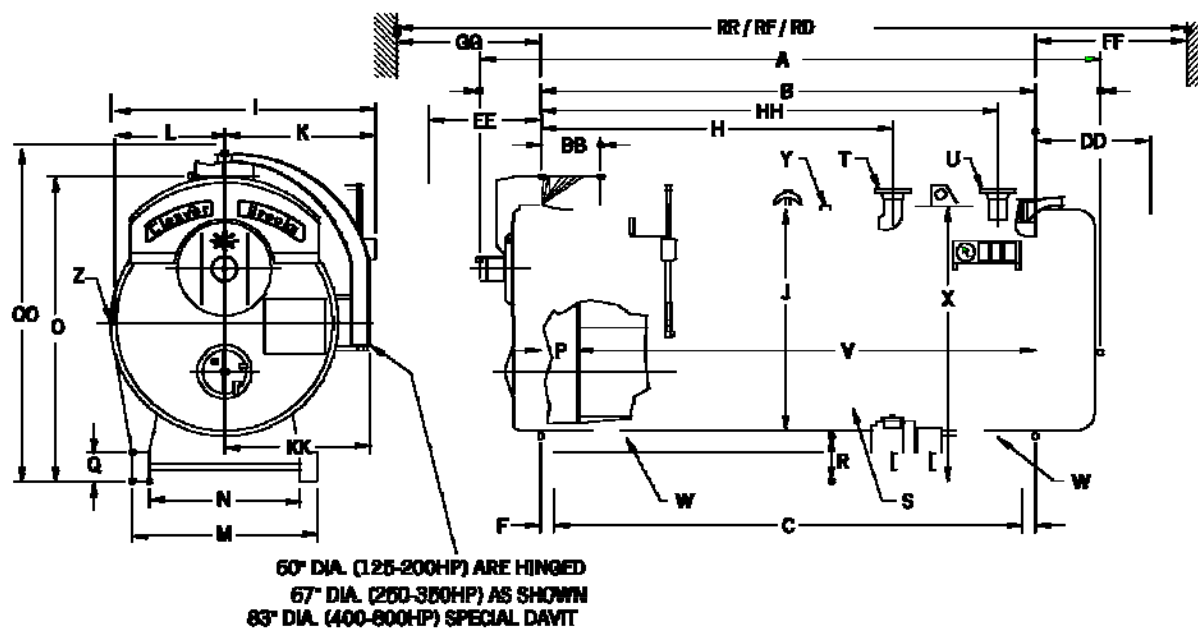


Figure A10-2. Model CBR Hot Water Boiler Dimensions - Sheet 1 of 2

BOILER H.P.	DIM	125	150	200	250	300	350	400	500	600	700	800
LENGTHS												
Overall Length (60 PPM system)	A	196.5	199.5	231.5	207	226	258	224	230	266	300	301
Overall Length (30 PPM system)	A	199.5	200.5	233.5	211	228	260	225	234	267	302	303
Shell	B	149	149	180	156	171	201	163	168	200	233	233
Base Frame	C	136	136	167	143	158	188	150	155	187	220	220
Front Head Ex tension (60 PPM system)	D	28	31	32	28	32	34	29	30	34	35	36
Front Head Ex tension (30 PPM system)	D	31	32	34	32	34	36	30	34	35	37	38
R ear Head Extension	E	19.5	19.5	19.5	23	23	23	32	32	32	32	32
Shell Ring Flange to Base	F	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
R ear Ring Flange to Base	G	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Shell Flange to Return	H	102	102	131	115.5	130.5	160.5	124.75	124.75	151.25	184.75	184.75
Shell Flange to Outlet	HH	136	136	167	143	157	187	151.75	151.75	182.75	216.25	216.25
Front Shell Extension	P	12	12	12	15	15	15	17	17	17	17	17
Over Tube sheets	V	137	137	168	141	156	186	146	151	183	216	216
WIDTHS												
Overall Width	I	75.5	75.5	75.5	82	82	82	100	100	100	100	100
I.D. Boiler	J	60	60	60	67	67	67	83	83	83	83	83
Center to Entrance Box	K	42.5	42.5	42.5	45.5	45.5	45.5	55.5	55.5	55.5	55.5	55.5
Center to Outside Davit/Hinge	KK	35	35	35	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5
Center to Lagging	L	33	33	33	36.5	36.5	36.5	44.5	44.5	44.5	44.5	44.5
Base Outside	M	52.5	52.5	52.5	51	51	51	60	60	60	60	60
Base Inside	N	44.5	44.5	44.5	43	43	43	47	47	47	47	47
HEIGHTS												
Overall Height	OO	86	86	86	102.5	102.5	102.5	120.5	120.5	120.5	120.5	120.5
Base to Vent Outlet	O	85	85	85	94.5	94.5	94.5	112	112	112	112	112
Height of Base Frame	Q	12	12	12	12	12	12	12	12	12	12	12
Base to Bottom of Boiler	R	16	16	16	14	14	14	16	16	16	16	16
Base to Return & Outlet	X	82.375	82.375	82.375	90.25	90.25	90.25	108	108	108	108	108
BOILER CONNECTIONS												
Waterfill Connection (Both Sides)	S	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Water Return (See Note "A")	T	6	6	6	8	8	8	10	10	12	12	12
Water Outlet (See Notes "A & B")	U	6	6	6	8	8	8	10	10	12	12	12
Drain-Front & Rear	W	1.5	1.5	2	2	2	2	2	2	2	2	2
Air Vent	Y	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2
VENT STACK												
Vent Stack Diameter (Flanged)	BB	16	16	16	20	20	20	24	24	24	24	24
MINIMUM CLEARANCES												
Rear Door Swing	DD	32	32	32	36	36	36	45	45	45	45	45
Front Door Swing	EE	67	67	67	75	75	75	80	80	80	80	80
Tube Removal - Rear	FF	139	139	170	143	157	187	147	152	184	217	217
Tube Removal - Front	GG	127	127	158	128	142	172	130	135	167	200	200
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:												
Thru Window or Door	RD	248	248	279	267	282	312	288	293	325	358	358
Front of Boiler	RF	308	308	370	320	349	409	338	348	412	478	478
Rear of Boiler	RR	355	355	417	374	403	463	390	400	464	530	530
WEIGHTS IN LBS												
Normal Water Weight		10,800	10,800	13,050	11,750	12,750	15,000	16,900	17,150	20,500	23,250	23,250
Approx. Shipping Weight - (30 psig)		11,850	11,850	13,550	15,400	17,550	19,750	26,400	27,100	30,700	35,700	35,700
Approx. Shipping Weight - (125 psig)		13,200	13,200	15,100	18,350	18,400	20,700	29,400	28,150	31,900	37,050	37,050

Figure A10-2. Model CBR Hot Water Boiler Dimensions - Sheet 2 of 2

Table A10-3. Steam Boiler Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
125	1	2-1/2	1	2	1	1-1/2	1	1-1/2
150	1	3	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/4	2	1
200	2	(1) 2-1/2 (1) 2	2	1-1/2	2	(1) 1-1/4 (1) 1-1/2	2	1-1/4
250	2	2-1/2	2	(1) 2 (1) 1-1/2	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/2 (1) 1-1/4
300	2	(1) 2-1/2 (1) 3	2	(1) 2 (1) 1-1/2	2	1-1/2	2	(1) 1-1/2 (1) 1-1/4
350	2	3	2	2	2	(1) 2 (1) 1-1/2	2	(1) 1-1/2
400	2	3	2	(1) 2-1/2 (1) 2	2	(1) 2 (1) 1-1/2	2	(1) 2 (1) 1-1/2
500	3	(2) 3 (1) 2-1/2	2	(1) 2-1/2 (1) 2	2	(1) 2 (1) 2-1/2	2	(1) 2 (1) 1-1/2
600	3	3	2	2-1/2	2	(1) 2 (1) 2-1/2	2	2
700	4	(3) 3 (1) 2-1/2	3	(2) 2-1/2 (1) 1-1/4	2	2-1/2	2	(1) 2-1/2 (1) 1-1/2
800	4	3	3	(2) 2-1/2 (1) 2	2	2-1/2	2	(1) 2-1/2 (1) 2

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

Table A10-4. Hot Water Boiler Relief Valve Openings

VALVE SETTING	30 PSIG HW		125 PSIG HW		150 PSIG HTHW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
125	1	2-1/2 1		1-1/4	2	1-1/2
150	1	2-1/2 1		1-1/4	2	(1) 1-1/2 (1) 2
200	2	(1) 1 (1) 2-1/2	2	1	2	2
250	2	(1) 1-1/4 (1) 2-1/2	1	2	2	(1) 2 (1) 2-1/2
300	2	(1) 2 (1) 2-1/2	1	2	2	(1) 2 (1) 2-1/2
350	2	2-1/2 1		2-1/2	2	2-1/2
400	3	(1) 1 (2) 2-1/2	1	2-1/2	2	(1) 2 (1) 3
500	3	(1) 2 (2) 2-1/2	1	2-1/2	2	(1) 2-1/2 (1) 3
600	3	(3) 2-1/2	2	(1) 1 (1) 2-1/2	2	3
700	4	(1) 2 (3) 2-1/2	2	(1) 1 (1) 2-1/2	3	(1) 3 (2) 2-1/2
800	4	2-1/2 2		(1) 2 (1) 2-1/2	3	(2) 3 (1) 2-1/2

NOTE: Relief valve is Kunkle #537 for 30# & 125#(Section IV) boiler and is Kunkle #927 for 150# HTHW (Section I) boiler.

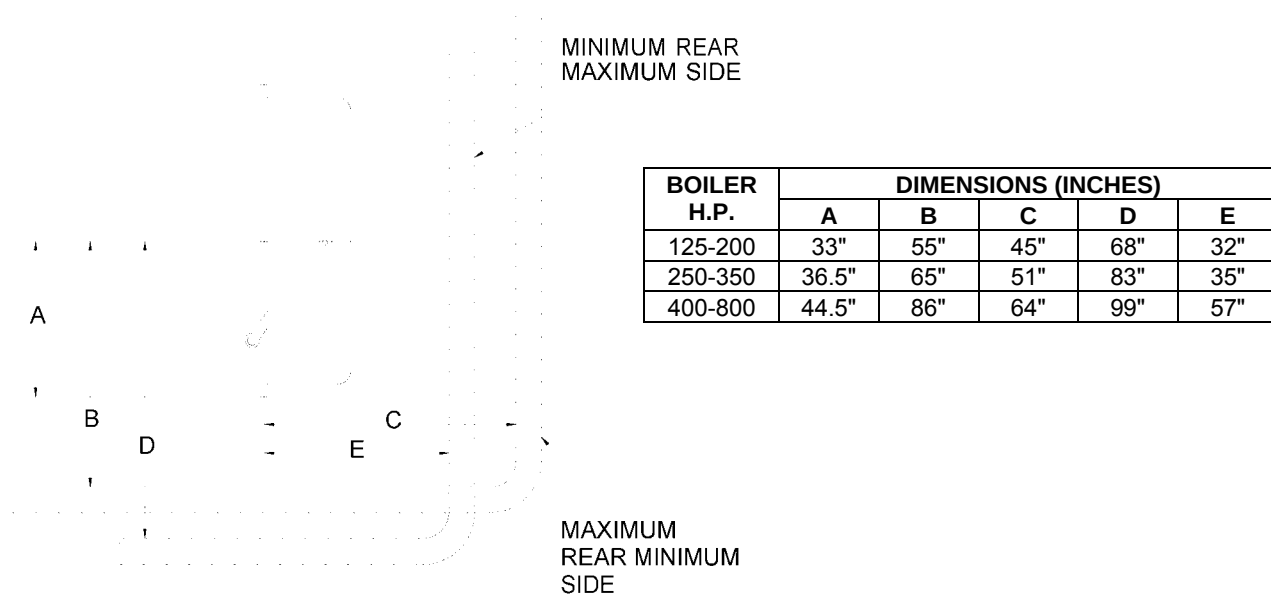
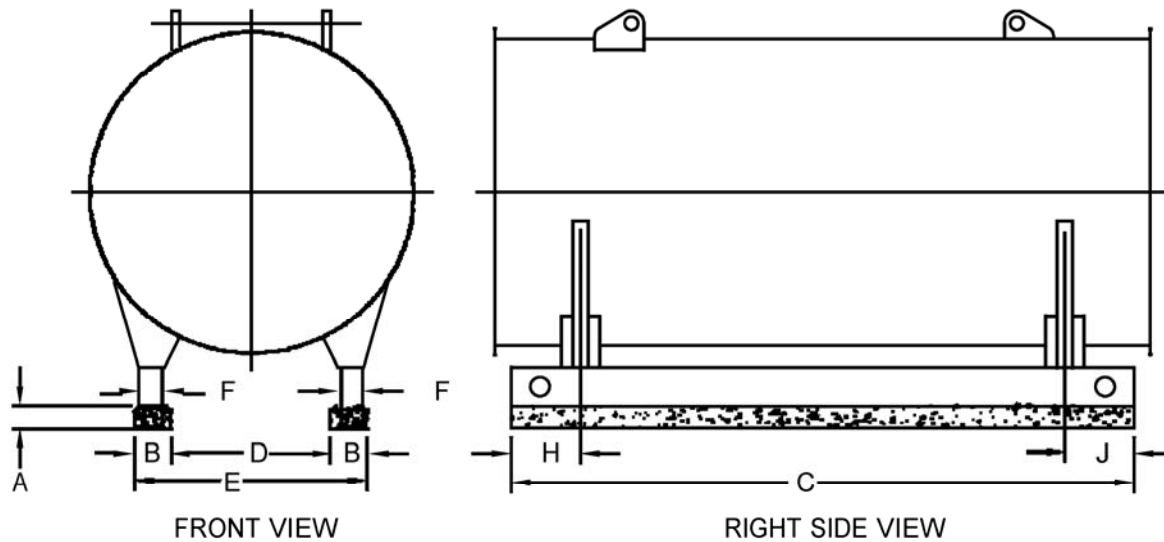


Figure A10-3. Space Required to Open Rear Head on Model CBR Boilers Equipped with Davits

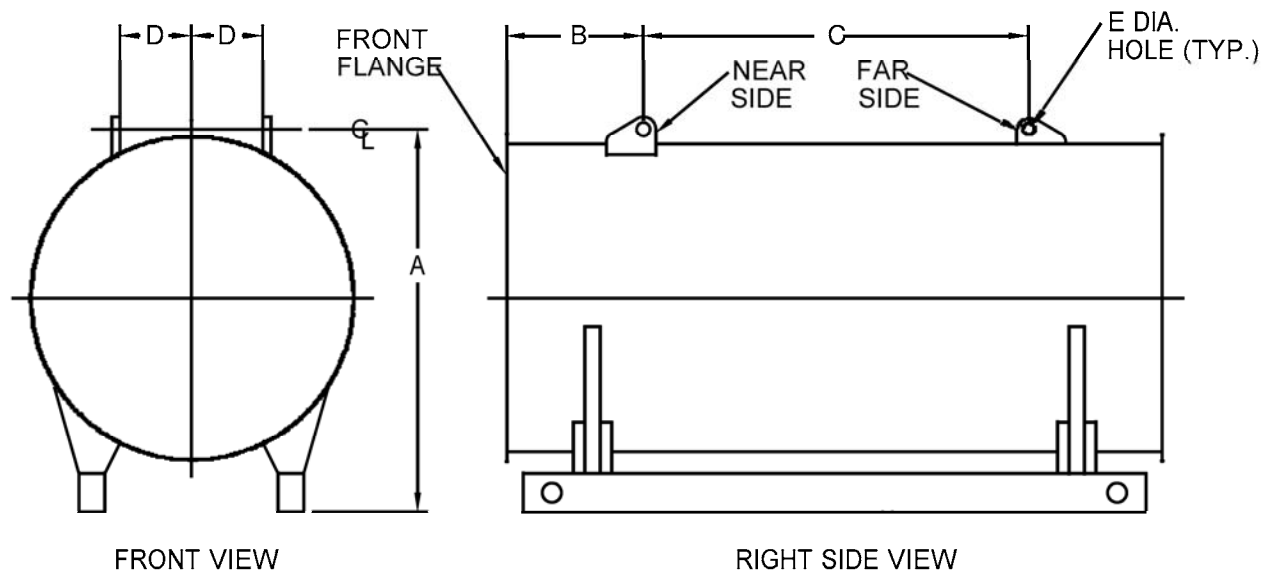


BOILER H.P.	DIMENSIONS (INCHES)								
	A	B	C	D	E	F	G	H	J
125-150	6"	9"	136"	39.5"	57.5"	4"	44.5"	10"	9.75"
200	6"	9"	167"	39.5"	57.5"	4"	44.5"	10"	9.75"
250	6"	12"	143"	48"	72"	4"	56"	10"	22"
300	6"	12"	158"	48"	72"	4"	56"	10"	22"
350	6"	12"	188"	48"	72"	4"	56"	10"	22"
400-500	6"	14"	154.75"	51.38"	79.38"	6.5"	58.88"	12"	22.75"
600	6"	14"	186.75"	51.38"	79.38"	6.5"	58.88"	12"	22.75"
700-800	6"	14"	219.75"	51.38"	79.38"	6.5"	58.88"	12"	22.75"

NOTE:

1. ALL NUMBERS IN TABLE ARE IN INCHES.
2. 6 INCH HIGH MOUNTING PIERS RECOMMENDED FOR USE BENEATH THE BOILER BASE FRAME. THE USE OF THESE PIERS PROVIDES INCREASED INSPECTION ACCESSIBILITY TO THE PIPING BENEATH THE BOILER AND ADDED HEIGHT FOR WASHING DOWN THE AREA BENEATH THE BOILER.

Figure A10-4. Model CBR Boiler Mounting Piers



BOILER H.P.		DIMENSIONS (INCHES)				
		A	B	C	D	E
125-150	ALL	80.25"	29.75"	83.5"	10"	3"
200	ALL	80.25"	29.75"	114.5"	10"	3"
250	STEAM	87.12"	36"	84"	10"	3"
	HOT WATER	87.12"	36"	93"	10"	3"
300	STEAM	87.12"	36"	99"	10"	3"
	HOT WATER	87.12"	36"	108"	10"	3"
350	STEAM	87.12"	36"	129"	10"	3"
	HOT WATER	87.12"	36"	138"	10"	3"
400-500	ALL	105.5"	35.75"	99"	11"	3"
600	ALL	105.5"	35.75"	131"	11"	3"
700-800	ALL	105.5"	35.75"	164"	11"	3"

NOTE: A, B, AND C DIMENSIONS MAY VARY BY 1/2".

Figure A10-5. Lifting Lug Locations, Model CBR Boilers

PERFORMANCE DATA

Efficiency Tables A10-5, A10-6, and A10-7 show predicted fuel-to-steam efficiencies (excluding radiation and convection losses) for Cleaver-Brooks Model CBR Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

Emissions The emission data included in this section (Table A10-8) consists of typical uncontrolled emission levels for Cleaver-Brooks Model CBR Firetube Boilers.

Cleaver-Brooks Firetube boilers are available with the standard burner package for Model CBR, or optional internal flue gas recirculation on.

The Cleaver-Brooks IFGR packages are integrated boiler/burner/control packages designed specifically for Cleaver-Brooks boilers. For detailed information on Cleaver-Brooks IFGR packages, refer to Model CB (LE) in Section A2.

Notice

The data in Table A10-8 represents typical emission levels only. Guaranteed emission levels are available from your local Cleaver-Brooks authorized representative.

Table A10-5. Predicted Fuel-to-Steam Efficiencies (%), Model CBR Boilers, Natural Gas

BHP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
125	84.4	84.5	84.0	83.4	81.6	81.8	81.5	81.0
150	84.3	84.4	83.7	83.0	81.5	81.6	81.2	80.7
200	84.5	84.9	84.5	84.1	81.7	82.2	82.0	81.7
250	84.2	84.2	83.5	82.6	81.4	81.5	80.9	80.3
300	84.4	84.5	84.0	83.4	81.5	81.8	81.5	81.0
350	84.6	85.1	84.8	84.5	81.8	82.4	82.3	82.1
400	84.8	84.3	83.6	82.7	82.0	81.8	81.1	80.4
500	84.7	84.2	83.4	82.5	82.0	81.7	81.0	80.1
600	85.0	84.8	84.4	83.8	82.3	82.3	81.9	81.4
700	85.3	85.3	85.1	84.8	82.6	82.8	82.7	82.4
800	85.2	85.3	85.0	84.6	82.5	82.7	82.6	82.3

Table A10-6. Predicted Fuel-to-Steam Efficiencies (%), Model CBR Boilers - No. 6 Oil

BHP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
125	88.3	88.4	87.8	87.2	85.3	85.6	85.2	84.7
150	88.2	88.2	87.5	86.8	85.2	85.4	84.9	84.3
200	88.4	88.8	88.4	87.9	85.5	85.9	85.7	85.5
250	88.1	88.0	87.3	86.4	85.1	85.2	84.6	84.0
300	88.3	88.4	87.8	87.1	85.3	85.5	85.2	84.7
350	88.5	89.0	88.7	88.3	85.6	86.1	86.1	85.9
400	88.6	88.1	87.3	86.5	85.8	85.5	84.8	84.0
500	88.6	88.0	87.2	86.2	85.7	85.4	84.6	83.8
600	88.9	88.7	88.2	87.6	86.1	86.1	85.7	85.1
700	89.2	89.2	89.0	88.6	86.3	86.6	86.4	86.2
800	89.1	89.1	88.9	88.5	86.3	86.5	86.3	86.0

Table A10-7. Predicted Fuel-to-Steam Efficiencies (%), Model CBR Boilers - No. 2 Oil

BHP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
125	87.8	88.0	87.4	86.8	85.0	85.2	84.9	84.5
150	87.7	87.8	87.2	86.4	84.9	85.1	84.6	84.1
200	88.0	88.3	88.0	87.5	85.2	85.6	85.4	85.2
250	87.6	87.6	86.9	86.1	84.8	84.9	84.3	83.7
300	87.8	88.0	87.4	86.8	85.0	85.2	84.9	84.4
350	88.1	88.5	88.3	87.9	85.3	85.8	85.7	85.6
400	88.2	87.7	87.0	86.1	85.5	85.2	84.5	83.8
500	88.1	87.6	86.8	85.9	85.4	85.1	84.4	83.6
600	88.5	88.3	87.8	87.2	85.7	85.7	85.4	84.9
700	88.7	88.8	88.5	88.2	86.0	86.2	86.1	85.8
800	88.7	88.7	88.4	88.1	85.9	86.2	86.0	85.7

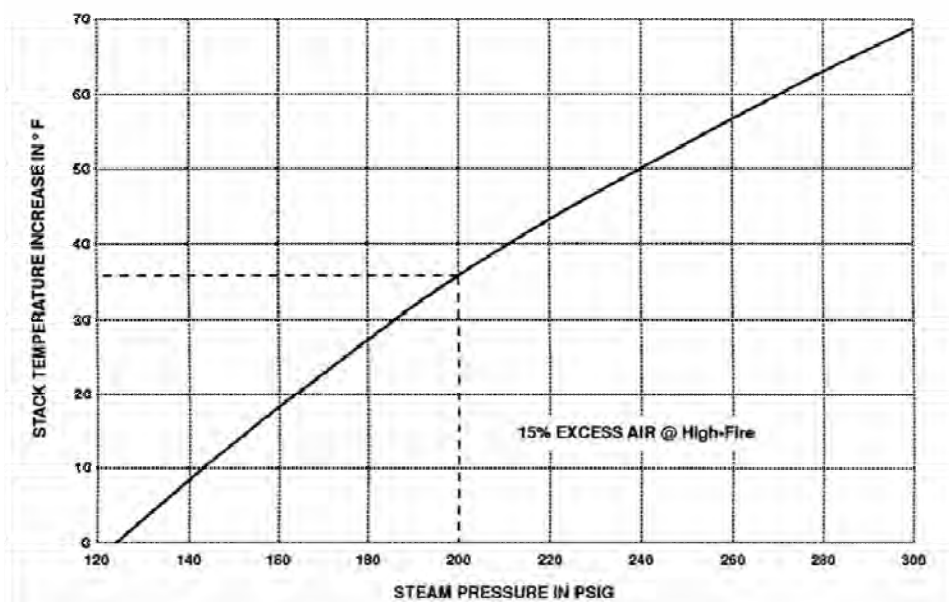
**Figure A10-6. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig**

Table A10-8. Model CBR Boiler Emission Data

POLLUTANT		ESTIMATED LEVELS - UNCONTROLLED				
		NATURAL GAS		NO. 2 OIL ^B		NO. 6 OIL ^C
		60 PPM System	30 PPM System	60 PPM System	30 PPM System	
CO	ppm ^A	50/150B	50/150B	50	50	95
	Lb/MMBtu	0.04/0.11	0.04/0.11	0.04	0.04	0.075
NOx	ppm ^A	60	30	185	140	502
	Lb/MMBtu	0.07	0.035	0.25	0.187	0.67
SOx	ppm ^A	1	1	278	278	278
	Lb/MMBtu	0.001	0.001	0.52	0.52	0.52
HC/VOCs	ppm ^A	10	10	4	4	70
	Lb/MMBtu	0.004	0.004	0.002	0.002	0.035
PM	ppm ^A	-	-	-	-	-
	Lb/MMBtu	0.01	0.01	0.025	0.256	0.160

NOTES:

Refer to Section E for detailed emission information.

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

B. CO emission is 50 ppm when boiler is operating above 50% of rated capacity. CO emission is 150 ppm when boiler is operating below 50% of rated capacity.

Based on fuel constituent levels of:

Fuel-bound nitrogen content = 0.05% by weight

Sulfur content = 0.5% by weight

Ash content = 0.01% by weight

Conradson carbon residue = 16% by weight

ENGINEERING DATA

The following engineering information is provided for Model CBR Firetube Boilers. Additional detail is available from your local Cleaver-Brooks authorized representative.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Sound Level

Table A10-13 summarizes predicted sound pressure levels for Model CBR Boilers.

These values are based on standard motors. Optional motor types and altitude conditions can increase sound levels.

Units

The units for the sound level tables are dBA (decibels, measured on the A-weighted scale) in reference to 0.0002 microbars (20 micro-Newtons per square meter). They are standardly referenced in specifying and reporting sound pressure levels on industrial equipment.

Test Method

The sound pressure levels in Table A10-13 were obtained from tests in accordance with the "ABMA Test Code for the Measurement of Sound from Packaged Boilers." In accordance with this code, the sound pressure levels reported were measured on the

boiler centerline 4-1/2 feet vertically above the bottom of the base rails and 3 feet horizontally in front of the end of the blower motor or front surface of the electrical cabinet.

Sound Level Meter

The sound level meter used complies with ANSI S1.4, Type 1 (Precision). The readings are taken with the meter set for slow response.

Table A10-9. Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA SQ-IN	
	HIGH PRESSURE (A)	LOW PRESSURE (B)	HIGH PRESSURE (A)	LOW PRESSURE (B)
125	61.8	67.7	7675	7790
150	61.8	67.7	7675	7790
200	75.8	83	9403	9561
250	53.7	64.7	8093	8453
300	59.4	71.5	8957	9345
350	70.8	85.3	10670	11145
400	84.7	98.8	10627	11016
500	84.7	98.8	10627	11016
600	102.6	119.7	12873	13363
700	121.1	141.3	15206	15768
800	121.1	141.3	15206	15768

NOTE:

1. Based on normal water level.
- A. Based on 150 psig design pressure.
- B. Based on 15 psig design pressure.

Table A10-10. Recommended Steam Nozzle Size (To Maintain 4000 to 5000 fpm Nozzle Velocity)

OPERATING PRESSURE	BOILER HP										
PSIG	125	150	200	250	300	350	400	500	600	700	800
15	8	8	10	10	12	12	12	12	12	12	12
30	6	6 8 8 8				10	10	10	12	12	12
40	6	6 6 8 8 8					10	10	10	12	12
50	6	6 6 6 8 8 8						10	10	10	12
75	4	4 6 6 6 8 8 8							8	10	10
100	4	4 6 6 6 6 6 8							8	8	10
125	4	4 4 6 6 6 6 8							8	8 8	
150	3	4 4 4 6 6 6 6							6	8 8	
200	2.5	3	4 4 4 4 6 6						6	6 6	
250	2.5	3	3 4 4 4 4 6						6	6 6	

NOTES:

1. Steam nozzle sizes given in inches.
2. Standard nozzle size for 15-psi steam boiler is as listed above for 15-psig operating pressure
3. Standard steam nozzle for a 150-psig or higher design steam boiler is listed above for 125-psig operating pressure. It will be changed only if requested at the time of order.
4. For expanded operating pressure table, see Table I3-1 (System Fundamentals)
5. Shaded area denotes special surge load baffles must be installed.

Table A10-11. Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURE (PSIG)							
		50	75	100	125	150	175	200	250
125	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA	
150	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA	NA
200	6900	3*	3	3	3	3	2-1/2	2-1/2	2-1/2
250	8625	4	3*	3	3	3	3	3	3
300	10350	4	4 4		3*	3	3	3	3
350	12025	4	4 4		4	4	3*	3	3
400	13800	5	4 4		4	4	4	4	3*
500	17210	6	5 5		4	4	4	4	4
600	20700	6	6 5		5	5	4	4	4
700	24150	6	6 6		5	5	5	5	4
800	27600	6	6 6		6	6	5	5	5

NOTE:

Valve sizes (300 psig flanges) given in inches.

Standard Non-Return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output)

NA Indicates that there is not a standard 2:1 turndown valve selection available

* Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop

Selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative. For high turndown applications see Boiler Book Section I3, Table I3-2.

Table A10-12. Model CBR Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
125	136
150	136
200	167
250	145
300	161
350	191
400	190
500	190
600	230
700	272
800	272

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Table A10-13. Predicted Sound Levels (30 ppm NOx Systems) at High Fire

BHP	Sound Level-dbA
125	84
150	84
200	84
250	83
300	84
350	85
400	84
500	85
600	85
700	88
800	90

Sound Pressure

On large size boilers, the need for auxiliary equipment, and the necessary interconnecting piping, make it impractical (and sometimes impossible) to provide a boiler testing environment that is suitable for obtaining the data needed to develop Sound Pressure Power levels.

Typical Values

Sound pressure levels (dBA) for identical boilers will vary between boiler rooms. In addition, variations will occur between different people using different sound meters on the same boiler. And finally, no two boilers can be expected to give precisely the same sound levels. For these reasons, we can only predict, but not guarantee, sound levels (dBA).

Octave Band

When predicting sound pressures in octave bands (e.g., dBA at 125 Hz), even greater variations between boilers, between sound meters, and between operators can be expected. These larger variations in the low and high frequencies make octave band levels a less reliable method of reporting than A-scale sound levels. (Since A-scale sound levels are dominated by mid-frequency sounds, the A-scale sound levels between two boilers can be in reasonable agreement even though the low and high frequencies of octave band measurement do not closely correspond).

Gas-Fired Burners

Table A10-14 shows gas pressure requirements for Model CBR Boilers.

Table A10-15 shows minimum required gas pressure altitude conversion.

Figure A10-10 shows typical gas train piping layouts for multiple boiler applications.

Oil-Fired Burners

Fuel oil consumption information is shown on the boiler rating sheets in the Dimensions and Ratings Section.

Figure A10-11 through Figure A10-13 show typical oil systems and layouts.

Figure A10-14 shows the detail of an oil transfer tank (day tank) typically utilized to provide a storage reservoir between the oil system supply pump and the boiler oil pump.

No. 6 Oil Piping, Storage Tank Heating

If the oil viscosity exceeds 4,000 SSU at the pumping temperature, tank preheating is required.

Based on the climate conditions for the job location, the minimum pumping temperature can be predicted, and the viscosity for the particular oil at this pumping temperature can be determined.

It is recommended to provide for tank and/or line heating on all No. 6 oil installations to ensure against high viscosities at decreased pumping temperatures. The following are two common methods:

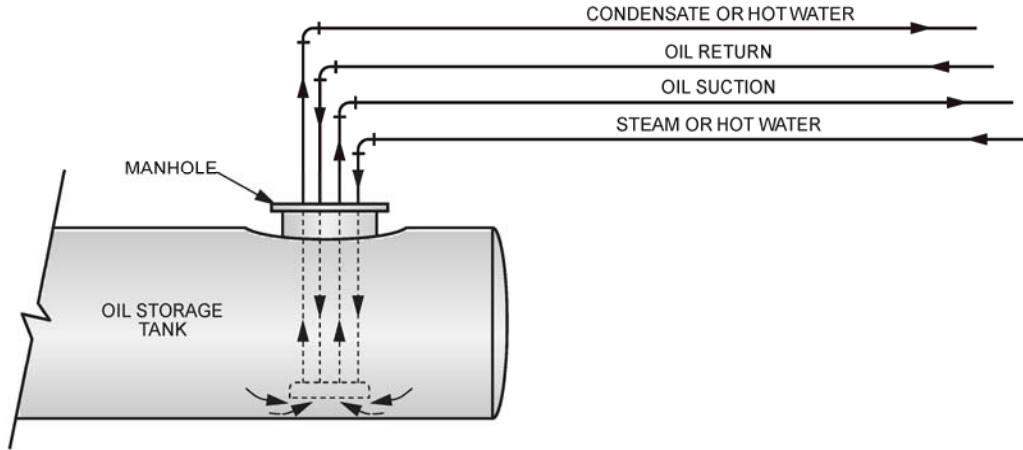
1. Provide a tank suction heater and bundle the steam or water "tracers" from the tank to the oil heater.
2. Provide electric heating equipment on the oil lines and/or in the storage tank.

Notice

The temperature in the oil suction line should not exceed 130 °F as higher temperatures could cause vapor binding of the oil pump and decreased oil flow.

See Figure A10-7 and Figure A10-8 for an example of (No. 1 above) tank heating method.

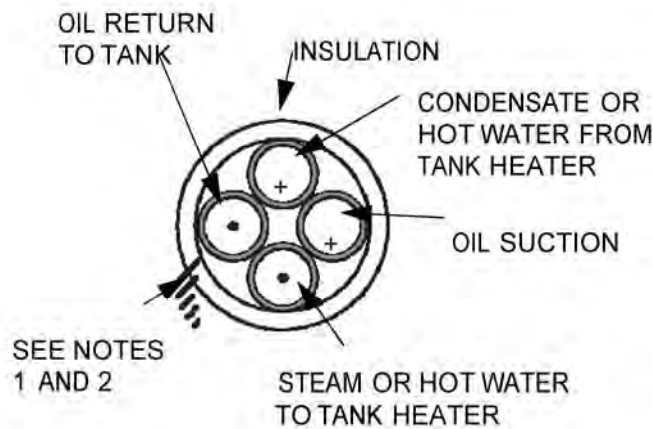
See Figure A10-9 for an example of a preheating system.



Note:

Observe all local and national (eg. Fire underwriters) code requirements governing the installation of fuel oil storage tanks and supply systems.

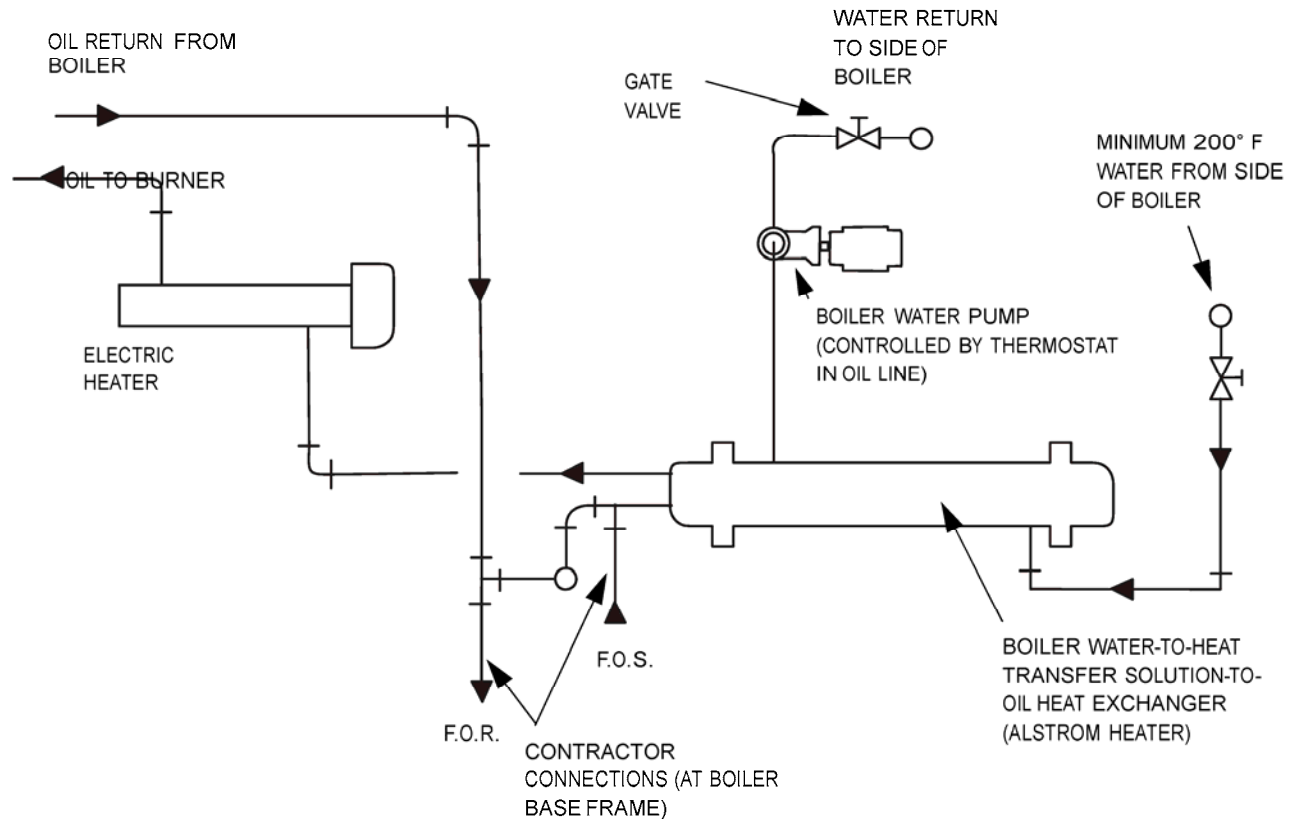
Figure A10-7. Typical Fuel Storage Tank Arrangement



Note 1: The outer jacket of the four line bundle should be protected by a waterproof covering to protect the lines and insulation from moisture damage. Tar paper and hot asphalt sealer have been successfully used as a waterproof covering.

Note 2: When the bundle runs under driveways or other traffic areas, a heavy duty outer jacket of reinforced concrete, vitrified tile, or a corrugated steel is recommended.

Figure A10-8. Typical Cross Section of Bundled Lines



In order to properly preheat No. 6 oil, the minimum recommended boiler water temperature is 200 °F. Some No. 6 oils must be preheated up to 210 °F, and higher boiler water temperatures are then desirable.

Although lower boiler water temperatures can be used, this condition means that the electric preheater will be doing more of the work. It is more economical to use higher temperature boiler water for preheating than to use lower temperature water which increases the electric preheating load.

To ensure the most trouble-free, dependable preheating system, a boiler water-to-water-to-oil preheating system is furnished as standard equipment and is mounted, piped and wired on the boiler. This safety type system or double heat exchanger eliminates the possibility of an oil leak fouling the boiler, oil heater, piping, control valves, and circulating pumps. Insurance companies recognize this as the best system for the application.

The standard system does not have provisions for a hot water line to a storage tank heater.

Figure A10-9. Schematic of Standard Alstom Hot Water Safety-Type Preheating System

Table A10-14. CBR Gas Pressure Requirements

Boiler HP	CBR 30 PPM		Boiler HP	CBR 60 PPM	
	Gas Train Size, in	Pressure Range PSI		Gas Train Size, in	Pressure Range PSI
125	1.5	0.8 - 3.0	125	1.5	0.7 - 3.0
150	1.5	1.0 - 3.0	150	1.5	1.0 - 3.0
200	1.5	1.6 - 4.0	200	1.5	1.6 - 4.0
	2	1.1 - 1.6		2	1.1 - 1.6
250	1.5	2.7 - 5.0	250	1.5	2.7 - 5.0
	2	1.8 - 2.7		2	1.8 - 2.7
300	1.5-2	3.5 - 5.0	300	1.5-2	3.5 - 5.0
	2	2.5 - 3.5		2	2.5 - 3.5
	3	1.6 - 2.5		3	1.6 - 2.5
350	1.5-2	4.0 - 6.0	350	1.5-2	4.0 - 6.0
	2	3.0 - 4.0		2	2.9 - 4.0
	2.5	2.2 - 3.0		2.5	2.1 - 2.9
	3	1.4 - 2.2		3	1.4 - 2.1
400	1.5-2	4.8 - 7.0	400	1.5-2	4.7 - 7.0
	2	3.3 - 4.8		2	3.1 - 4.7
	2.5	2.3 - 3.3		2.5	2.3 - 3.1
	3	1.4 - 2.3		3	1.4 - 2.3
500	1.5-2.5	7.0 - 10	500	1.5-2.5	7.0 - 10
	2-2.5	5.1 - 7.0		2-2.5	5.1 - 7.0
	2.5	3.5 - 5.1		2.5	3.5 - 5.1
	3	2.1 - 3.5		3	2.1 - 3.5
600	2-2.5	7.3 - 10	600	2-2.5	7.3 - 10
	2.5	5.1 - 7.3		2.5	5.0 - 7.3
	2.5-3	4.3 - 5.1		2.5-3	4.3 - 5.0
	3	2.9 - 4.3		3	2.9 - 4.3
700	2-3	9.0 - 10.0	700	2-3	9.0 - 10.0
	2.5-3	5.7 - 9.0		2.5-3	5.7 - 9.0
	3	3.8 - 5.7		3	3.8 - 5.7
	4	2.8 - 3.8		4	2.8 - 3.8
800	2.5-3	7.3 - 10	800	2.5-3	7.3 - 10
	3	5.0 - 7.3		3	5.0 - 7.3
	4	3.6 - 5.0		4	3.6 - 5.0

Note: Some units list two diameters because the gas train increases in size after the regulating valve. The first number is the customer connection size.

Table is based on Siemens gas train, which includes a regulating actuator.

UNDERSIZE

STANDARD

OVERSIZE

Table A10-15. Minimum Required Gas Pressure Altitude Conversion

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet,

multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

Oz/sq-in x 1.732 = Inches WC.

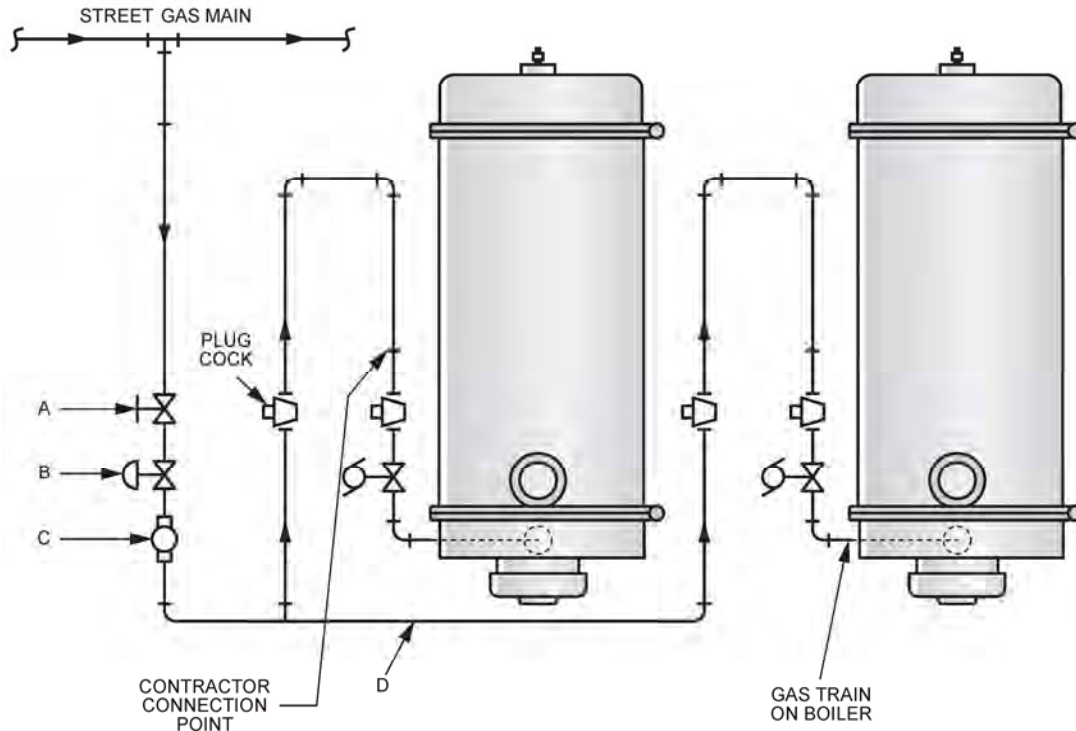
Inches WC x 0.0361 = psig.

Oz/sq-in x 0.0625 = psig.

Psig x 27.71 = Inches WC.

Psig x 16.0 = Oz/sq-in.

This figure illustrates the basic gas valve arrangement on Cleaver-Brooks Model CBR Boiler and shows the contractor's connection point. The valves and controls between the contractor connection point and the gas main in the street are representative of a typical installation. Actual requirements may vary depending on local codes or local gas company requirements which should be investigated prior to preparation of specifications and prior to construction.



- A. Utilities service valve.
- B. Utilities service regulator.
- C. Gas meter.
- D. Piping from meter to boiler.

The size of the gas line from the meter to the gas pressure regulator at the boiler can be very important if gas pressures are marginal. The gas line sizing is dependent on:

1. Gas pressure at outlet of gas meter (C)
2. Rate of gas flow required, CFH
3. Length of pipe run (D)
4. Pressure required at contractor connection point.

The local gas utility will advise the pressure that is available at the outlet of their meter.

Figure A10-10. Typical Gas Piping Layout

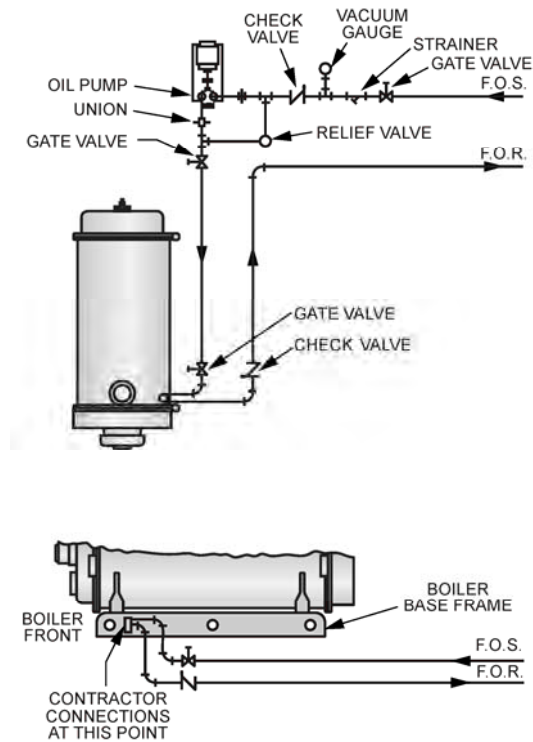


Figure A10-11. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pumps

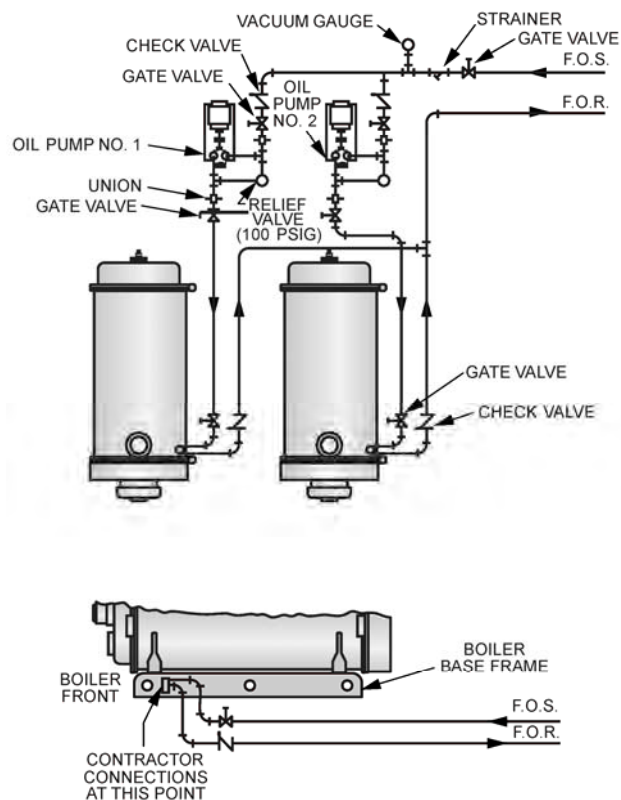


Figure A10-12. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

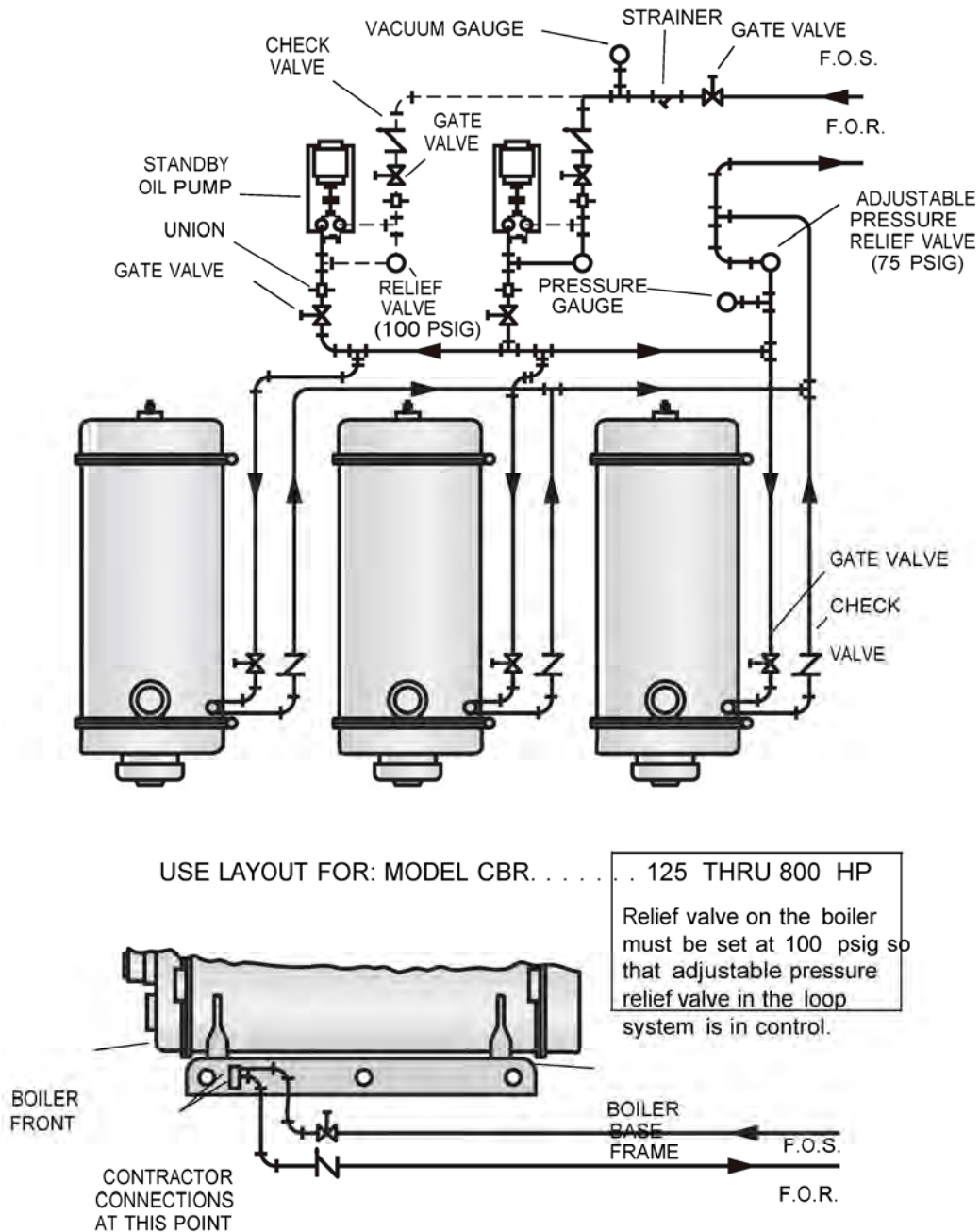


Figure A10-13. No. 2 Oil Piping, Multiple Boiler Installation

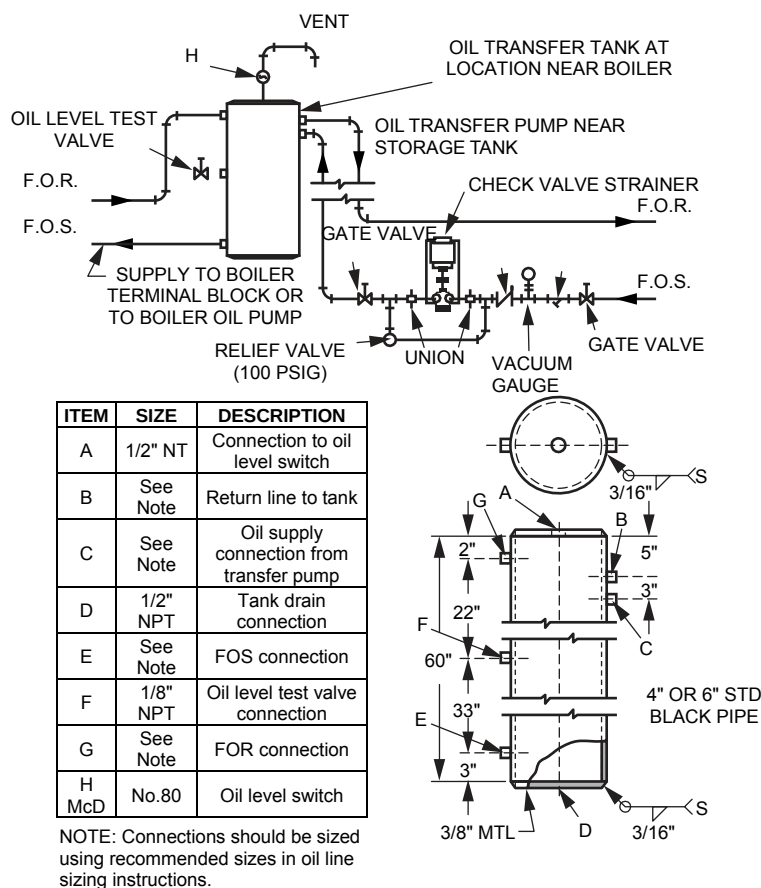


Figure A10-14. No. 2 Oil Transfer Tank Detail

(For elevated boiler room locations using an oil transfer pump and tank)

Boiler Room Information

Figure A10-15 shows typical boiler room length requirements.

Figure A10-16 shows typical boiler room width requirements.

Figure A10-17 shows typical breeching arrangements.

Stack Support Capabilities

Cleaver-Brooks Firetube Boilers 125 hp through 800 hp can support up to 2,000 lbs without additional support.

Firetube sizes 250 hp through 800 hp can be reinforced to support 3,000 lbs.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Model CBR is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. For boiler sizes 125 – 800 horsepower, the allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

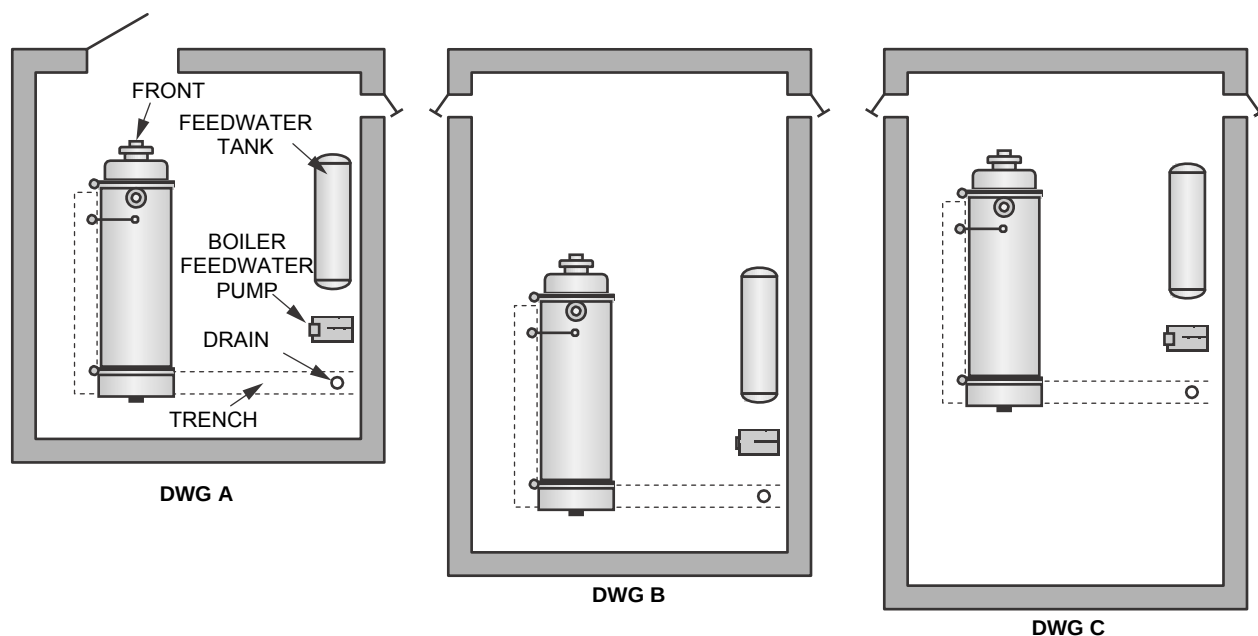
1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - B. 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - E. Size the openings by using the formula:
$$\text{Area (sq-ft.)} = \text{cfm/fpm}$$
2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp
 - C. Total recommended air, 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in boiler room (fpm).
 - A. From floor to (7) foot height - 250 fpm.
 - B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} / 250 = 3000 / 250 = 12$ sq-ft total.
- Area/Opening: $12 / 2 = 6$ sq-ft/opening (2 required).

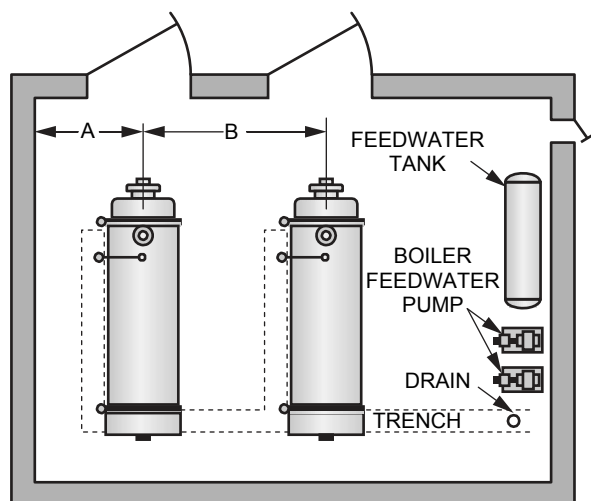
Notice

Consult local codes, which may supersede these requirements.



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear. If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.
2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear. If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.
3. A slightly longer boiler room (Dwg C) is obtained by allowing for possible future tube replacement from the rear of the boiler. Allowance for door swing at the front provides sufficient aisle and working space at the front.

Figure A10-15. Boiler Room Length (Typical Layout)

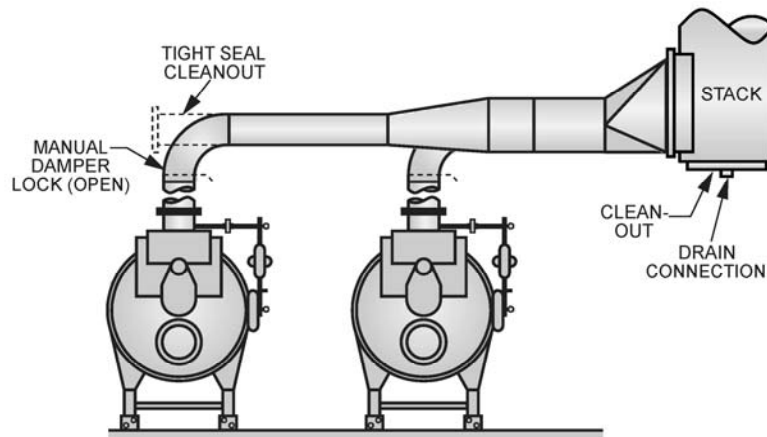


BOILER HP	125-200	250-350	400-800
Dimension A	87"	91"	99"
Dimension B	120"	127"	149"

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of:
 42" - 125-200 hp
 48" - 250-350 hp
 60" - 400-800 hp
 If space permits, this aisle should be widened.

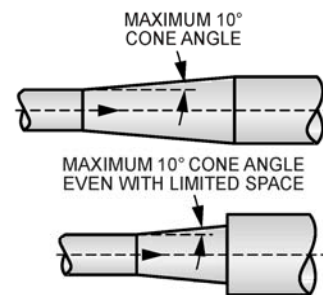
Figure A10-16. Boiler Room Width (Typical Layout)



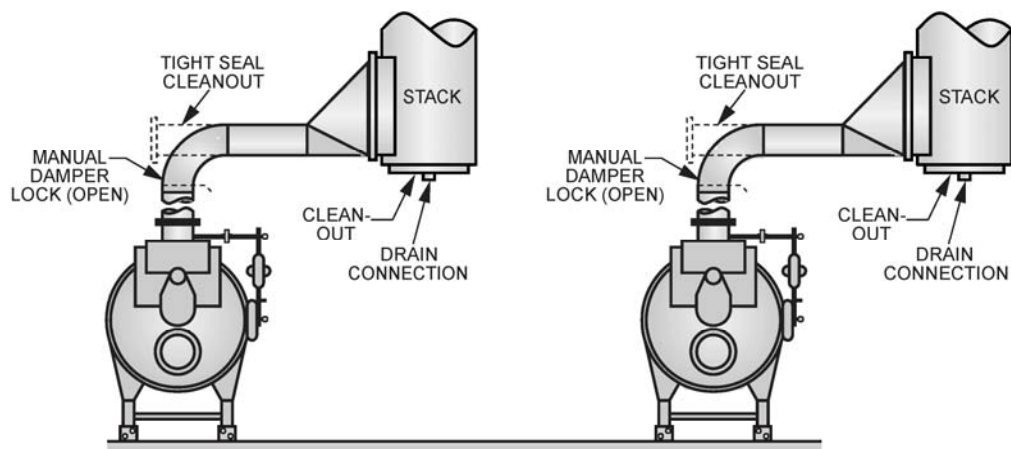
MULTIPLE BOILERS WITH A COMMON STACK

NOTE: These stack breaching arrangements for multiple boilers are typical and not intended for your specific design requirements. For additional information, review Section F, Stacks.

Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on your specific criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of stack and breeching design.



DETAIL OF TRANSITION PIECES



MULTIPLE BOILERS WITH INDIVIDUAL STACKS

Figure A10-17. Breeching Arrangement

SECTION A10
MODEL CBR STEAM BOILER

125-800 hp, Steam (15, 150, 200, or 250 psig) Sample Specification

STEAM SPECIFICATIONS

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2.02	BOILER SHELL (STEAM)	A10-30
2.03	STEAM BOILER TRIM	A10-31
2.04	BURNER.....	A10-32
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2.06	WARRANTY	A10-37
PART 3	EXECUTION.....	A10-37

MODEL CBR STEAM BOILER (125-800 HP, STEAM 15, 150, 200, OR 250 PSIG)

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.

PART 1 GENERAL

1.01 BOILER CHARACTERISTICS (STEAM)

- A. The Steam Boiler shall be Cleaver-Brooks Model CBR Fuel Series _____ (100,200, 700), _____ hp designed for _____ psig (15 or _____ psig steam). The maximum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS12-48 No. 2 oil and/or natural gas, _____ Btu/cu-ft. Electrical power available shall be _____ Volt _____ Phase _____ Cycle and 115/1/60 for the control circuit.

PART 2 PRODUCTS

2.01 GENERAL BOILER DESIGN

- A. The boiler shall be a two-pass horizontal firetube updraft boiler with _____ square feet of total heating surface for the _____ hp boiler. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls. The complete packaged boiler is built as a unit with Underwriters Laboratories listed controls.

The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/cUL label, except in the case where 50 Hz has been selected.

- 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent, steam, and blowdown connections.

2.02 BOILER SHELL (STEAM)

- 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished the purchaser.
- 2. Two lifting eyes shall be located on top of the boiler.
- 3. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.

4. Rear refractory and insulation shall be contained in the formed door which must swing open for inspection of brick work.
5. The boiler tubes shall be rifled tube design, extending heat transfer surfaces.
6. Front and rear tube sheets and all tubes must be fully accessible for inspection and cleaning when the doors are swung open. The boiler shall be furnished with adequate handholes to facilitate boiler inspection and cleaning.
7. For boilers 125 horsepower and over, a manhole shall be provided.
8. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting:
125-225 hp 2000 lbs. and shall contain a stack thermometer.
9. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
10. The boiler insulation shall consist of a 2 inch fiberglass blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
11. The entire boiler base frame and other components shall be factory painted before shipment using a hard-finish enamel coating.

2.03 STEAM BOILER TRIM

- A. WATER COLUMN/LOW WATER CUTOFF AND WATER LEVEL CONTROL SYSTEM (150-250 psig design): Shall be a CB LEVEL MASTER Water level control system and shall be comprised of a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows: The electronic controller shall be panel mounted and operate in ambient temperatures from 32 degrees F to 125 degrees F, the pressure chamber shall be boiler mounted and operate to pressures of 250PSIG and the level sensor shall operate to pressures of 250 PSIG and temperatures to 400 degrees F. The pressure containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase-60 Hz. All wiring shall be in compliance with the National Electrical Code.

The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/menu switch and the following features:

1. Continuous Level Indication
2. Low Water Cutoff & Alarm
3. High Water Alarm
4. Low & High Water Warning
5. Full Modulating Control of Modulating Feedwater Control Valve
6. Continuous Monitoring of Float Operation
7. Column Blowdown Detection and Reminder
8. Auto or Manual Reset
9. Real Time Clock
10. Alarm Annunciation

11. Alarm History Files with Time Stamp
 12. Water Column Blowdown Record
 13. Auxiliary Low Water Cutoff Check
 14. RS 232 Interface
 15. Maximum Contacts Rating 15 amps Resistive Load
- B. Feedwater Pump Control
- The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feedwater pump maintaining the boiler water level within normal limits.
- C. Low Water Cutoff
- The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.
- D. Auxiliary Low Water Cutoff
- Auxiliary low water cutoff shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.
- E. Steam Pressure Gauge
- The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- F. Safety Relief Valves
- Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- G. Steam Pressure Controls
- The steam pressure control to regulate burner operation shall be mounted near the water column.

2.04 BURNER

- A. Mode of Operation
- Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.
- B. Forced Draft Blower
1. All air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
 2. Maximum sound level of the boiler/burner package shall not exceed _____ dBA (when measured in accordance with ABMA Sound Test Standards).
 3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.
- C. Combustion Air Control
- Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Single point positioning controls shall be provided to regulate operation of the damper control motor.

D. Fuel Specification and Piping

Refer to the following fuel series specifications:

- Fuel series 700 - gas fired.
- Fuel series 100 - light oil fired.
- Fuel series 200 - light oil or gas fired.

Series 400 (heavy oil and gas) and series 600 (heavy oil only) also available. Check with your local Cleaver-Brooks representative for specification details.

1. Fuel Series 700 - Gas Fired

- a. **Burner Type** - The burner shall be integral with the front head of the boiler and of high radiant annular gas entry on 125-225 hp. and of high radiant multi-port type for gas burner 300-800 hp. The burner shall be approved for operation on natural gas fuel.
- b. **Gas Pilot** - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
- c. **Gas Burner Piping** - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The valve is spring return to start or stop the gas burner and to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly shutoff valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 125-250 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 2) 300-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.
- d. **Burner Turndown** - Turndown range of the burner shall be 4:1 when firing natural gas.
 - 1) 125-200 hp. Turndown range of burner shall be 4:1 when firing natural gas.
 - 2) 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas with a 60 or 30 ppm LE option.

2. Fuel Series 100 - Light Oil Fired

- a. **Burner Type** - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil.
- b. **Gas Pilot** - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

- c. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. A separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
 - d. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - e. Low Pressure Air Atomizing - Select one of the following:
 - 1) 125-250 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 2) 300-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves.
 - f. Burner Turndown - Select one of the following:
 - 1) 125-200 hp. Turndown range of burner shall be 4:1 when firing natural gas.
 - 2) 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas with a 60 or 30 ppm LE option.
3. Fuel series 200 - Light Oil or Gas Fired
- a. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant annular gas entry on 125-225 hp and multi-port type for gas entry on 100 hp. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas.
 - b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 - c. Oil Burner
 - Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. A separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 - Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - Low pressure air atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

d. Gas Burner

1) Gas Burner Piping - gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The valve is spring return to start or stop the gas burner and to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly shutoff valve shall be furnished at entrance to gas train. Select one of the following:

- 125-250 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
- 300-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus and additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.

e. Burner Turndown - Select one of the following:

- 125-200 hp. Turndown range of the burner shall be 4:1.
- 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas and 8:1 on No. 2 oil.

E. Boiler Flame Safeguard Controller and Control Panel

1. CB780E Flame Safeguard Controller

Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

a. Control Panel - The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.

The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers, the panel shall contain the fuel selector switch.

- b. Lights
 - White - load demand.
 - White - fuel valve open.
 - Red - low water.
 - Red - flame failure.
 - c. Control Switches
 - Burner On-Off.
 - Manual-Automatic.
 - Manual Firing Rate Control.
 - d. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
 - e. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
 - f. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.
2. Control Panel
- a. The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.
 - b. The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.
 - c. Panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers the panel shall contain the fuel selector switch.
 - d. Oil, heat, and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
 - e. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
 - f. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.05 EFFICIENCY GUARANTEE

The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of percent from 25 to 100 percent of rating when burning natural gas and fuel-to- steam efficiency at 100% firing rate when burning oil.

The specified boiler efficiency is based on the following conditions.

A. Fuel specification used to determine boiler efficiency:

- Natural Gas
Carbon, % (wt) = 69.98
Hydrogen, % (wt) = 22.31
Sulfur, % (wt) = 0.0
Heating value, Btu/lb = 21,830
- No. 2 Oil
Carbon, % (wt) = 85.8
Hydrogen, % (wt) = 12.7
Sulfur, % (wt) = 0.2
Heating value, Btu/lb = 19,420
- No. 6 Oil
Carbon, % (wt) = 86.6
Hydrogen, % (wt) = 10.9
Sulfur, % (wt) = 2.09
Heating value, Btu/lb = 18,830

2.06 WARRANTY

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

PART 3 EXECUTION

A. Shop Tests

The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

B. Start-up Service

1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and timing the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

SECTION A10

MODEL CBR HOT WATER SPECIFICATIONS

(125-800 hp, 30 psig, 125 psig)

HOT WATER SPECIFICATIONS

CONTENTS

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MODEL CBR HOT WATER BOILER SPECIFICATIONS (125-800 HP, 30 PSIG, 125 PSIG)

PART 1 GENERAL

1.1 BOILER CHARACTERISTICS (HOT WATER)

- A. The Hot Water Boiler shall be Cleaver-Brooks Model CBR, Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (30, 125 psig, or other hot water). The maximum water temperature shall be _____ degree F, and the maximum system temperature drop shall be _____ degrees F.
- B. The boiler shall have a maximum output of _____ Btu/hr., or _____ horsepower when fired with CS 12-48 _____ oil and/or natural gas, _____ Btu/cu-ft. Electrical power available shall be _____ Volt _____ Phase _____ Cycle.

PART 2 PRODUCTS

2.1 GENERAL BOILER DESIGN

- A. The boiler shall be a two-pass horizontal firetube updraft boiler with _____ square feet of total heating surface for the _____ hp boiler. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls. The complete packaged boiler is built as a unit with Underwriters Laboratories listed controls.

The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/cUL label, except in the case where 50 Hz has been selected.

- 1. The boiler shall be completely pre assembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
- 2. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, Industrial Risk Insurance, ASME CSD-1).
- B. Boiler Shell (Hot Water)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 - 2. The hot water return and outlet connections shall be located on the top center line of the boiler. The boiler shall be designated to rapidly mix the return water with the boiler water. Forced internal circulation shall be used.
 - 3. A dip tube shall be included as an integral part of the water outlet.
 - 4. Two lifting eyes shall be located on top of the boiler.

5. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
 6. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
 7. The boiler tubes shall be rifled tube design, extending heat transfer surfaces.
 8. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The shell must be furnished with adequate handholes to facilitate boiler inspection and cleaning.
 9. A manhole shall be provided.
 10. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 2000 lbs and shall contain a stack thermometer.
- C. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
- D. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
- E. The entire boiler based frame and other components shall be factory painted before shipment using a hand finish enamel coating.
- F. Emission Controls
1. Boiler shall be equipped with a low emission (LE) option for guaranteed NO_x performance at ppm, dry volume basis and corrected to 3% O₂ when firing natural gas.
 2. The low emission option shall include an integral front head, burner, and boiler package, providing NO_x reduction through an internal flue gas recirculation system using the combustion air fan, internal recirculation valve, and enhanced boiler design to achieve the guaranteed NO_x levels. The emission control system shall not use an external fan, control valve, and piping. Boiler fuel-to-steam efficiency and rated boiler capacity shall be guaranteed while the boiler is operating at the low NO_x performance levels.
 3. Burner, boiler, and low NO_x system shall be manufactured as a package by a single manufacturer. The Low Emission Option to the CB Boiler shall included factory testing as a package, and shall bear the UL packaged label. The boiler nameplate shall include the approved UL low NO_x boiler model designation. No field assembly of the burner or low NO_x equipment shall be required.

2.2 HOT WATER BOILER TRIM

- A. Low Water Cutoff
A low water cutoff control (manual reset) shall be mounted on the top centerline of the boiler wired into the burner control circuit to prevent burner operation if boiler water falls below a safe level.
- B. Pressure and Temperature Gauges
Pressure and temperature gauges shall be mounted on the boiler with temperature sensing element located adjacent to the hot water outlet.
- C. Relief Valves
Water relief valves of a type and size to comply with ASME Code requirements shall be shipped loose.

D. Temperature Controls

Temperature controls to regulate burner operation shall be mounted on the unit with temperature sensing elements located adjacent to the hot water outlet. Controls shall be high limit (manual reset), operating limit (auto reset), and firing rate control.

2.3 BURNER AND CONTROLS

A. Mode of Operation

Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.

B. Blower

1. Air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
2. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

C. Combustion Air Control

Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor (remove this sentence when CB-HAWK flame safeguard is used).

D. Fuel Specification and Piping

Select one of the following fuel types:

- Fuel series 700 - Gas fired.
- Fuel series 100 - Light oil (No. 2) fired.
- Fuel series 200 - Light oil or gas fired.
Series 400 (heavy oil and gas) and series 600 (heavy oil only) and available.
Check with your local Cleaver-Brooks representative for specification details.

1. Fuel Series 700 - Gas Fired

- a. Burner Type - The burner shall be integral with the front head of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel and equipped with an LE option.
- b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
- c. Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock on butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 125-250 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.

- 2) 300-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.
 - d. Burner Turndown - Select one of the following:
 - 1) 125-200 hp. Turndown range of burner shall be 4:1 when firing natural gas.
 - 2) 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas when equipped with a 60 or 30 ppm LE option.
2. Fuel Series 100 - Light Oil Fired
 - a. Burner Type - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil and equipped with an LE option.
 - b. Oil Pilot - The oil pilot shall be air atomizing type with automatic electric ignition and include oil solenoid valve. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until flame has been established.
 - c. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
 - d. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - e. Low Pressure Air Atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
 - f. Burner Turndown - Select one of the following:
 - 1) 125 hp through 200 hp. Turndown range shall be 4:1 when firing No. 2 oil.
 - 2) 250 hp through 800 hp. Turndown range shall be 8:1 when firing No. 2 oil.
3. Fuel Series 200 - Light Oil or Gas Fired
 - a. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas. The burner shall be equipped with an LE option.
 - b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 - c. Oil Burner

- 1) Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
- 2) Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
- 3) Low pressure air atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

d. Gas Burner

- 1) Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 125-250 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - 300-800 hp. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus and additional plugged leakage test connection shall be provided. A valve proving switch shall be located between the safety shutoff valves.

e. Burner Turndown - Select one of the following:

- 125-200 hp. Turndown range of the burner shall be 4:1.
- 250-800 hp. Turndown range of the burner shall be 10:1 when firing natural gas and 8:1 on No. 2 oil. (Consult your local Cleaver-Brooks authorized representative regarding high turndown capability based on available gas pressure and No. 2 oil turndown capabilities when utilizing LE Options to achieve NOx levels of 25 or 20 ppm when firing natural gas.)

E. Boiler Flame Safeguard Controller and Control Panel

1. CB780E Flame Safeguard

- a. Boilers with CB780E Control - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

- b. Control Panel - The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet shall have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.

The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers the panel shall contain the fuel selector switch.

The panel shall contain the following lights and switches:

- c. Lights
- White - load demanded.
 - White - fuel valve open.
 - Red - low water.
 - Red - flame failure.
- d. Control Switches
- Burner On-Off.
 - Manual-Automatic.
 - Manual Firing Rate Control.
- e. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
- f. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
- g. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.
- h. Control Panel: The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet shall have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, indicating lights and selector switches.

Panel shall have a removable sub-base for mounting the flame safeguard controller, and terminal blocks. For combination gas-oil fired boilers the panel shall contain the fuel selector switch.

- i. Oil, heat, and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
- j. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
- k. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.4 EFFICIENCY GUARANTEE

- A. The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve _____ fuel-to-steam efficiency at 100% firing rate when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

- B. Fuel specification used to determine boiler efficiency:

- Natural Gas
Carbon,% (wt) = 69.98
Hydrogen,% (wt) = 22.31
Sulfur,% (wt) = 0.0
Heating value, Btu/lb. = 21,830
- No. 2 Oil
Carbon,% (wt) = 85.8
Hydrogen,% (wt) = 12.7
Sulfur,% (wt) = 0.2
Heating value, Btu/lb. = 19,420
- No. 6 Oil
Carbon,% (wt) = 86.6
Hydrogen,% (wt) = 10.9
Sulfur,% (wt) = 2.09
Heating value, Btu/lb. = 18,830

- C. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
- D. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).
- E. Any efficiency verification testing will be based on the stack loss method.

PART 3 EXECUTION

3.1 WARRANTY

All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

3.2 SHOP TESTS

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.
- B. Start-up Service
 - 1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

MODEL CBL

900 - 1800 HP
Steam
Wet-back Package Burner



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The following information applies to the Cleaver-Brooks CBL Boiler.

FEATURES AND BENEFITS

The CBL 900-1800 HP Firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firetube boilers, the following features apply to the CBL.

Three-Pass or Four-Pass Design:

- The packaged boiler offers high efficiency, flexibility, reliability, safety and ease of operation.

Front and Rear Doors:

- Davited, front and rear doors, all sizes.
- Provides access to front tube sheet and furnace.
- Large rear access plug for turnaround and furnace access.
- Rear door completely covers and insulates rear tube sheet.

Natural Gas, No. 2 Oil, No. 6 Oil, or Combination Burners Available:

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.

PRODUCT OFFERING

Cleaver-Brooks CBL Boilers are available in low pressure and high pressure steam and hot water designs. Burners are available to fire natural gas, No. 2 oil, No. 6 oil, or a combination of oil and gas. Standard product offering is:

- 900 - 1800 hp.
- Three-pass wetback design or four-pass wetback design.
- 4 or 5 square foot of heating surface per boiler horsepower
- 15- 250 psig steam in most sizes.
- 30 & 125 psig hot water in most sizes.
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks authorized representative for option details).

- Boiler Options:
 - Additional screwed or flanged tappings.
 - Blowdown valves.
 - Non-return valves.
 - Feedwater valves and regulators.
 - Surface blowdown systems.
 - Surge load baffles.
 - Seismic design.
- Burner/Control Options:
 - Flame safeguard controllers.
 - Lead/lag system.
 - Special insurance and code requirements (e.g., IRI, FM, NFPA8501).

Alarm bell/silence switch.
Special motor requirements (TEFC, high efficiency).
Special indicating lights.
Main disconnect.
Elapsed time meter.
NEMA enclosures.
Remote emergency shut-off (115V).
Circuit breakers.
Day/night controls.
Special power requirements.
Low NOx Equipment.
HAWK ICS

- Fuel Options:
 - Gas strainer.
 - Gas pressure gauge.
 - Future gas conversion.
 - Oversized/undersized gas trains.
 - Optional Oil Pumps.

DIMENSIONS AND RATINGS

Dimensions and ratings for the CBL Boilers are shown in the following tables and illustrations. The information is subject to change without notice.

- Table A5-1. CBL Steam Boiler Ratings
- Table A5-2. Heating Surface
- Figure A5-1. CBL Steam Boiler Dimensions
- Figure A5-2. CBL Boiler Space Requirements to Open Rear Door
- Figure A5-3. Lifting Lug Location, CBL Boilers
- Figure A5-4. CBL Boiler Mounting Piers

Table A5-1. CBL Steam Boiler Ratings

BOILER HP	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
RATINGS - SEA LEVEL TO 1000 FT^B											
Rated Capacity (lbs-steam/hr from and at 212 °F)	27600	31050	34500	37950	41400	44850	48300	51750	55200	58650	62100
Btu Output (1000 Btu/hr)	26780	30125	33475	36820	40170	43515	46865	50210	53550	56905	60255
POWER REQUIREMENTS — SEA LEVEL TO 1000 FT (60 HZ)											
Blower Motor, hp ^A (Gas and Oil)	60	60	60	75	75	100	100	100	Contact Factory		
Oil Pump Motor hp (#2 oil)	1	1	1	1	1-1/2	1-1/2	1-1/2	1-1/2			
Oil Pump Motor hp (#6 oil)	1	1	1	1	1	1	1	1-1/2			
Air Comp. Motor, hp (#2 oil)	7-1/2	15	15	15	15	15	15	15			
Oil heater Kw (#6 oil)	10	10	10	15	15	15	15	15			

NOTE:

- A. Blower motor HP may increase if a low NOx option is added
 B. Ratings based on nominal 80% efficiency.
 C. Ratings based on 60 hertz, please verify 50 hertz ratings with factory.

Table A5-2. CBL Input Ratings (3-Pass Boilers)

Boiler Square Foot Heating Surface	4000	4500	5000	5500	6000	6500	7000	7500
Approximate Fuel Consumption^D								
Horsepower (5 sq.ft./bhp)	800	900	1000	1100	1200	1300	1400	1500
Natural Gas ^A (cfh)	33475	37660	41845	46025	50215	54395	58585	62765
No. 2 Oil ^B (gph)	239.3	269.0	299.0	329.0	359.0	388.5	418.0	447.5
No. 6 Oil ^C (gph)	223.4	251.1	279.0	307.0	335.0	363.0	390.0	417.0
Horsepower (4 sq.ft./bhp)	1000	1100	1200	1300	1500	1600	1700	1800
Natural Gas ^A (cfh)	41845	46025	50215	54395	62765	66950	71133	75318
No. 2 Oil ^B (gph)	299.0	329.0	359.0	388.5	447.5	477.3	507.2	537
No. 6 Oil ^C (gph)	279.0	307.0	335.0	363.0	417.0	444.8	472.6	500.4

NOTE:

- A. Natural gas based on heating value of 1000 BTU/cu.ft
 B. No. 2 oil based on heating value of 140,000 BTU/gal.
 C. No. 6 oil based on heating value of 150,000 BTU/gal.
 D. Ratings based on nominal 80% efficiency.

Table A5-3. CBL Input Ratings (4-Pass Boilers)

Boiler Square Foot Heating Surface	4000	4500	5000	5500	6000	6500	7000	7500
Approximate Fuel Consumption^D								
Horsepower (5 sq.ft./bhp)	800	900	1000	1100	1200	1300	1400	1500
Natural Gas ^A (cfh)	32659	36741	40824	44906	48989	53071	57153	61236
No. 2 Oil ^B (gph)	233.3	262.4	291.6	320.8	349.9	379.1	408.2	437.4
No. 6 Oil ^C (gph)	217.7	244.9	272.2	299.4	326.6	353.8	381.0	408.2
Horsepower (4 sq.ft./bhp)	1000	1100	1200	1300	1500	1600	1700	1800
Natural Gas ^A (cfh)	40824	44906	48989	53071	57153	65317	69399	73481
No. 2 Oil ^B (gph)	291.6	320.8	349.9	379.1	437.4	466.6	495.7	524.9
No. 6 Oil ^C (gph)	272.2	299.4	326.6	353.8	408.2	435.4	462.6	489.9

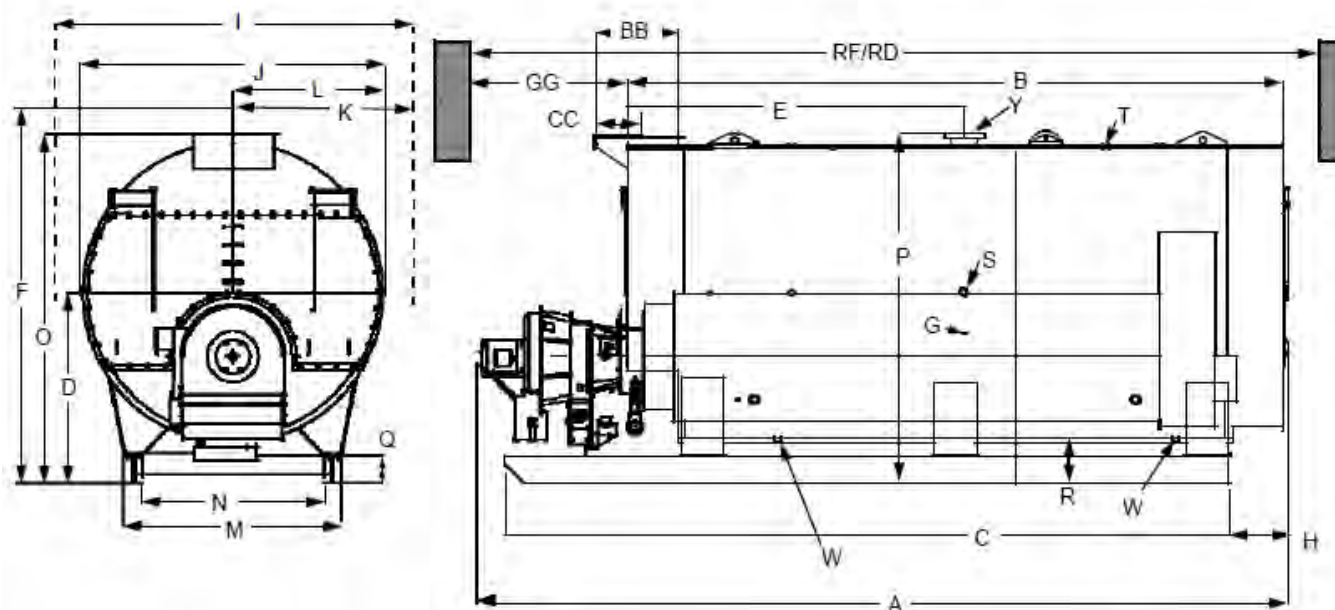
Note:

A. Natural gas based on heating value of 1000 BTU/cu.ft

B. No. 2 oil based on heating value of 140,000 BTU/gal.

C. No. 6 oil based on heating value of 150,000 BTU/gal.

D. Ratings based on nominal 82% efficiency.



BOILER SQUARE FOOT HEATING SURFACE	DIM	4000	4500	5000	5500	6000	6500	7000	7500
Boiler Horsepower@ 5 ft ² /bhp		800	900	1000	1100	1200	1300	1400	1500
Boiler Horsepower @ 4 ft ² /bhp		1000	1100	1200	1300	1500	1600	1700	1800
LENGTHS									
Overall * ^B	A	367	394	386	411	434	387	406	425
Shell	B	293	323	288	312	335	304	323	342
Base Frame *	C	285	317	282	304	327	296	315	334
Base Frame to Rear Flange	H	26	26	26	26	26	26	26	26
Flange to Steam Nozzle	E	148	148	148	148	148	148	148	148
WIDTHS									
Overall With Trim	I	144	144	156	156	156	168	168	168
I. D. Boiler	J	114	114	126	126	126	138	138	138
Center to Water Column	K	72	72	78	78	78	84	84	84
Center to Lagging	L	59-1/2	59-1/2	65-3/4	65-3/4	65-3/4	71 3/4	71 3/4	71 3/4
Base Outside	M	96	96	96	96	96	96	96	96
Base Inside	N	80	80	80	80	80	80	80	80
* Approximate - varies with burner selection									
Boiler Horsepower@ 5 ft ² /bhp		800	900	1000	1100	1200	1300	1400	1500
Boiler Horsepower @ 4 ft ² /bhp		1000	1100	1200	1300	1500	1600	1700	1800

Figure A5-1. CBL Steam Boiler Dimensions, 4-Pass (Page 1 of 2)

BOILER SQUARE FOOT HEATING SURFACE	DIM	4000	4500	5000	5500	6000	6500	7000	7500
HEIGHTS									
Base to piping connections	F	149	149	161	161	161	168-1/8	168-1/8	168-1/8
Base to Boiler Centerline	D	77-1/2	77-1/2	83-3/4	83-3/4	83-3/4	86-1/2	86-1/2	86-1/2
Base to Vent Outlet	O	141	141	153-1/2	153-1/2	153-1/2	162-1/8	162-1/8	162-1/8
Base to Steam Outlet	P	141	141	153-1/2	153-1/2	153-1/2	162-1/8	162-1/8	162-1/8
Base Frame	Q	12	12	12	12	12	12	12	12
Base to Bottom Boiler	R	20	20	20	20	20	17	17	17
CONNECTIONS									
Chemical Feed	G	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Feedwater Inlet (Both Sides)	S	3	3 3		3	3	3	3 3	
Steam Nozzle ^A (150 psig)	Y	10	10	10	12	12	12	12	12
Blowdown - Front & Rear	W	2	2	2	2	2	2	2	2
Surface Blowoff	T	1	1 1		1	1	1	1 1	
Vent Stack Diameter (Flanged)	BB	32	32	36	36	36	42	42	42
Flange to Center Vent	CC	17-1/2	17-1/2	19-1/2	19-1/2	19-1/2	24	24	24
MISCELLANEOUS									
Rear Door Swing ^C	AA	-	-	-	--		-	-	-
Tube Removal - Front Only	GG	246	276	217	241	264	233	252	271
Min. Boiler Room Length For Tube Removal Front	RF	537	597	538	586	632	665	703	741
Min. Boiler Room Length For Tube Removal Thru Door	RD	484	514	489	513	536	528	547	566
Normal Water Weight (Lbs)		43800	49400	49300	54000	60000	61000	66000	71000
Flooded Water Weight (Lbs)		54500	61300	65300	71900	78300	83000	89000	96000
Approx. Wt. 15/30 psig (Lbs.)		58000	63000	73100	77200	82200	87000	91700	96600
Approx. Wt. 150 psig (Lbs.)		65000	71000	79600	85300	90900	97300	102600	108200
Approx. Wt. 200 psig (Lbs.)		73500	82200	88600	95000	101500	107800	115500	121000
Approx. Wt. 250 psig (Lbs.)		81300	89000	97200	104000	110000	118000	124000	132000

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for actual option requirements.

A. 300 psig Flange. See recommended steam nozzle size chart for operating pressure greater than 125 psig.

B. Add 11 1/2 inches to dimension "B" for a three pass boiler.

C. Reference Figure A11-2.

Figure A5-1. CBL Steam Boiler Dimensions, 4-Pass (Page 2 of 2)

BOILER ID	DIMENSION (INCHES)				
	A	B	C	D	E
114"	60	72	39	82	22
126"	66	78	52	93	33
138"	72	84	66	105	45

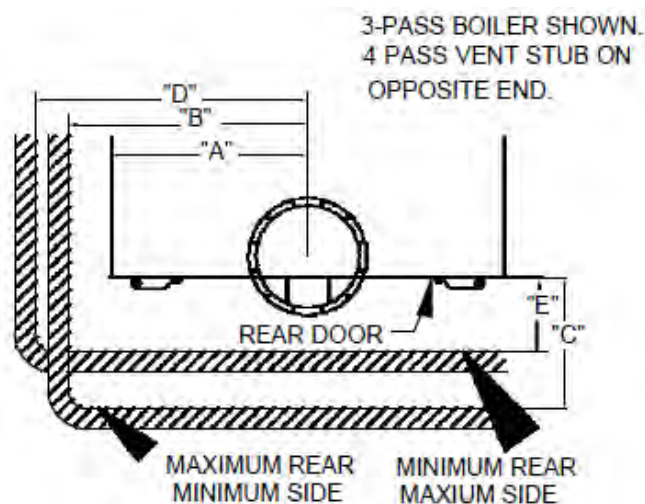
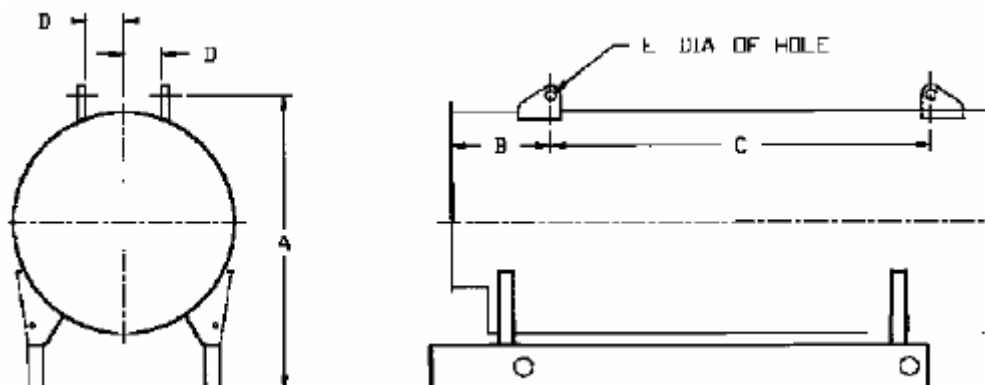
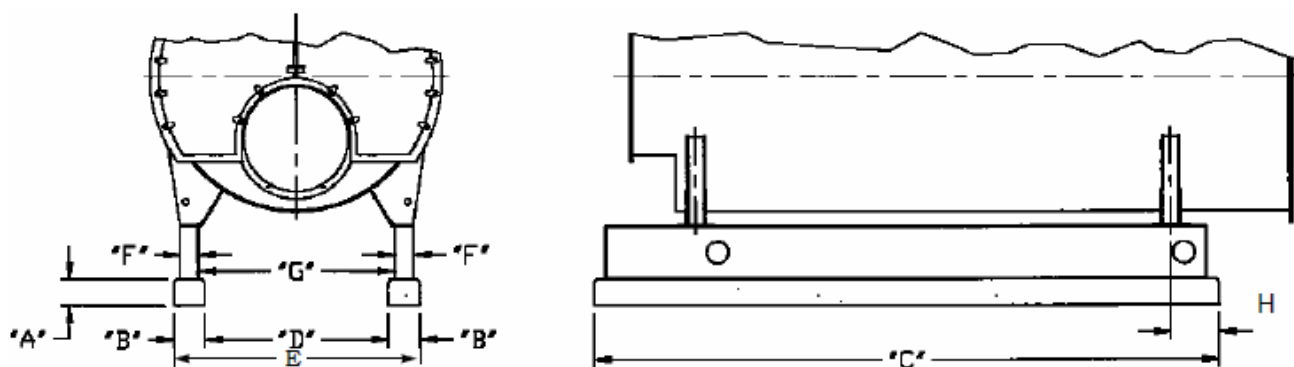


Figure A5-2. Space Required to Open Rear Doors on CBL Boilers



BOILER SQUARE FOOT OF HEATING SURFACE	BHP		A	B	C	D	E
	4 sq.ft.	5 sq.ft.					
4000	1000	800	138	47	205	12	3
4500	1100	900	138	47	238	12	3
5000	1200	1000	150	47	200	12	3
5500	1300	1100	150	47	222	12	3
6000	1500	1200	150	47	247	12	3
6500	1600	1300	162	47	216	12	3
7000	1700	1400	162	47	235	12	3
7500	1800	1500	162	47	254	12	3

Figure A5-3. CBL Boilers Lifting Lug Location



BOILER SQUARE FOOT OF HEATING SURFACE	BHP		A	B	C	D	E	F	G	H
	4 sq-ft	5 sq-ft								
4000	1000	800	6	12	*	76	100	8	80	12
4500	1100	900	6	12	*	76	100	8	80	12
5000	1200	1000	6	12	*	76	100	8	80	15
5500	1300	1100	6	12	*	76	100	8	80	15
6000	1500	1200	6	12	*	76	100	8	80	15
6500	1600	1300	6	12	*	76	100	8	80	15
7000	1700	1400	6	12	*	76	100	8	80	15
7500	1800	1500	6	12	*	76	100	8	80	15

NOTE: All numbers in table are in inches.

6-inch high mounting piers recommended for beneath the boiler frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

The (*) varies with horsepower rating and burner selection, see Dimension Diagram for job-specific mounting pier length.

Figure A5-4. CBL Boiler Mounting Piers

PERFORMANCE DATA

Efficiency

Tables A5-4, A5-5, A5-6, A5-7, A5-8, and A5-9 show predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks CBL Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for CBL Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7767 for a detailed description of efficiency calculations).

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in the tables listed above) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to

achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level. The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:
 - Natural Gas
Carbon,% (wt) = 69.98
Hydrogen,% (wt) = 22.31
Sulfur,% (wt) = 0.0
Heating value, Btu/lb = 21,830
 - No. 2 Oil
Carbon,% (wt) = 85.8
Hydrogen,% (wt) = 12.7
Sulfur,% (wt) = 0.2
Heating value, Btu/lb = 19,420
 - No. 6 Oil
Carbon,% (wt) = 86.6
Hydrogen,% (wt) = 10.9
Sulfur,% (wt) = 2.09
Heating value, Btu/lb = 18,830
2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
3. Efficiencies are based on the following radiation and convection losses. Firing rate of 25% - 1.2%, 50% - 0.6%, 75% - 0.4%, and 100% - 0.3%.

ENGINEERING DATA

The following engineering information is provided for CBL Boilers. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

Table A5-12 shows steam volume and disengaging area for CBL boilers.

Table A5-10 lists quantity and outlet size for safety valves supplied on CBL boilers.

Table A5-11 gives recommended steam nozzle sizes on CBL Boilers.

Table A5-13 shows recommended non-return valve sizes for CBL Boilers.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table A5-14 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks CBL Boilers.

Burner/Control Information**Burner Characteristics**

Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures. Also 50 Hz applications and low NOx options should be reviewed by the Cleaver-Brooks authorized representative.

Gas-Fired Burners

Table A5-15 gives gas train connection sizes and gas pressure requirements.

Table A5-16 shows correction factors for gas pressure at elevations over 1000 ft. above sea level.

For oversized or undersized gas trains or altitude above 1,000 feet, contact your local Cleaver-Brooks authorized representative.

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Figure A5-5 shows a typical fuel oil supply arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Boiler Room Information

Figure A5-7 shows typical boiler room length requirements.

Figure A5-8 shows typical boiler room width requirements.

Stack Support Capabilities

CBL Boilers can support up to 2000 lbs. without additional support. CBL Boilers can be reinforced to support up to 3000 lbs.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than one (1) square foot.
 - E. Size the openings by using the formula:
$$\text{Area (sq-ft)} = \text{CFM/FPM}$$
2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
 - A. From floor to (7) foot height - 250 fpm.
 - B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 1000 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $1000 \times 10 = 10000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm/fpm} = 10000/250 = 40$ Sq-ft total.
- Area/Opening: $40/2 = 20$ sq-ft/opening (2 required).

Stack/Breeching Size Criteria**Notice**

Consult local codes, which may supersede these requirements.

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the CBL is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.50''$ W.C. to $+0.50''$ W.C. The maximum pressure variation at any firing rate for the boiler is $0.50''$ W.C.

The low NOx option allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C. The maximum pressure variation at any firing rate for the boiler is $0.25''$ W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Table A5-4. Predicted Fuel-to-Steam Efficiencies (%) CBL Boilers - 125 psig, Natural Gas, 5 sq. ft./BHP, 4-Pass

BOILER HP	FIRING RATE (%)			
	25	50	75	100
800	82.0	82.3	82.7	82.5
900	82.3	82.0	82.5	82.5
1000	82.0	82.6	82.7	82.6
1100	82.3	82.7	82.7	82.7
1200	82.2	83.0	83.2	83.2
1300	82.5	82.8	83.0	83.0
1400	82.3	82.3	82.8	82.8
1500	82.0	83.0	83.0	83.0

Table A5-6. Predicted Fuel-to-Steam Efficiencies (%) CBL Boilers - 125 psig, No. 6 Oil, 5 sq. ft./BHP, 4-Pass

BOILER HP	FIRING RATE (%)			
	25	50	75	100
800	86.5	86.0	86.5	86.8
900	86.6	86.5	86.5	86.9
1000	86.5	86.6	86.5	86.8
1100	86.5	86.7	86.6	86.9
1200	86.5	87.0	87.0	87.0
1300	86.3	86.6	87.0	87.0
1400	86.0	86.5	86.8	86.7
1500	86.0	86.5	86.8	86.6

Table A5-5. Predicted Fuel-to-Steam Efficiencies (%) CBL Boilers - 125 psig, No. 2 Oil, 5 sq. ft./BHP, 4-Pass

BOILER HP	FIRING RATE (%)			
	25	50	75	100
800	85.2	85.9	85.9	86.0
900	85.3	85.8	86.0	86.0
1000	85.8	86.0	86.0	86.2
1100	85.5	85.6	85.6	86.0
1200	85.8	86.0	86.3	86.5
1300	85.3	86.0	86.4	86.6
1400	85.9	86.0	86.4	86.5
1500	86.0	86.6	86.5	86.6

Table A5-7. Predicted Fuel-to-Steam Efficiencies (%) CBL Boilers - 125 psig, Natural Gas, 4 sq. ft./BHP, 3-Pass

BOILER HP	FIRING RATE (%)			
	25	50	75	100
1000	81.4	81.5	81.5	81.5
1100	81.3	81.6	82.0	82.0
1200	81.2	81.4	82.0	82.0
1300	81.0	81.3	81.6	82.0
1400	81.0	81.3	81.4	81.8
1500	81.0	81.4	81.4	81.9

**Table A5-8. Predicted Fuel-to-Steam Efficiencies
(%) CBL Boilers- 125 psig, No. 2 Oil, 4 sq.
ft./BHP, 3-Pass**

BOILER HP	FIRING RATE (%)			
	25	50	75	100
1000	84.8	85.0	85.0	85.0
1100	84.7	85.0	85.0	85.0
1200	85.0	85.2	85.4	85.2
1300	85.0	85.0	84.8	85.5
1400	85.0	85.6	84.8	85.5
1500	85.0	85.5	84.9	85.6

**Table A5-9. Predicted Fuel-to-Steam Efficiencies
(%) CBL Boilers- 125 psig, No. 6 Oil, 4 sq.
ft./BHP, 3-Pass**

BOILER HP	FIRING RATE (%)			
	25	50	75	100
1000	86.2	86.2	85.8	85.6
1100	86.3	86.4	86.1	85.9
1200	86.2	86.2	85.8	86.0
1300	86.0	86.4	86.1	85.8
1400	86.0	86.4	86.0	85.8
1500	86.0	86.3	86.2	85.9

Table A5-10. CBL Steam Boiler Safety Valve Outlet Size

VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE ("FPT)	NO. OF VALVES REQ'D	OUTLET SIZE ("FPT)	NO. OF VALVES REQ'D	OUTLET SIZE ("FPT)	NO. OF VALVES REQ'D	OUTLET SIZE ("FPT)
800	-	-	2	1 - 3 1 - 4	2	1 - 2 1/2 1 - 3	2	2 1/2
900	-	-	2	1 - 3 1 - 4	2	3	2	1 - 2 1/2 1 - 3
1000	3	2 - 8 1 - 6	2	4	2	3	2	1 - 2 1/2 1 - 3
1100	3	2 - 8 1 - 6	2	4	2	1 - 3 1 - 4	2	3
1200	2	8	2	4	2	1 - 3 1 - 4	-	-
1300	3	8	3	2 - 3 1 - 4	3	1 - 2 1/2 2 - 3	-	-
1400	3	8	3	1 - 3 2 - 4	3	3	-	-
1500	3	8	3	1 - 3 2 - 4	3	3	-	-

NOTES:

Table A11-8 only applies to 5 Sq Ft/BHP units.

Valve manufacture is Kunkle.

Valve requirements can vary with special pressure settings.

Table A5-11. CBL Recommended Steam Nozzle Size

OPERATING PRESSURE PSIG	BOILER HP										
	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
12	18	18	20	20	24	24	24	24	24	24	24
30	14	16	16	16	18	18	18	20	20	20	20
50	12	12	12	14	16	16	16	16	16	16	16
75	10	10	12	12	12	12	12	14	14	14	14
100	10	10	10	10	12	12	12	12	12	12	14
125	8	10	10	10	10	10	12	12	12	12	12
150	8	8	8	10	10	10	10	10	10	10	12
200	8	8	8	8	10	10	10	10	10	10	10
225	6	8	8	8	8	10	10	10	10	10	10

NOTES:

Steam nozzle sizes given in inches.

All standard steam nozzle sizes for the 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.

Table A5-12. CBL Steam Volume and Disengaging Areas

BOILER SQUARE FOOT OF HEATING SURFACE	BHP		STEAM VOLUME (CU-FT)	STEAM RELIEVING AREA (SQ-IN)
	4 SQ.FT.	5 SQ.FT.	HIGH PRESSURE (A)	HIGH PRESSURE (A)
4000	1000	800	155	20566
4500	1100	900	174	23105
5000	1200	1000	250	24141
5500	1300	1100	273	26372
6000	1500	1200	300	28908
6500	1600	1300	352	28918
7000	1700	1400	379	31079
7500	1800	1500	405	33242

NOTES:

Based on normal water level.

Values are based on standard controls. Optional controls may result in different values.

A. Based on 150 psig design pressure.

Table A5-13. CBL Recommended Non-Return Valve Size

BOILER HP	CAPACITY LBS.PER HR.	OPERATING PRESSURE							
		50	75	100	125	150	175	200	225
900	31050	8	6 6		6	6	6	6	5
1000	34500	8	6*	6	6	6	6	6	5
1100	37950	8	8 6		6	6	6	6	6
1200	41400	8	8 8		6	6	6	6	6
1300	44850	8	8 8		8	6	6	6	6
1400	48300	8	8 8		8	8	6	6	6
1500	51750	8	8 8		8	8	8	6	6
1600	55200	10	10	8	8	8	8	8	6
1700	58650	10	10	8	8	8	8	8	8
1800	62100	10	10	10	8	8	8	8	8

NOTE:

Valve sizes (300# flanges) given in inches).

Standard non-return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output); selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative. For high turndown applications see Boiler Book Section I3, Table I3-3.

*Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table A5-14. CBL Blowdown Tank Sizing Information

BOILER SQUARE FOOT OF HEATING SURFACE	BHP		WATER (GAL)
	4 SQ.FT.	5 SQ.FT.	
4000	1000	800	356
4500	1100	900	400
5000	1200	1000	418
5500	1300	1100	460
6000	1500	1200	500
6500	1600	1300	500
7000	1700	1400	538
7500	1800	1500	575

NOTE: Quantity of water removed from boiler by lowering normal water line 4". Optional level controls can alter water quantities.

Table A5-15. CBL Gas Train Connection Size and Gas Pressure Requirements

Boiler HP	4 ft ² /bhp							
	3-pass				4-pass			
	std		30 ppm		std		30 ppm	
	Gas train connection	Pressure required	Gas train connection	Pressure required	Gas train connection	Pressure required	Gas train connection	Pressure required
1000	2.5	8.2	2.5	8.3	2.5	8.1	2.5	8.2
1100	3	5.4	3	5.4	3	5.4	3	5.6
1200	3	6.3	3	6.3	3	6.3	3	6.4
1300	3	7.2	3	7.3	3	7.2	3	7.3
1400	3	8.4	3	8.5	3	8.3	3	8.5
1500	4	5.4	4	5.5	4	5.6	4	5.8

Boiler HP	4.5 ft ² /bhp							
	3-pass				4-pass			
	std		30 ppm		std		30 ppm	
	Gas train connection	Pressure required	Gas train connection	Pressure required	Gas train connection	Pressure required	Gas train connection	Pressure required
900	2.5	7.4	2.5	7.4	2.5	7.3	2.5	7.4
1000	2.5	8.2	2.5	8.3	2.5	8.1	2.5	8.2
1100	3	5.3	3	5.4	3	5.3	3	5.4
1200	3	6.3	3	6.3	3	6.2	3	6.4
1300	3	7.2	3	7.3	3	7.2	3	7.3
1400	3	8.4	3	8.4	3	8.2	3	8.3
1500	4	5.4	4	5.5	4	5.4	4	5.6

Boiler HP	5 ft ² /bhp							
	3-pass				4-pass			
	std		30 ppm		std		30 ppm	
	Gas train connection	Pressure required	Gas train connection	Pressure required	Gas train connection	Pressure required	Gas train connection	Pressure required
800	2.5	6.0	2.5	6.1	2.5	5.9	2.5	6.0
900	2.5	7.4	2.5	7.4	2.5	7.3	2.5	7.4
1000	2.5	8.2	2.5	8.2	2.5	7.9	2.5	8.0
1100	3	5.3	3	5.4	3	5.3	3	5.4
1200	3	6.3	3	6.3	3	6.2	3	6.3
1300	3	7.2	3	7.2	3	7.1	3	7.2
1400	3	8.4	3	8.4	3	8.2	3	8.3
1500	4	5.4	4	5.5	4	5.4	4	5.6

Notes:

- 3-pass boilers are based on 80% efficiency
- 4-pass boilers are based on 82% efficiency
- Pressure shown is minimum required and is listed as psi
- Incoming pressure is not to exceed 10 psi
- Ultra Low NO_x (9 and 15ppm) are handled on a case by case basis

Table is based on Siemens gas train, which includes a regulating actuator.

Table A5-16. Altitude Correction for Gas

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

inches WC x 0.577 = oz/sq-in.

oz/sq-in x 1.732 = inches WC.

inches WC x 0.0361 = psig.

oz/sq-in x 0.0625 = psig.

psig x 27.71 = Inches WC.

psig x 16.0 = oz/sq-in.

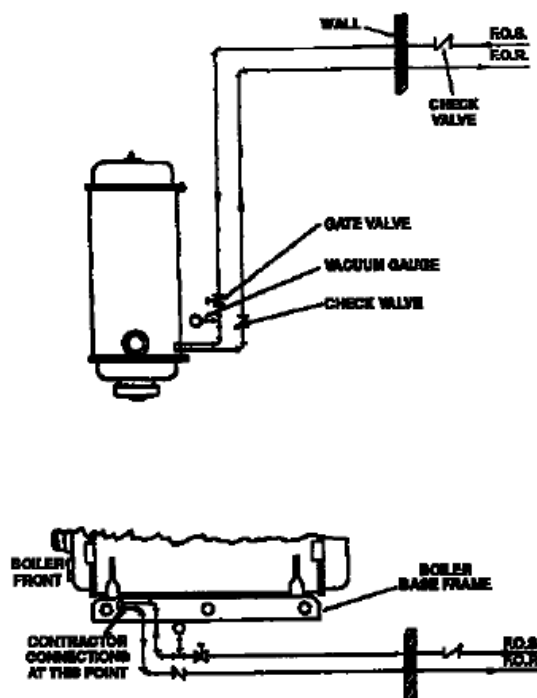


Figure A5-5. No. 2 Oil Piping, Single Boiler Installation, Oil Pump Integral With Boiler

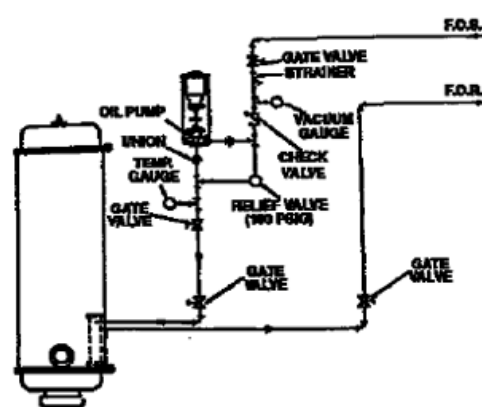


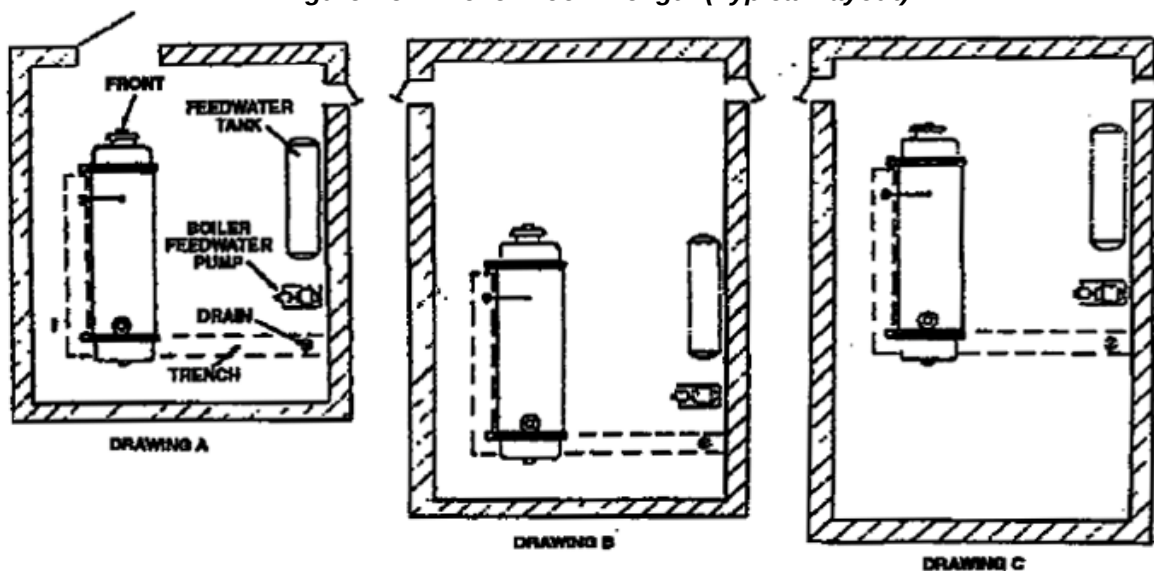
Figure A5-6. No. 6 Oil Piping, Single Boiler Installation, Remote Oil Pumps

BOILER SQUARE FOOT OF HEATING SURFACE	BHP		A	B
	4 sq.ft.	5 sq.ft.		
4000	1000	800	610	484
4500	1100	900	670	514
5000	1200	1000	606	489
5500	1300	1100	654	513
6000	1500	1200	700	536
6500	1600	1300	642	515
7000	1700	1400	680	534
7500	1800	1500	718	553

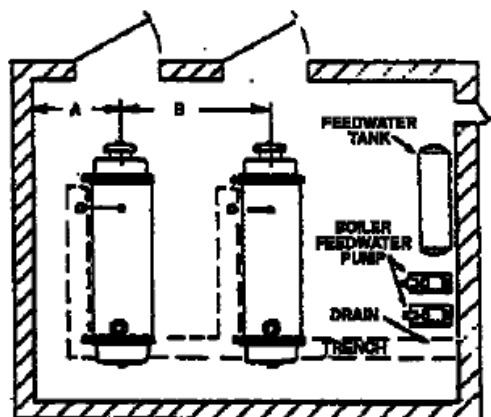
NOTE: A = Minimum length based on removing tubes in the boiler room.

B = Minimum length based on removing tubes through a wall opening.

Figure A5-7. Boiler Room Length (Typical Layout)



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement from front of boiler through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.
If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.
2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear.
If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.



Boiler Square Foot of Heating Surface	4000-4500	5000-6000	6500-7500
Dimension A (inches)	117	123	129
Dimension B (inches)	198	210	222

For reference to Boiler Horsepower per square foot see A11-7

Figure A5-8. Boiler Room Width (Typical Layouts)

SECTION A5

SAMPLE SPECIFICATIONS MODEL CB

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1.1 Boiler Characteristics (Steam)..... A5-22

PART 2 PRODUCTS..... A5-22

2.1 General Boiler Design..... A5-22

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PART 3 EXECUTION..... A5-27

3.1 Warranty A5-27

3.2 Shop Tests..... A5-27

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in meeting your customer's specific needs and application.

The detailed burner and control specifications, and detailed control specifications for CB100E Flame Safeguard control are provided. See Section D, Controls, for additional information on control options.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.



PART 1 GENERAL

CBL Steam Boiler (900-1800 hp, Steam 15-250 psig)

1.1 Boiler Characteristics (Steam)

- A. The Steam Boiler shall be Cleaver-Brooks Fuel Series _____ (100, 200, 400, 600, 700), _____ hp designed for _____ psig (15, 150, 200, or 250 psig steam). The maximum operating pressure shall be _____ psig and the minimum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS12-48 _____ oil and/or natural gas, _____ Btu/cu-ft. Electrical power available shall be _____ Volt _____ Phase _____ Cycle.

PART 2 PRODUCTS

2.1 General Boiler Design

- A. The boiler shall be a three pass or four pass horizontal firetube updraft boiler with _____ square feet of heating surface per rated boiler horsepower. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls.
 - 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, fuel, electrical, vent, and blowdown connections.
 - 2. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, Industrial Risk Insurance, ASME, NFPA 8501).
- B. Boiler Shell (Steam)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 - 2. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning. Two lifting lugs must be located on top of the boiler.
 - 3. The front door shall be davited and the rear door shall be davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
 - 4. The boiler tubes shall not include turbulators, swirlers, or other add-on appurtenances.
 - 5. The rear door shall be insulated with a blanket material with a steel covering to give the surface a hard durable finish.
 - 6. The exhaust gas vent shall be located at the front or rear of the boiler and be capable of supporting 2000 lbs. The boiler vent shall contain a stack thermometer.
 - 7. Observation ports for the inspection flame conditions shall be provided at each end of the boiler.
 - 8. The boiler insulation shall consist of 2 inch blanket under a sectional pre-formed sheet metal lagging. The insulation must be readily removable and capable of being reinstalled, if required.

9. The entire boiler base frame and other components shall be factory-painted before shipment, using a hard-finish enamel coating.
10. The boiler shall contain a chemical feed connection.

2.2 Steam Boiler Trim

- A. Water Column

A water column shall be located on the right-hand side of the boiler complete with gauge glass set, and water column blowdown valves.

 1. Modulating feedwater Control

The boiler modulating feedwater control and valve shall be included to automatically maintain the boiler water level within normal limits.
 2. Low Water Cutoff

The low water cutoff shall be included as an integral part of the boiler feedwater control and wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.
- B. Auxiliary Low Water Cut-off

Auxiliary low water cut-off shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.
- C. Steam Pressure Gauge

The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- D. Safety Valves

Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- E. Steam Pressure Controls

The steam pressure control to regulate burner operation shall be mounted near the water column. Controls shall be a high limit (manual reset), operating limit (auto reset), and firing rate control.

2.3 Burner and Controls

- A. Mode of Operation
 1. Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.
 2. A low fire hold temperature control is mounted and wired on the boiler.
- B. Blower
 1. All air for combustion shall be supplied by a forced draft blower mounted on the burner, to eliminate vibration and reduce noise level.
 2. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
 3. The impeller shall be fabricated aluminum with radial blade, carefully balanced, and directly connected to the blower motor shaft.
- C. Combustion Air Control

Combustion air damper and cam-operated fuel metering valve shall be operated by a single damper control motor that regulates the flame according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.

2.4 Fuel Specification and Piping

Select one of the following fuel types:

- Fuel series 700 - Gas-fired.
- Fuel series 100 - Light oil (No. 2) fired.
- Fuel series 200 - Light oil or gas-fired.
- Fuel series 600 - No. 6 oil-fired.
- Fuel series 400 - No. 6 oil or gas-fired.

A. Fuel Series 700 - Gas-Fired

1. **Burner Type** - The burner shall be mounted at the front of the boiler and of high radiant multi-port type gas entry. The burner shall be approved for operation on natural gas fuel.
2. **Gas Pilot** - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. **Gas Burner Piping** - Gas burner piping on all units shall include a gas pressure regulator, a primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valves shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves.
4. **Burner Turndown**: Turndown range shall be 8:1 when firing natural gas on standard burners with uncontrolled emissions (100 ppm NO_x). Consult Cleaver-Brooks representative regarding turndown capability for low NO_x burners 30 ppm and less.

B. Fuel Series 100 - Light Oil-Fired

1. **Burner Type** - The burner shall be mounted at the front of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil.
2. **Gas Pilot** - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and one (1) plugged leakage test connection (Canada only).
3. **Oil Pump** - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
4. **Oil Burner Piping**
 - a. Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges, all integrally mounted on the unit.

5. Low Pressure Air Atomizing: Separate air compressor module, “shipped loose” with burner mounted low atomizing air pressure switch.
 6. Turndown range shall be 6:1 when firing No. 2 oil on standard burners with uncontrolled emissions. Consult Cleaver-Brooks representative regarding turndown capability for low NOx burners.
- C. Fuel Series 200 - Light Oil or Gas-Fired
1. Burner Type - The burner shall be mounted at the front of the boiler and shall be a combination of the low pressure air atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas.
 2. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and pressure gauge and one (1) plugged leakage test connection (Canada only).
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor-driven pump set, shipped loose, shall be provided, to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low pressure Air Atomizing - Separate air compressor module, “shipped loose” with burner-mounted low-atomizing air pressure switch.
 - d. Burner Turndown - Turndown range shall be 6:1 when firing No. 2 oil on standard burners with uncontrolled emissions. Consult Cleaver-Brooks representative regarding turndown capability for low NOx burners.
 4. Gas Burner
 - a. Gas Burner Piping - Gas burner piping on all units shall include a gas pressure regulator, and a primary gas shutoff valve, motor-operated with proof-of-closure switch and plugged leakage test connection. The main gas valves shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as a means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus and additional plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves.
 - b. Burner Turndown - Turndown range shall be 8:1 when firing natural gas on standard burners with uncontrolled emissions (100 ppm NOx). Consult Cleaver-Brooks representative regarding turndown capability for low NOx burners 30 ppm and less.
- D. Fuel Series 600 - No. 6 Oil-Fired
1. Burner Type - The burner shall be mounted at the front of the boiler and low pressure air atomizing type approved for operation with CS12-48, Commercial No. 6 Oil.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot

- open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and pressure gauge and one (1) plugged leakage test (Canada only).
3. Oil Pump - An oil pump set with a capacity of approximately twice the maximum burning rate shall be included.
 - The motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank shall be provided.
 4. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves and pressure gauges all integrally mounted on the unit.
 5. Low Pressure Air-Atomizing - Separate air compressor module, "shipped loose" with the burner-mounted low-atomizing air pressure switch.
 6. Oil Preheat
The oil shall be preheated by a steam heater and electric heater, each with thermostatic control. Both heaters shall be installed in a single compact shell; mounted, piped, and wired. The thermostatic controls shall be set to cut-out the electric heater when steam is available.
 7. Burner Turndown - Turndown range will be 4:1 when firing No. 6 oil on standard burners with uncontrolled emissions. Consult Cleaver-Brooks representative regarding turndown capability for low NOx burners.
- E. Fuel Series 400 - No. 6 Oil or Gas-Fired
1. Burner Type - The burner shall be mounted at the front the boiler and shall be a combination of the low pressure atomizing type for oil and multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 6 oil or natural gas.
 2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one manual shut-off valve, solenoid valve, pressure regulator and pressure gauge, and one (1) plugged leakage test connection. (Canada only.)
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. The motor driven pump set, shipped loose, shall be provided to be installed in a location favorable to the oil storage tank.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, low oil pressure switch, two (2) motorized oil valves, and pressure gauges all integrally mounted on the unit.
 - c. Low Pressure Air-Atomizing: Separate air compressor module "shipped loose" with burner mounted low atomizing air pressure switch.
 - d. Oil Preheat - The oil shall be preheated by a steam heater and electric heater, each with thermostatic control. Both heaters shall be installed in a single compact shell mounted, piped, and wired. The thermostatic controls shall be sent to cut-out the electric heater when steam is available.
 - e. Burner Turndown - Turndown range will be 4:1 when firing No. 6 oil on standard burners with uncontrolled emissions. Consult Cleaver-Brooks representative regarding turndown capability for low NOx burners.
 - f. Gas Burner
 - 1) Gas Burner Piping - Gas burner piping on all units shall include a gas pressure regulator, and a primary gas shutoff valve, motor-operated with proof-of-closure switch and plugged leakage test connection. The main

gas valves shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock shall be provided as means for a tightness check of the primary shutoff valve. An additional plug cock shall be furnished at entrance to gas train. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided. A vent valve shall be located between the safety shutoff valves.

- 2) Burner Turndown - Turndown range shall be 6:1 when firing natural gas on standard burners with uncontrolled emissions (100 ppm NOx). Consult Cleaver- Brooks representative regarding turndown capability for low NOx burners 30 ppm and less.

2.5 Boiler Flame Safeguard Controller and Control Panel

A. CB100E Flame Safeguard

1. Each boiler shall be factory-equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB100E. Flame safeguard shall be a Cleaver-Brooks Model CB 100E microprocessor-based control to monitor all critical boiler and burner interlocks, control and supervise burner light-off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. The system shall provide status, fault history, and diagnostic information by means of a BACKLIT LCD display. The system shall be approved by UL, FM, and CSA, and shall be acceptable by IRI.

B. Control Panel

A factory prewired control panel shall be supplied with the boiler/burner package. Panel may be mounted on the burner or boiler.

1. The panel will have a NEMA 1A rating and contain the flame safeguard controller, burner motor starter, air compressor motor starter, oil-metering pump motor starter, control circuit transformer and fuses, selector switches, indicating lights and terminal strips. Lights shall indicate load demand, flame failure, low water, and fuel valve open.
2. The panel shall contain over-current protection for the burner motor, air compressor motor, and oil metering pump.

2.6 Efficiency Guarantee

- A. The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of _____ percent at 100 percent of rating when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (Contact your local Cleaver-Brooks authorized representative for efficiency details).

PART 3 EXECUTION

3.1 Warranty

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up, or 18 months from date of shipment; whichever comes first.

3.2 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

B. Start-up Service

1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - a. A factory-approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

MODEL CB

15 - 100 HP
Steam and Hot Water
Dryback Integral Burner



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FEATURES AND BENEFITS

In addition to the features provided on all Cleaver-Brooks Firetube Boilers, the following features apply specifically to Model CB Firetube Boilers. The CB four-pass dryback boiler is the premium firetube boiler design available.

Four-Pass Dryback Design:

- Four-pass design provides high flue gas velocities and low stack temperature for guaranteed maximum efficiency.
- Dryback design provides full access to boiler tubes, tube sheet, and furnace for ease of maintenance.
- Dryback design includes single rear tube sheet construction, providing reduced tube sheet stresses.

Five Square Feet of Heating Surface per Boiler hp:

- Maximum heat transfer with minimum thermal stresses provide guaranteed efficiency and long boiler life.
- Highest guaranteed fuel-to-steam efficiencies.

Low Furnace Location

- Furnace located well below water level with generous clearance from bottom of boiler, allowing proper circulation.
- Low furnace provides additional safety margin between furnace and water level.
- Reduces water carryover, producing drier steam.

Hinged or Davited Front and Rear Doors:

- Provides full access to front and rear tube sheet and furnace.
- Reduces maintenance costs.

High Turndown Burner:

- 4:1 turndown (gas and oil) is standard.
- Advanced burner design provides maximum combustion efficiencies and high turndown.
- Reduced boiler cycling and maintenance.
- Boiler stays on line during low load conditions for optimum efficiency and performance.

Gas, No. 2 Oil, No. 6 Oil, and Combination Gas and Oil Burners Available:

- High radiant multi-port gas burner designed for high gas velocities and complete fuel/air mixing, providing maximum combustion efficiencies.
- Air atomizing oil burner available for proper oil atomization, maximum combustion efficiency, and low maintenance requirements.
- Air atomizing compressor provided with the boiler package for clean oil burning and ease of maintenance.
- Combination gas/oil burners provide quick fuel changeover without re-adjustment of the burner.
- Fuel oil controller eliminates the need for over 40 connections, combining gauges, valves, and regulators into a single casting.
- Retractable oil nozzle provides easy access and cleaning and eliminates coking of oil and nozzle tip when firing gas.

PRODUCT OFFERING

Model CB Firetube Boilers are available in low pressure steam, high pressure steam, and hot water designs. Burners are available to fire natural gas, light oil, heavy oil, or a combination of oil and gas. Optional alternate fuel burners are also available.

Model CB Boilers include:

- Four-pass dryback design.
- 15 hp through 100 hp.
- 150 psig - 350 psig high pressure steam.
- 15 psig low pressure steam.
- 30 psig or 125 psig hot water.
- Natural gas, light oil, or heavy oil firing.

The Model CB Boiler is the premium firetube product offering providing maximum boiler efficiency, the widest range of size and pressures, and premium control packages.

Available options: For option details, contact your Cleaver-Brooks authorized representative. Options include the following:

Boiler Options

- Auxiliary low water cut-off (standard on steam boilers).
- Drain valves.
- Additional screwed or flanged tappings.
- Special design pressures.
- Surge load baffles.
- Seismic design.
- Internal hot water coils.
- Blowdown valves.
- Non-return valves.
- Feedwater valves and regulators.
- Special doors, davited, hinged, left swing.
- Special base rails.
- Surface blowdown systems.
- Combustion relief door.
- Weather-proofing.
- Blend pump.

Burner/Control Options

- Special modulation controls.
- Optional flame safeguard controller.
- Lead/lag system.
- High altitude design, up to 12,000 ft.
- Special insurance and code requirements (e.g. FM, ASME CSD-1).
- Alarm bell/silence switch.

- Special motor requirements (TEFC, high efficiency).
- Remote contacts.
- Special purpose indicator lights.
- Main disconnect.
- Elapsed time meter.
- Voltmeter/micro-ammeter.
- NEMA enclosures.
- Low fire hold controls.
- Remote emergency shut-off (115V).
- Circuit breaker.
- Day/night controls.
- Special power requirements.

Fuel Options

- Automatic fuel changeover.
- Special gas pressure regulator.
- Oversized/undersized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Special pilot.
- Alternate fuel firing (propane, digester gas, etc.).
- Special oil pumps.

DIMENSIONS AND RATINGS

- Dimensions and ratings for the Model CB boilers are shown in the following tables and illustrations:
- Table A6-1. Model CB Steam Boiler Ratings (15 thru 100 hp)
- Table A6-2. Model CB Hot Water Boiler Ratings (15 thru 100 hp)
- Table A6-3. Safety Valve Openings
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- Figure A6-1. Model CB Steam Boiler Dimensions (15 and 150 lb design pressure) (15 thru 100 hp)
- Figure A6-2 Model CB Hot Water Boiler Dimensions (15 and 150 lb design pressure) (15 thru 100 hp)
- Figure A6-3. Space Required to Open Rear Head on Model CB Boilers Equipped with Davits
- Figure A6-4. Model CB Boiler Mounting Piers
- Figure A6-5. Lifting Lug Locations, Model CB Boilers

Table A6-1. Model CB Steam Boiler Ratings (15 - 100 hp)

BOILER HP	15 ^C	20 ^C	30 ^C	40 ^C	50	60	70	80	100
RATINGS - SEA LEVEL TO 3000 FT									
Rated Cap. (lbs steam/hr @ 212°F)	518	690	1035	1380	1725	2070	2415	2760	3450
Btu Output (1000 Btu/hr)	502	670	1004	1339	1674	2009	2343	2678	3348
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY									
Light Oil (gph) ^A	4.5	6.0	9.0	12.0	15.0	18.0	21.0	24.0	30.0
Heavy Oil (gph) ^B	-	-	-	-	14.0	16.5	19.5	22.5	28.0
Gas (cfh) 1000 Btu-Nat	625	835	1255	1675	2095	2510	2930	3350	4185
Gas (Therm/hr)	6.3	8.4	12.6	16.8	21.0	25.1	29.3	33.5	41.9
POWER REQUIREMENTS - SEA LEVEL TO 3000 FT, 60 HZ									
Blower Motor hp (except gas)	1	1	1-1/2	2	2	2	2	2 ^D	3
Gas Models (only)	1	1	1-1/2	2	2	2	2	2 ^D	3
Oil Pump Motor, hp No. 2 Oil	Belt-Driven From Blower				1/3	1/3	1/3	1/3	1/3
Oil Pump Motor, hp No. 6 Oil	-	-	-	-	1/3	1/3	1/3	1/3	1/3
Oil Heater kW No. 6 Oil	-	-	-	-	5	5	5	5	5
Air Compressor Motor hp (Oil firing Only)	Air Compressor Belt-Driven from Blower Motor				2	2	2	2	

NOTES:

1. For altitudes above 3000 ft, contact your local Cleaver-Brooks authorized representative for verification of blower motor hp.

A. Based on 140,000 Btu/gal.

B. Based on 150,000 Btu/gal.

C. No. 6 Oil not available in 15-40 hp range.

D. 3 hp above 2000 ft.

Table A6-2. Model CB Hot Water Boiler Ratings (15 - 100 hp)

BOILER HP	15 ^C	20 ^C	30 ^C	40 ^C	50	60	70	80	100
RATINGS - SEA LEVEL TO 3000 FT									
Rated Cap Btu Output (1000 Btu/hr)	502	670	1004	1339	1674	2009	2343	2678	3348
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY									
Light Oil (gph) ^A	4.5	6.0	9.0	12.0	15.0	18.0	21.0	24.0	30.0
Heavy Oil (gph) ^B	-	-	-	-	14.0	16.5	19.5	22.5	28.0
Gas (cfh) MBtu- nat	625	835	1255	1675	2095	2510	2930	3350	4185
Gas (Therm/hr)	6.3	8.4	12.6	16.8	21.0	25.1	29.3	33.5	41.9
POWER REQUIREMENTS - SEA LEVEL TO 3000 FT, 60 HZ									
Blower Motor hp (except gas)	1	1	1-1/2	2	2	2	2	2 ^D	3
Gas Models (only)	1	1	1-1/2	2	2	2	2	2 ^D	3
Oil Pump Motor, hp No. 2 Oil	Belt-Driven From Blower				1/3	1/3	1/3	1/3	1/3
Oil Pump Motor, hp No. 6 Oil	-	-	-	-	1/3	1/3	1/3	1/3	1/3
Oil Heater kW No. 6 Oil	-	-	-	-	5	5	5	5	5
Air Compressor Motor hp (Oil firing Only)	Air Compressor Belt-Driven from Blower Motor				2	2	2	2	2

NOTES:

1. For altitudes above 3000 ft, contact your local Cleaver-Brooks authorized representative for verification of blower motor hp.

A. Based on 140,000 Btu/gal.

B. Based on 150,000 Btu/gal.

C. No. 6 Oil not available in 15-40 hp range.

D. 3 hp above 2000 ft.

Table A6-3. Steam Boiler Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		100 PSIG STEAM		125 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
15	1	1-1/2	1	1	1	3/4	1	3/4	1	3/4	1	3/4
20	1	1-1/2	1	1	1	1	1	3/4	1	3/4	1	3/4
25	1	2	1	1	1	1	1	1	1	3/4	1	3/4
30	1	2	1	1-1/4	1	1	1	1	1	3/4	1	3/4
40	1	2-1/2	1	1-1/4	1	1-1/4	1	1	1	1	1	1
50	1	2-1/2	1	1-1/2	1	1-1/2	1	1-1/4	1	1	1	1
60	1	2	1	1-1/2	1	1-1/2	1	1-1/4	1	1	1	1
70	1	2	1	2	1	1-1/2	1	1-1/2	1	1-1/4	1	1
80	1	2-1/2	1	2	1	1-1/2	1	1-1/2	1	1-1/4	1	1-1/4
100	1	2-1/2	1	2	1	2	1	1-1/2	1	1-1/2	1	1-1/4

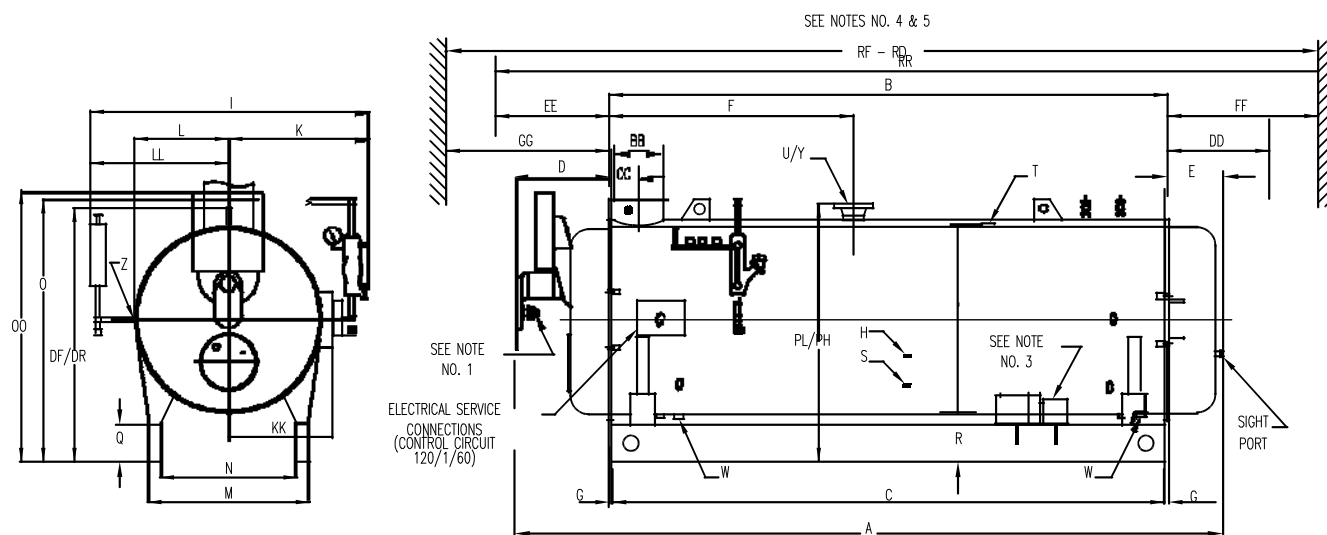
Table A6-4. Hot Water Boiler Relief Valve Openings

VALVE SETTING	30 PSIG HW		60 PSIG HW		100 PSIG HW		125 PSIG HW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
15	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1
25	1	1-1/4	1	1	1	1	1	1
30	1	1-1/4	1	1	1	1	1	1
40	1	1-1/4	1	1	1	1	1	1
50	1	2	1	1-1/4	1	1	1	1
60	1	2	1	1-1/4	1	1	1	1
70	1	2	1	2	1	1-1/4	1	1
80	1	2	1	2	1	1-1/4	1	1-1/4
100	1	2-1/2	1	2	1	1-1/4	1	1-1/4

NOTES:

1. Hot water relief valves are Kunkle #537.

2. BHP followed by "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in the upper portion of the vessel.



BOILER HP	DIM	15	20	30	40	50	60	70	80	100
LENGTHS										
Overall	A	96-5/8	96-5/8	114-5/8	140-5/8	129	129	168	168	187
Shell	B	62-5/8	62-5/8	80-5/8	106-5/8	92	92	131	131	150
Base Frame	C	59	59	77	103	91	91	130	130	148
Front Head Extension	D	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Rear Head Extension	E	15-1/2	15-1/2	15-1/2	15-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Front Ring Flange to Nozzle - 15 psig	F	36	36	45	57	46	46	65-1/2	65-1/2	75
Front Ring Flange to Nozzle - 150 psig	F	36	36	45	57	46	46	72-1/2	72-1/2	82
Ring Flange to Base	G	1-13/16	1-13/16	1-13/16	1-13/16	5/8	1/2	1/2	1/2	1/2
WIDTHS										
Overall	I	61	61	61	61	73	73	73	73	73
ID, Boiler	J	36	36	36	36	48	48	48	48	48
Center to Water Column	K	33	33	33	33	39	39	39	39	39
Center to Outside Hinge	KK	22	22	22	22	29	29	29	29	29
Center to Lagging	L	20	20	20	20	27	27	27	27	27
Center to Auxiliary LWCO	LL	28	28	28	28	34	34	34	34	34
Base, Outside	M	28	28	28	28	37-5/8	37-3/8	37-3/8	37-3/8	37-3/8
Base, Inside	N	22	22	22	22	29-5/8	29-5/8	29-5/8	29-5/8	29-5/8

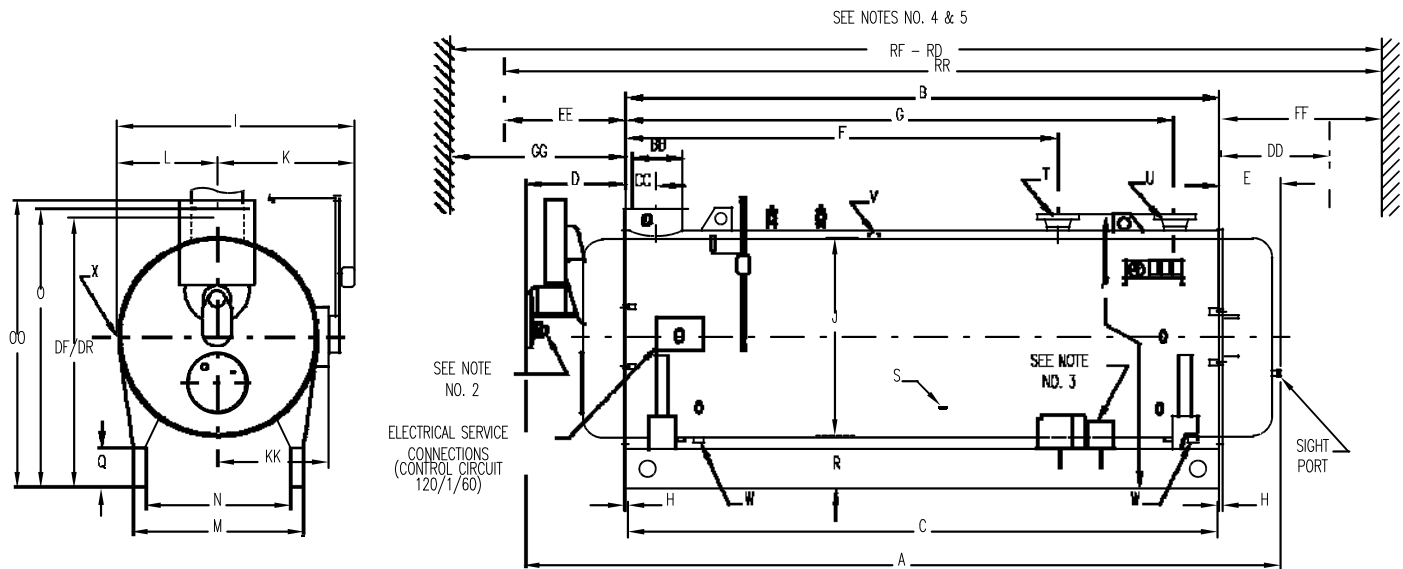
Figure A6-1. Model CB Steam Boiler Dimensions and Weights (15 and 150 psig Design Pressure - 15 to 100 hp) Sheet 1 of 2

BOILER HP	DIM	15	20	30	40	50	60	70	80	100
HEIGHTS										
Base to Steam Outlet (15 psig only)	PL	50-1/4	50-1/4	50-1/4	50-1/4	70-5/16	70-5/16	70-5/16	70-5/16	70-5/16
Overall	OO	66	66	66	66	78-3/4	78-3/4	78-3/4	78-3/4	78-3/4
Base to Vent Outlet	O	53-1/2	53-1/2	53-1/2	53-1/2	70	70	70	70	70
Base to Steam Outlet (150 psig only)	PH	50-1/4	50-1/4	50-1/4	50-1/4	66-31/2	66-1/2	66-1/2	66-1/2	70-5/16
Height of Base	Q	8	8	8	8	12	12	12	12	12
Base to Bottom of Boiler	R	12	12	12	12	16	16	16	16	16
BOILER CONNECTIONS										
Chemical Feed	H	1	1 1 1	1 1 1 1 1						
Feedwater, Right and Left	S	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Low Pressure (15 psig only)										
Steam Nozzle	U	4	4	4	6 ^A	6 ^A	6 ^A	6 ^A	6 ^A	8 ^A
Drain, Front and Rear	W	1	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2
High Pressure (150 psig only)										
Surface Blowoff, Top C _L	T	1	1	1	1	1	1	1	1	1
Steam Nozzle	Y	1-1/2	1-1/2	2	2	3	3	3	3	4 ^B
Blowdown, Front and Rear	W	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
VENT STACK										
Diameter (flgd connection)	BB	6	6	8	8	10	10	12	12	12
Front Ring Flange to Vent C _L	CC	4	4 5 5	6 6 7 7 7						
MINIMUM CLEARANCES										
Rear Door Swing ^C	DD	44	44	44	44	55	55	55	55	55
Front Door Swing ^C	EE	44	44	44	44	55	55	55	55	55
Tube Removal, Rear	FF	56	56	74	100	84	84	123	123	142
Tube Removal, Front	GG	46	46	64	90	74	74	113	113	132
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:										
Rear of Boiler	RR	163	163	199	251	231	231	309	309	347
Front of Boiler	RF	153	153	189	241	221	221	299	299	337
Thru Window or Doorway	RD	151	151	169	195	202	202	241	241	260
WEIGHT IN LBS										
Normal Water Capacity		1340	1300	1710	2290	3130	2920	4620	4460	5088
Approx. Ship Wgt - 15 psig		3000	3100	3650	4350	6900	7000	8100	8200	9000
Approx. Ship Wgt - 150 psig		3100	3200	3800	4500	7000	7200	8800	9000	9500
Approx. Ship Wgt - 200 psig		3300	3400	4100	4700	7400	7600	9300	9500	10000

NOTES:

1. Air compressor belt driven from blower motor on sizes 15 thru 40
 2. Air compressor module on sizes 50 thru 100 hp.
 3. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
- A. ANSI 150 psig flange.
 B. ANSI 300 psig flange.
 C. 15 thru 100 hp standard hinged door.

Figure A6-1. Model CB Steam Boiler Dimensions and Weights (15 and 150 psig Design Pressure - 15 to 100 hp) Sheet 2 of 2



BOILER HP	DIM	15	20	30	40	50	60	70	80	100
LENGTHS										
Overall	A	97	97	114-5/8	140-5/8	129	129	168	168	187
Shell	B	62-5/8	62-5/8	80-5/8	106-5/8	92	92	131	131	150
Base Frame	C	59	59	77	103	91	91	130	130	148
Front Head Ext.	D	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Rear Head Ext.	E	15-1/2	15-1/2	15-1/2	15-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Front Ring Flange to Return	F	43-5/8	43-5/8	62	81	69	69	108	108	127
Front Ring Flange to Outlet	G	55-1/8	55-1/8	73-1/8	98-1/2	84-5/8	84-5/8	123-5/8	123-5/8	142-5/8
Ring Flange to Base	H	1-13/16	1-13/16	1-13/16	1-13/16	5/8	5/8	5/8	5/8	1
WIDTHS										
Overall	I	48-3/4	48-3/4	48-3/4	48-3/4	63	63	63	63	63
ID, Boiler	J	36	36	36	36	48	48	48	48	48
Center to Entrance Box	K	28-3/4	28-3/4	28-3/4	28-3/4	36	36	36	36	36
Center to Outside Hinge	KK	22	22	22	22	29	29	29	29	29
Center to Lagging	L	20	20	20	20	27	27	27	27	27
Base, Outside	M	28	28	28	28	37-5/8	37-5/8	37-5/8	37-5/8	37-5/8
Base, Inside	N	22	22	22	22	29-5/8	29-5/8	29-5/8	29-5/8	29-5/8

Figure A6-2. Model CB Hot Water Boiler Dimensions (30 psig and 125 psig Design Press. - 15 to 100 hp)
Sheet 1 of 2

BOILER HP	DIM	15	20	30	40	50	60	70	80	100
HEIGHTS										
Overall	OO	66	66	66	66	72-5/8	72-5/8	72-5/8	72-5/8	72-5/8
Base to Vent Outlet	O	53-1/2	53-1/2	53-1/2	53-1/2	70	70	70	70	70
Base to Return and outlet	P	50	50	50	50	70-5/16	70-5/16	70-5/16	70-5/16	70-5/16
Davit (Front)	DF	-	-	-	-	-	-	-	-	-
Davit (Rear)	DR	-	-	-	-	-	-	-	-	-
Height of Base	Q	8	8	8	8	12	12	12	12	12
Base to bottom of boiler	R	12	12	12	12	16	16	16	16	16
BOILER CONNECTION										
Waterfill Conn. Right & Left	S	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Water Return ^A	T	2-1/2	2-1/2	3	3	4	4	4	4	4
Water Outlet ^A -dip tube included	U	2-1/2	2-1/2	3	3	4	4	4	4	4
Air Vent	v	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Drain, Front and Rear	W	1	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2
Auxiliary Connection	X	1	1	1	1	1	1	1	1	1
VENT STACK										
Diameter (flgd. connection)	BB	6	6	8	8	10	10	12	12	12
Front Ring Flange to vent C _L	CC	4	4	5	5	6	6	7	7	7
MINIMUM CLEARANCES										
Rear Door Swing	DD	44	44	44	44	55	55	55	55	55
Front Door Swing	EE	44	44	44	44	55	55	55	55	55
Tube Removal, Rear	FF	56	56	74	100	84	84	123	123	142
Tube, Removal, Front	GG	46	46	64	90	74	74	113	113	132
MINIMUM BOLER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:										
Rear of Boiler	RR	163	163	199	251	231	231	309	309	347
Front of Boiler	RF	153	153	189	241	221	221	299	299	337
Thru Window or Doorway	RD	151	151	169	195	202	202	241	241	260
WEIGHT IN LBS										
Water Capacity Flooded		1500	1460	1915	2585	3665	3500	5420	5250	5960
Approx. Ship. Wgt. – 30 psig		3000	3100	3650	4350	6800	7000	8000	8100	8800
Approx. Ship. Wgt. – 125 psig		3300	3400	3880	4580	7100	7300	8350	8450	9150

NOTES:

1. Accompanying dimensions and ratings while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
2. Air compressor belt driven from blower motor on sizes 15 thru 40 hp.
3. Air compressor module on sizes 50 thru 100 hp.
4. 15 - 100 hp, hinged door standard.
5. Add 370 lbs to the 80 hp ship weight for 100A and 485 lbs to the 100 hp ship weight for the 125A.

A. 15-40 HP are threaded connection; 50-100 HP are 150# flange.

Figure A6-2. Model CB Hot Water Boiler Dimensions (30 psig Design Pressure - 15 to 100 hp) - Sheet 2 of 2

BOILER HP	DIMENSION (INCHES)				
	A	B	C	D	E
15 - 40	20	36	28	45	20
50 - 100	27	48	38	60	26

NOTE:

1. Dimensions in inches.
2. 15 - 100 hp (100A & 125A) boilers are standardly equipped with hinges. Davit available as an option.

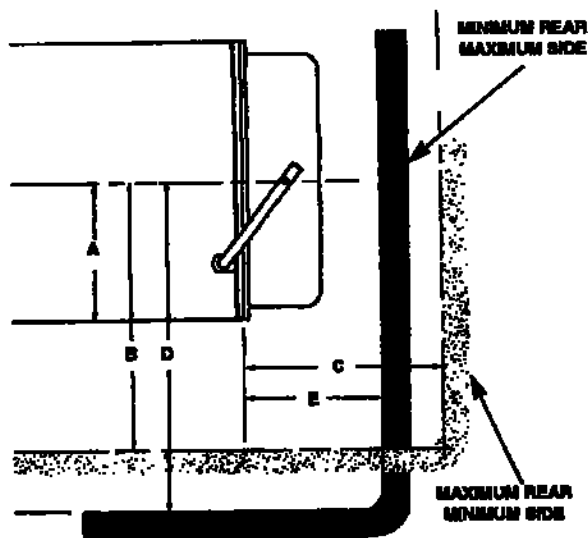
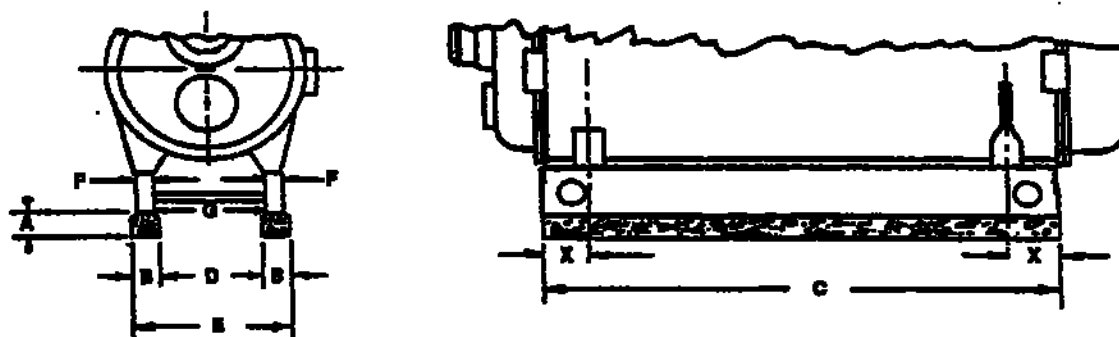


Figure A6-3. Space Required to Open Rear Head on Model CB Boilers Equipped with Davits

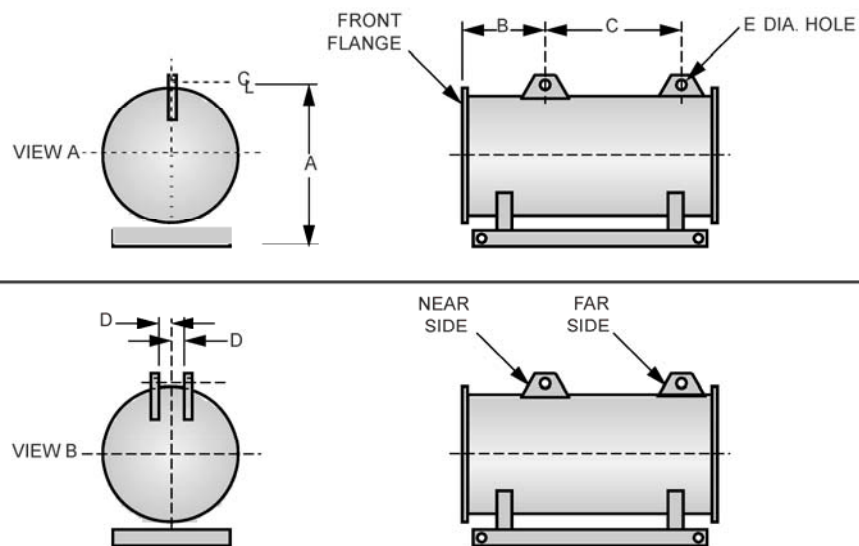


BOILER HP	A	B	C	D	E	F	G	X1	X2
15-20	6	8	59	17	33	3	22	9-3/4	9-3/4
25-30	6	8	77	17	33	3	22	9-3/4	9-3/4
40	6	8	103	17	33	3	22	9-3/4	9-3/4
50-60	6	8	91	26	42	4	29-5/8	8-1/4	8-1/4
70-80	6	8	130	26	42	4	29-5/8	8-1/4	8-1/4
100	6	8	148	26	42	4	29-5/8	8-1/4	8-1/4

NOTE:

1. All numbers in table are in inches.
2. 6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

Figure A6-4. Model CB Boiler Mounting Piers



BOILER HP		VIEW	ALL DIMENSIONS IN INCHES				
			A	B	C	D	E
15	Steam	A	51-3/4	12	38-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	38-3/4	6	2-1/2
20	Steam	A	51-3/4	12	38-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	38-3/4	6	2-1/2
25	Steam	A	51-3/4	12	56-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	56-3/4	6	2-1/2
30	Steam	A	51-3/4	12	56-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	56-3/4	6	2-1/2
40	Steam	A	51-3/4	12	82-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	82-3/4	6	2-1/2
50	All	B	68	18	57	10	2-1/2
60	All	B	68	18	57	10	2-1/2
70	All	B	68	27	67	10	2-1/2
80	All	B	68	27	67	10	2-1/2
100	All	B	68	27	86	10	2-1/2

NOTE:

1. A, B and C Dimensions may vary by 1/2 inch.
2. BHP followed by "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in upper portion of vessel.

Figure A6-5. Lifting Lug Locations, Model CB Boilers

PERFORMANCE DATA

Efficiency

Tables A6-5 through A6-10 show predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks Model CB Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for Model CB Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7768 for a detailed description of efficiency calculations).

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in the tables listed above) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level. The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:
 - Natural Gas
 - Carbon, % (wt) = 69.98
 - Hydrogen, % (wt) = 22.31
 - Sulfur, % (wt) = 0.0
 - Heating value, Btu/lb = 21,830
 - No. 2 Oil
 - Carbon, % (wt) = 85.8
 - Hydrogen, % (wt) = 12.7
 - Sulfur, % (wt) = 0.2
 - Heating value, Btu/lb = 19,420
 - No. 6 Oil
 - Carbon, % (wt) = 86.6
 - Hydrogen, % (wt) = 10.9
 - Sulfur, % (wt) = 2.09
 - Heating value, Btu/lb = 18,830
2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
3. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).
4. Any efficiency verification testing will be based on the stack loss method.

When specifying the efficiencies in the tables, be sure to include the specific guarantee conditions to maximize the effectiveness of your efficiency specification. If you have any questions regarding the efficiency specifications, please contact your local Cleaver-Brooks authorized representative. For efficiencies and stack temperatures at operating pressures not listed, follow these procedures:

When the operating steam pressure is between 10 psig and 125 psig, interpolate the values from the efficiency tables.

When the operating steam pressure is above 125 psig, estimated efficiency can be calculated as follows:

Example:

Boiler: 100 hp.

Fuel: natural gas.

Operating steam pressure: 200 psig.

Find the fuel-to-steam efficiency at 100% firing rate. From Figure A6-6 for a 100 hp boiler operating at 100% firing rate and an operating steam pressure of 125 psig, the efficiency is 88.0%.

Using Figure A6-6, note that the stack temperature increases 36 °F at the higher operating pressure. To estimate boiler efficiency, use this rule of thumb: For every 40 °F increase in stack temperature, efficiency decreases by 1%. Since the stack temperature rise is 36 °F, the decrease in the boiler efficiency at 200 psig operating pressure is calculated as follows: $36/40 = .9\%$. Therefore, the boiler efficiency at 200 psig operating pressure is $88.0 - .9 = 87.1\%$.

Emissions

The emission data included in this section consists of typical uncontrolled emission levels for Cleaver-Brooks Model CB Firetube Boilers.

Notice

The data in Table A6-11 represents typical emission levels only. Guaranteed emission levels are available from your local Cleaver-Brooks authorized representative.

Table A6-5. Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - 10 psig, Natural Gas

BOILER HP	FIRING RATE (%)			
	25	50	75	100
50	83.0	83.2	82.9	82.4
60	82.9	83.1	82.7	82.3
70	84.5	84.7	84.3	83.9
80	84.6	84.8	84.5	84.0
100	84.4	85.0	84.8	84.4

Table A6-6. Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - 125 psig, Natural Gas

BOILER HP	FIRING RATE (%)			
	25	50	75	100
50	80.2	81.9	80.4	80.1
60	80.1	80.4	80.3	80.1
70	81.7	82.0	81.9	81.7
80	81.8	82.1	82.0	81.8
100	81.5	82.4	82.3	82.2

Table A6-7. Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - 10 psig, No. 6 Oil

BOILER HP	FIRING RATE (%)			
	25	50	75	100
50	86.8	87.0	86.6	86.1
60	86.7	86.9	86.5	86.0
70	88.4	88.6	88.2	87.7
80	88.5	88.7	88.3	87.8
100	88.2	88.5	88.3	88.0

Table A6-8. Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - 125 psig, No 6 Oil

BOILER HP	FIRING RATE (%)			
	25	50	75	100
50	83.9	84.2	84.0	83.8
60	83.8	84.1	83.9	83.8
70	85.5	85.8	85.6	85.4
80	85.6	85.9	85.7	85.6
100	84.6	85.8	85.9	85.8

Table A6-9. Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - 10 psig, No. 2 Oil

BOILER HP	FIRING RATE (%)			
	25	50	75	100
50	86.5	86.7	86.3	85.8
60	86.3	86.6	86.2	85.7
70	87.9	88.2	87.8	87.3
80	88.1	88.3	87.9	87.4
100	87.8	88.4	88.1	87.7

Table A6-10. Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - 125 psig, No 2 Oil

BOILER HP	FIRING RATE (%)			
	25	50	75	100
50	83.6	84.0	83.8	83.5
60	83.5	83.8	83.7	83.5
70	85.1	85.4	85.3	85.1
80	85.2	85.6	85.4	85.3
100	84.8	85.7	85.6	85.5

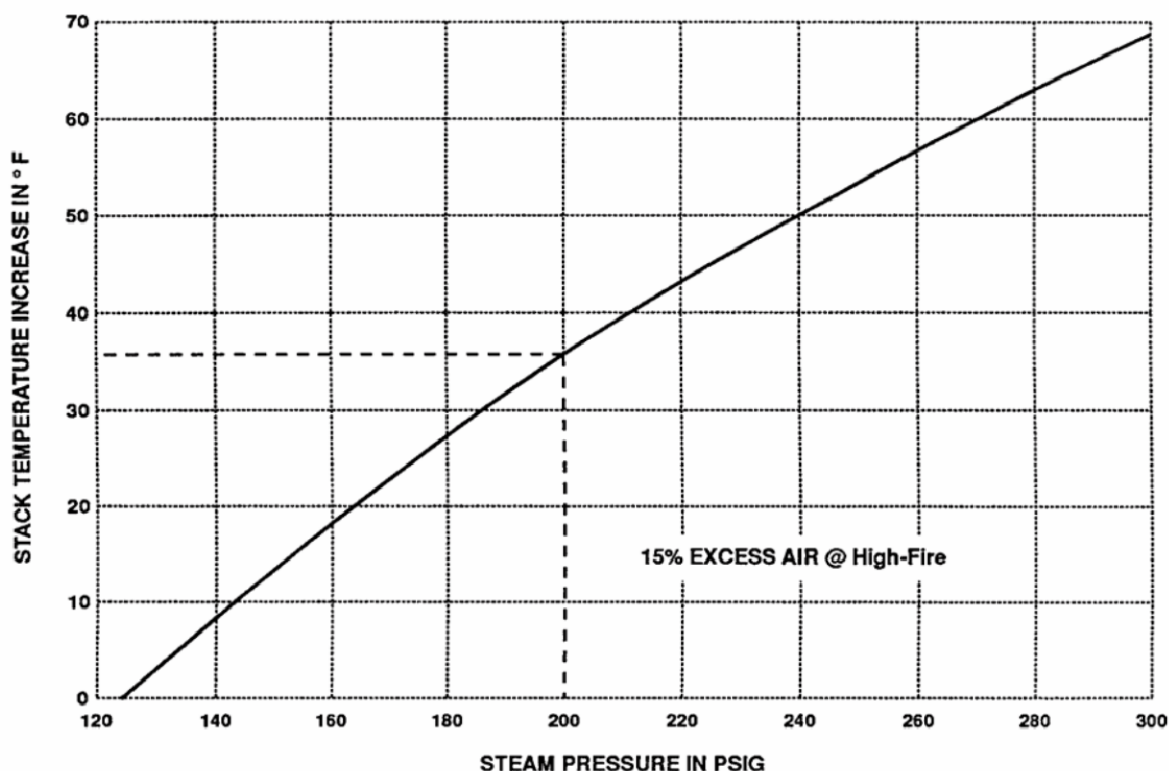


Figure A6-6. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig

Table A6-11. Model CB Boiler Emission Data

POLLUTANT		ESTIMATED LEVELS - UNCONTROLLED		
		NATURAL GAS	NO. 2 OIL ^B	NO. 6 OIL ^C
CO	ppm ^A	200	90	95
	Lb/MMBtu	0.15	0.07	0.075
NO _x	ppm ^A	100	185	502
	Lb/MMBtu	0.12	0.25	0.67
SO _x	ppm ^A	1	278	278
	Lb/MMBtu	0.001	0.52	0.52
HC/VOCs	ppm ^A	40	50	70
	Lb/MMBtu	0.016	0.025	0.035
PM	ppm ^A	-	-	-
	Lb/MMBtu	0.01	0.025	0.160

NOTES:

Refer to Section E for detailed emission information.

A. ppm levels corrected to 3% O₂, dry basis.

B. Based on fuel constituent levels of:

Fuel-bound nitrogen content = 0.015% by weight

Sulfur content = 0.5% by weight

Ash content = 0.01% by weight

C. Based on fuel constituent levels of:

Fuel-bound nitrogen content = 0.7% by weight

Sulfur content = 0.5% by weight

Ash content = 0.1% by weight

Conradson carbon residue = 16% by weight

Table A6-12. Heating Surface, Model CB Boilers

BOILER HP	HEATING SURFACE (SQ-FT)	
	FIRESIDE	WATERSIDE
15	75	85
20	100	109
25	125	144
30	150	162
40	200	219
50	250	266
60	300	323
70	350	388
80	400	441
100	500	544

ENGINEERING DATA

The following engineering information is provided for Model CB Firetube Boilers.

Additional detail is available from your local Cleaver-Brooks authorized representative.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Sound Level

Table A6-17 summarizes predicted sound pressure levels for Model CB Boilers.

Table A6-18 and A6-19 give detailed octave band sound pressure levels for each boiler. These values are based on standard motors. Optional motor types and altitude conditions can increase sound levels.

Units

The units for the sound level tables are dBA (decibels, measured on the A-weighted scale) in reference to 0.0002 microbars (20 micro-Newtons per square meter). They are standardly referenced in specifying and reporting sound pressure levels on industrial equipment.

Table A6-13. Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA, SQ-IN	
	HIGH PRESSURE ^A	LOW PRESSURE ^B	HIGH PRESSURE ^A	LOW PRESSURE ^B
15	2.9	5.9	1356	1637
20	2.9	5.9	1356	1637
25 & 30	3.9	7.9	1817	2195
40	5.3	10.8	2485	2999
50	9.7	16.0	2959	3372
60	9.7	16.0	2959	3372
70	14.3	23.7	4367	4975
80	14.3	23.7	4367	4975
100	16.6	27.4	5053	5757

NOTE: Based on normal water level.

A. Based on 150 psig design pressure.

B. Based on 15 psig design pressure.

Table A6-14. Water Circulation Rate and Temperature Drop for Hot Water Boiler

BOILER HP	BOILER OUTPUT (1000) BTU/HR	SYSTEM TEMPERATURE DROP - DEGREES F									
		10	20	30	40	50	60	70	80	90	100
		MAXIMUM CIRCULATING RATE - GPM									
15	500	100	50	33	25	20	17	14	12	11	10
20	670	134	67	45	33	27	22	19	17	15	13
30	1005	200	100	67	50	40	33	29	25	22	20
40	1340	268	134	89	67	54	45	38	33	30	27
50	1675	335	168	112	84	67	56	48	42	37	33
60	2010	402	201	134	101	80	67	58	50	45	40
70	2345	470	235	157	118	94	78	67	59	52	47
80	2680	536	268	179	134	107	90	77	67	60	54
100	3350	670	335	223	168	134	112	96	84	75	67

NOTES:

1. Minimum recommended return water temperature is 150 °F. Minimum recommended outlet temperature for Model CB Hot Water Boilers is 170 °F. Contact your local Cleaver-Brooks authorized representative for special hot water application information.
2. See Section H2 for over-pressure requirements.

Table A6-15. Recommended Steam Nozzle Size (To Maintain 4000 to 5000 fpm Nozzle Velocity)

BOILER HP										
OPERATING PRESSURE PSIG	15	20	25	30	40	50	60	70	80	100
15	4	4	4	4 6		6	6	6	6	8
30	2	2	2.5	2.5	3	4	4	4	4	6
40	2	2	2.5	2.5	3	3	4	4	4	6
50	1.5	2	2	2.5	2.5	3	3	4	4	4
75	1.5	2	2	2	2.5	3	3	3	4	4
100	1.5	1.5	2	2 2		3	3	3	3	4
125	1.5	1.5	2	2 2		3	3	3	3	4
150	1.5	1.5	2	2 2		2.5	2.5	2.5	2.5	2.5
200	1.5	1.5	2	2 2		2.5	2.5	2.5	2.5	2.5
250	1.5	1.5	2	2 2		2	2	2	2	2

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity. Spool pieces (300 lb flanges) are available in the following sizes (in inches): 3x2-1/2x30, 4x3x30, 6x4x36, 8x6x48, 10x8x48, and 12x8x48.
3. All standard steam nozzle sizes for 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.

Table A6-16. Model CB Blowdown Tank Sizing Information

BOILER HP	WATER (GAL.)
15-20	26
25-30	34
40	47
50-60	55
70-80	80
100	93

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Table A6-17. Sound Pressure Level Summary (50-100 hp)

BOILER HP	50	60	70	80	100
HFO, dBA	79	79	79	79	81
LFO, dBA	78	78	78	78	79
HFG, dBA	77	77	78	78	78
LFG, dBA	72	73	74	75	75

NOTES:

1. Boiler No. followed by an "a" designates hot water boilers furnished in a smaller vessel size with additional tubes in the upper portion of the vessel.
2. Sound Pressure levels measured on boilers operating in various locations and expressed in dBA are as follows:

NOTE: ABBREVIATIONS: HF = High Fire LF = Low Fire O = Oil G = Gas

Table A6-18. Model CB Boiler Sound Pressure Level Details (40 hp)

FIRING RATE FUEL	SOUND LEVEL dBA	OCTAVE BAND SOUND PRESSURE LEVELS IN dB RE .0002 MICROBAR									
		31Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	16kHz
40HP ^A											
LFG	76	73	75	72	74	76	70	67	68	64	57
LFO	77	73	75	75	76	75	72	67	66	66	58
HFG	79	81	78	74	80	78	71	69	68	64	58
HFO	79	72	77	77	81	78	73	69	66	66	58

A. The data shown above was taken on the 40 hp. Since the highest Sound Level is below 80 dBA, no additional 36" diameter Firetubes were tested. If Sound Level predictions are required for the 15 thru 30 hp, use the values shown for the 40 hp.

NOTE: ABBREVIATIONS: HF = High Fire LF = Low Fire O = Oil G = Gas

Table A6-19. Model CB Boiler Sound Pressure Level Details (50 - 100 hp)

FIRING RATE FUEL	SOUND LEVEL dBA	OCTAVE BAND SOUND PRESSURE LEVELS IN dB RE .0002 MICROBAR									
		31Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	16kHz
50 HP											
LFG	72	71	65	71	71	70	68	63	60	53	46
LFO	78	71	76	78	73	72	72	76	61	56	54
HFG	77	72	68	75	76	74	74	66	61	54	47
HFO	79	72	70	75	75	77	77	70	63	56	54
60 HP											
LFG	73	70	75	72	72	73	68	61	56	50	45
LFO	78	68	77	74	74	75	74	71	58	53	48
HFG	77	73	75	72	72	75	76	63	55	50	44
HFO	79	75	75	75	75	77	77	72	59	52	45
70 HP											
LFG	74	70	70	75	74	73	71	62	56	51	46
LFO	78	70	73	77	74	75	74	70	59	53	57
HFG	78	72	72	77	78	75	76	68	58	52	57
HFO	79	73	73	80	77	77	76	70	60	54	48
80 HP											
LFG	75	70	75	75	73	75	76	66	62	62	53
LFO	78	69	77	76	74	76	74	73	63	62	57
HFG	78	72	74	78	75	75	76	57	61	59	52
HFO	79	75	75	75	74	76	75	69	62	59	54
100 HP											
LFG	75	69	69	75	76	73	71	65	63	59	50
LFO	79	68	73	78	78	75	79	76	63	59	54
HFG	78	69	70	77	77	74	74	69	63	59	50
HFO	81	68	70	77	78	78	77	71	64	59	57

NOTES: ABBREVIATIONS: HF = High Fire LF = Low Fire O = Oil G = Gas

Boiler HP followed by an "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in the upper portion of the vessel.

Test Method

The sound pressure levels in the above tables were obtained from tests in accordance with the "ABMA Test Code for the Measurement of Sound from Packages Boilers." In accordance with this code, the sound pressure levels reported were measured on the boiler centerline 4-1/2 feet vertically above the bottom of the base rails and 3 feet horizontally in front of the end of the blower motor or front surface of the electrical cabinet.

Sound Level Meter

The sound level meter used complies with ANSI S1.4, Type 1 (Precision). The readings are taken with the meter set for slow response.

Sound Pressure

On large size boilers, the need for auxiliary equipment, and the necessary interconnecting piping, make it impractical (and sometimes impossible) to provide a boiler testing environment that is suitable for obtaining the data needed to develop Sound Pressure Power levels.

Typical Values

Sound pressure levels (dBA) for identical boilers will vary between boiler rooms. In addition, variations will occur between different people using different sound meters on the same boiler. And finally, no two boilers can be expected to give precisely the same sound levels. For these reasons, we can only predict, but not guarantee, sound levels (dBA).

Octave Band

When predicting sound pressures in octave bands (e.g., dB at 125 Hz), even greater variations between boilers, between sound meters, and between operators can be expected. These larger variations in the low and high frequencies make octave band levels a less reliable method of reporting than A-scale sound levels. (Since A-scale sound levels are dominated by mid-frequency sounds, the A-scale sound levels between two boilers can be in reasonable agreement even though the low and high frequencies of octave band measurement do not closely correspond).

Gas-Fired Burners

Table A6-20 shows minimum gas pressure requirements for Model CB Boilers.

Table A6-21 shows minimum required gas pressure altitude conversion.

Table A6-22 shows maximum gas consumption for natural gas and propane vapor.

Figure A6-7 shows standard gas train sizes and locations for Model CB Firetube Boilers.

Figure A6-8 shows typical gas train piping layouts for multiple boiler applications.

Figure A6-9 shows gas train components.

Oil-Fired Burners

Fuel oil consumption information is shown on the boiler rating sheets in the Dimensions and Rating Section.

Figure A6-10 shows the oil connection sizes and locations for Model CB Boilers firing No. 2 oil.

Figure A6-11 shows the oil connection sizes and locations for Model CB Boilers firing No. 5 and No. 6 oil.

Figure A6-12 through Figure A6-14 show typical oil systems and layouts.

Figure A6-15 shows the detail of an oil transfer tank (day tank) typically utilized to provide a storage reservoir between the oil system supply pump and the boiler oil pump.

No. 6 Oil Piping, Storage Tank Heating

If the oil viscosity exceeds 4,000 SSU at the pumping temperature, tank preheating is required.

Based on the climate conditions for the job location, the minimum pumping temperature can be predicted, and the viscosity for the particular oil at this pumping temperature can be determined.

It is recommended to provide for tank and/or line heating on all No. 6 oil installations to ensure against high viscosities at decreased pumping temperatures. The following are two common methods:

1. Provide a tank suction heater and bundling the steam or water lines to the heater with the oil lines.
2. Provide electric heating equipment on the oil lines and/or in the storage tank.

Notice

The temperature in the oil suction line should not exceed 130 °F as higher temperatures could cause vapor binding of the oil pump and decreased oil flow.

See Figure A6-16 for an example of tank heating method.

Table A6-20. Minimum Required Gas Pressure at Entrance to Gas Train

Boiler Hp	Train Size	Gas Supply Pressure Less Than 27" W.C.		Gas Supply Pressure Up To 10 Psi	
		Regulator Model*	Min. Supply Press "W.C.	Regulator Model*	Min. Supply Press "W.C.
15	1-1/4	Maxitrol 1-1/4", RV-61	4	Maxitrol 1", 210-D	4
20	1-1/4	Maxitrol 1-1/4", RV-61	7	Maxitrol 1", 210-D	7
30	1-1/2	Maxitrol 1-1/2", RV-81	6	Maxitrol 1-1/4", 210-D	7
40	1-1/2	Maxitrol 1-1/2", RV-81	9	Maxitrol 1-1/4", 210-D	10
50	2	Maxitrol 2", RV-91	6	Maxitrol 1-1/4", 210-D	6
60	2	Maxitrol 2", RV-91	7	Maxitrol 1-1/4", 210-D	8
70	2	Maxitrol 2", RV-91	10	Maxitrol 1-1/4", 210-D	11
80	2	Maxitrol 2", RV-91	12	Maxitrol 1-1/2", 210-D	13
100	2	Maxitrol 2", RV-91	12	Maxitrol 1-1/2", 210-D	14

*Maxitrol RV series is standard; 210 series is optional

Table A6-21. Minimum Required Gas Pressure Altitude Conversion

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

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

Table A6-22. Maximum Gas Consumption (CFH) for Natural Gas and Propane Vapor

BOILER HP	TYPE OF GAS AND HEAT CONTENT	
	NATURAL GAS 1000 (Btu/cu-ft)	PROPANE GAS 2550 (Btu/cu-ft)
15	625	245
20	835	330
25	1045	410
30	1255	490
40	1675	655
50	2095	820
60	2510	985
70	2930	1150
80	3350	1315
100	4185	1640

NOTES:

BHP followed by "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in upper portion of vessel.

Table A6-23. Gas Pilot Data

BHP	Connection (inches) NPT	Min. Required Gas Pressure (Up to 700) Inches WC	Max. Permissible Gas Pressure (psig)
50-100	1/2	4	5

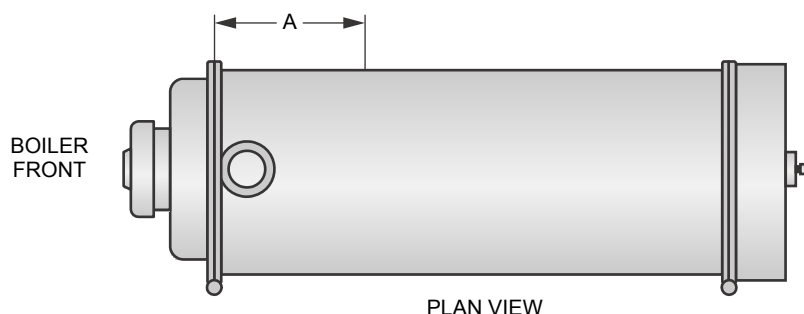
BHP	Manufactured 500 Btu/Cu. Ft	Natural 1000 Btu/ Cu. Ft	Propane 2500 Btu/Cu Ft
50-100	120	60	25

Approximate Gas Usage:

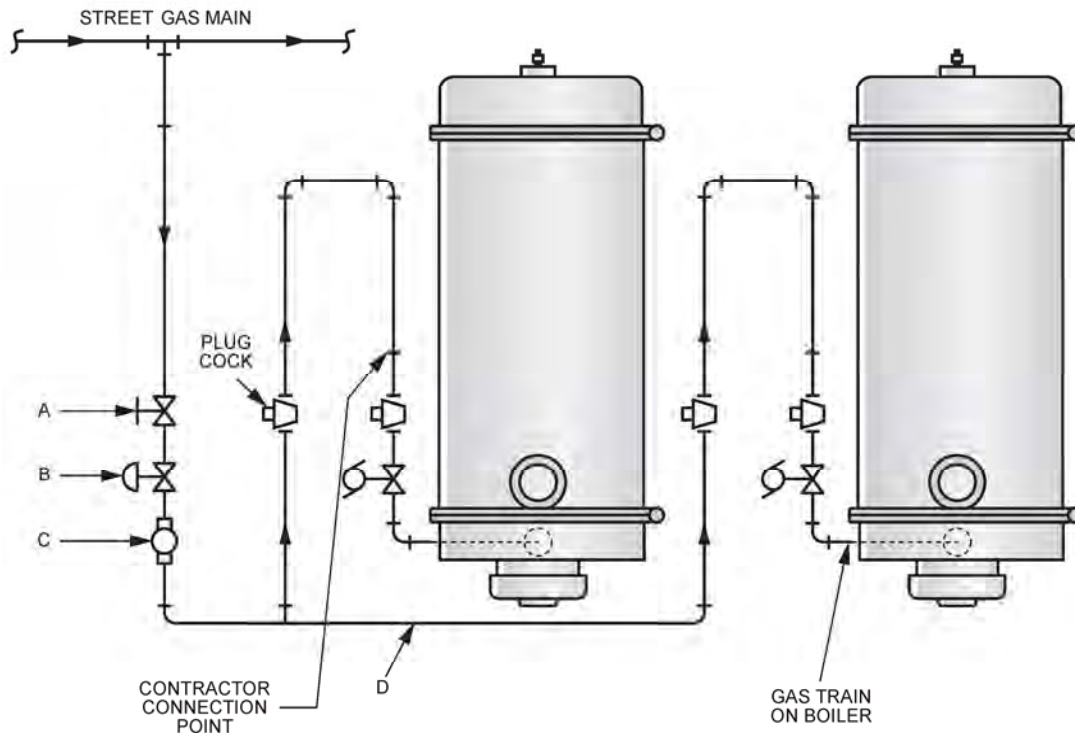
1. Multiply the CFH rate by 0.007 to obtain the number of cu. ft of gas used in 25 sec. (Length of (1) light off).
2. Multiply the number of cu. ft/light (item 1) by the estimated number of lights/hour or per day to obtain the approximate usage in cu. ft/hour or cu. ft/day.

BOILER HP	MODEL CB	
	CONNECTION SIZE (IN.) (NPT)	LOCATION DIMENSION "A" (IN.)
15, 20	1-1/4	65-1/2
30	1-1/2	68
40, 50A	1-1/2	68
50	2	74
60, 70, 80	2	74
100A, 100	2	74

NOTE: BHP followed by "A" designates hot water boiler furnished in a smaller vessel size with additional tubes in upper portion of vessel.

**Figure A6-7. Standard Gas Train Connection Size and Location**

This figure illustrates the basic gas valve arrangement on Cleaver-Brooks Model CB Boiler and shows the contractor's connection point. The valves and controls between the contractor connection point and the gas main in the street are representative of a typical installation. Actual requirements may vary depending on local codes or local gas company requirements which should be investigated prior to preparation of specifications and prior to construction.



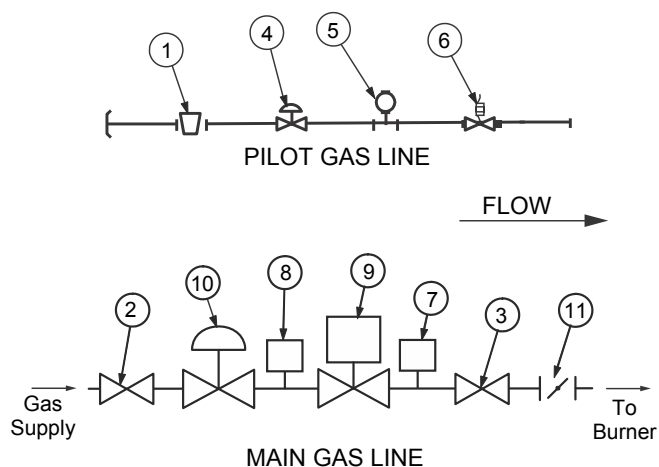
- A. Utilities service valve.
- B. Utilities service regulator.
- C. Gas meter.
- D. Piping from meter to boiler.

The size of the gas line from the meter to the gas pressure regulator at the boiler can be very important if gas pressures are marginal. The gas line sizing is dependent on:

1. Gas pressure at outlet of gas meter (C)
2. Rate of gas flow required, CFH
3. Length of pipe run (D)
4. Pressure required at contractor connection point.

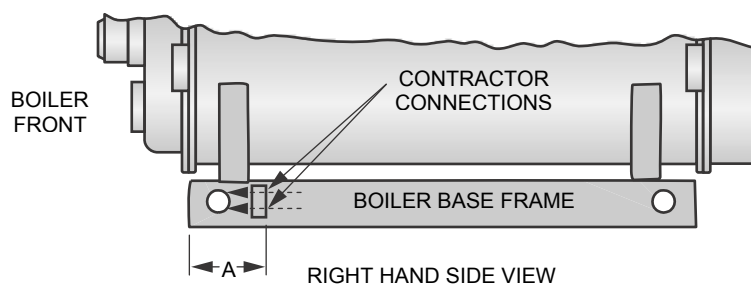
The local gas utility will advise the pressure that is available at the outlet of their meter.

Figure A6-8. Typical Gas Piping Layout



ITEM	DESCRIPTION	INS	UL			FM		CSD-1		
		BOILER HP	15-20	30-50	60-100	15-20	30-100	15-20	30-50	60-100
1	Pilot Shut Off Cock		x	x	x	x	x	x	x	x
2	Manual Shut Off Valve		x	x	x	x	x	x	x	x
3	Manual Shut Off Valve		x	x	x	x	x	x	x	x
4	Pilot Pressure Regulator		x	x	x	x	x	x	x	x
5	Pilot Pressure Gauge		x	x	x	x	x	x	x	x
6	Gas Pilot Valve		x	x	x	x	x	x	x	x
7	High Gas Pressure Switch				x	x	x			x
8	Low Gas Pressure Switch				x	x	x			x
9	Main Gas Valve with POC		x	x	x	x	x	x	x	x
10	Main Gas Regulator		x	x	x	x	x	x	x	x
11	Butterfly Valve			x	x		x		x	x

Figure A6-9. Model CB Gas Train Components



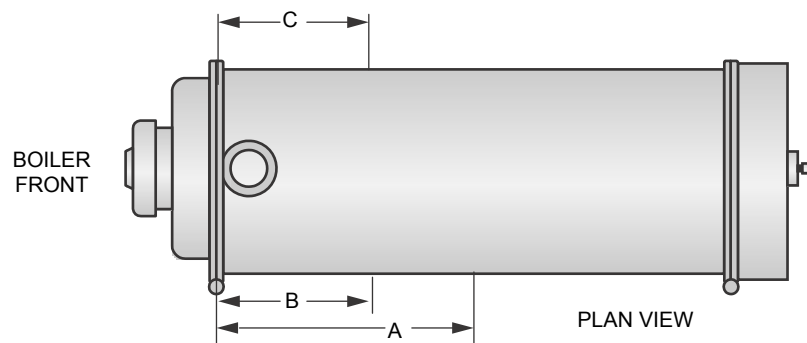
BOILER HP	SUPPLY AND RETURN CONN SIZES (IN.) (NPT)	DIM. A (IN.)	MODEL CB RECOMMENDED OIL LINE ^A SIZES (STANDARD PIPE) (IN.)		
			STORAGE TANK TO BOILER OR PUMP CONNECT	PUMP TO BOILER	RETURN LINE TO TANK
15, 20	3/4	8-1/4	3/4	NONE	3/4
30, 40	3/4	8-1/4	3/4	NONE	3/4
50, 60	3/4	11-1/2	3/4	1	3/4
70, 80	3/4	11-1/2	3/4	1	3/4
100	3/4	11-1/2	1	1	1

NOTE: See No. 2 Oil Line Sizing Instruction for systems with other conditions.

A. For suction line condition with a maximum of 10 Feet of lift and a total of 100 equivalent feet of suction line.

B. This table is based on a single boiler installation.

Figure A6-10. No. 2 Oil Connection Size, Location and Recommended Line Sizes



BOILER HP	SUPPLY CONNECTION		RETURN CONNECTION		RECOMMENDED OIL LINE SIZES (STANDARD PIPE) (IN.)		
	SIZE (IN.) (NPT)	A (IN.)	SIZE (IN.) (NPT)	B (IN.)	STORAGE TANK TO PUMP	PUMP TO BOILER	RETURN LINE TO TANK
50, 60, 70, 80, 100	1-1/4	27-3/4	3/4	19-3/4	2	1-1/4	1-1/4

NOTES:

1. All dimensions in inches.

2. For suction lines with a maximum of 10 feet of lift and a total of 100 equivalent feet of suction line.

3. This table is based on a single boiler installation.

Figure A6-11. No. 6 Oil Connection Size, Location and Recommended Line Sizes, Model CB Boiler

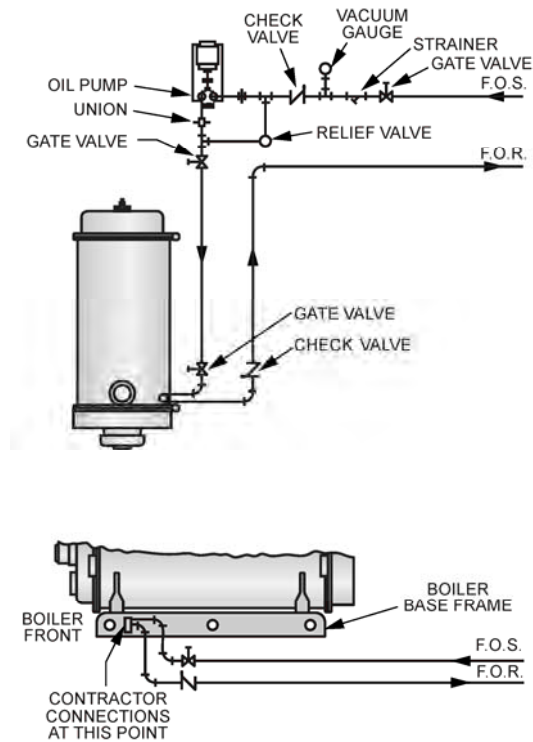


Figure A6-12. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump

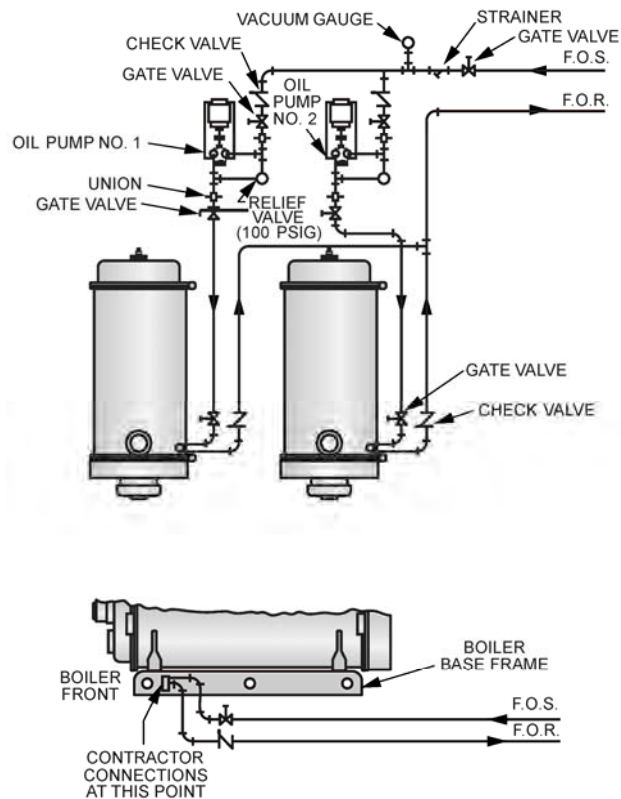


Figure A6-13. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

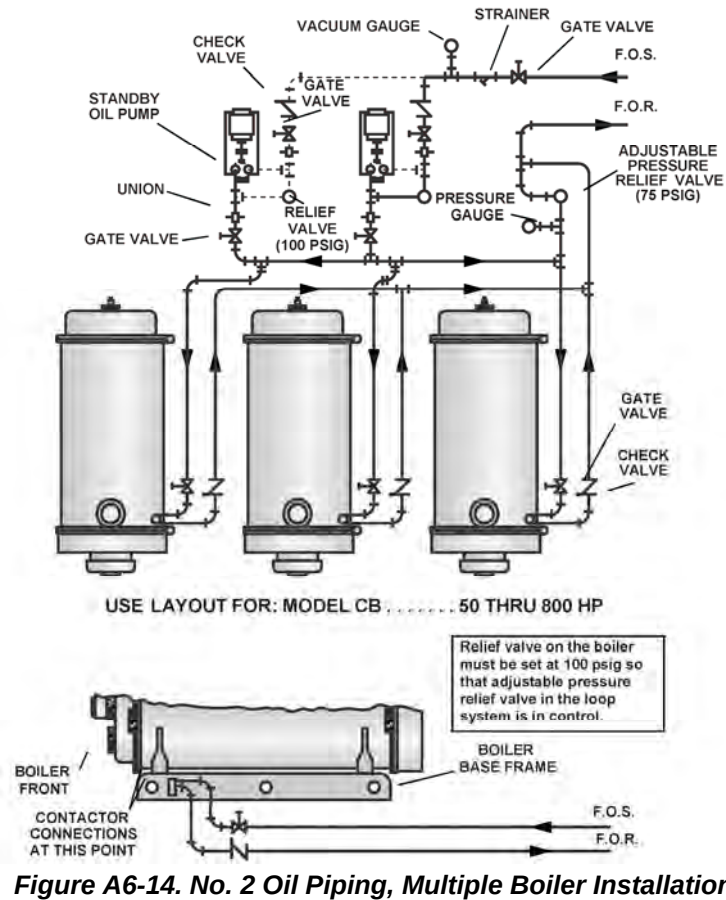


Figure A6-14. No. 2 Oil Piping, Multiple Boiler Installation

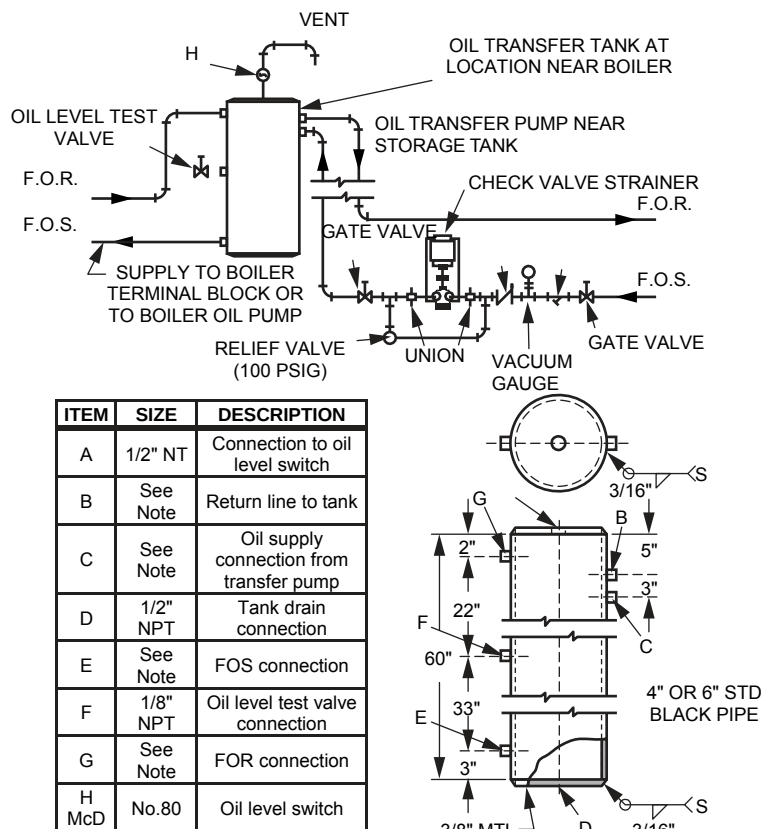


Figure A6-15. No. 2 Oil Piping

(For elevated boiler room locations using an oil transfer pump and tank)

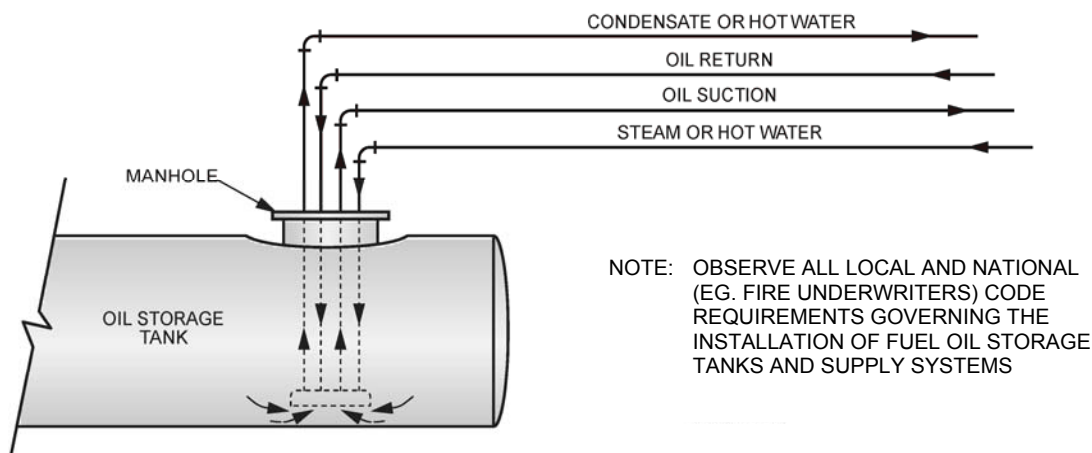


Figure A6-16. Typical Fuel Storage Tank Arrangement

Boiler Room Information

Figure A6-17 shows typical boiler room length requirements.

Figure A6-18 shows typical boiler room width requirements.

Figure A6-19 shows typical breeching arrangements.

Stack Support Capabilities

Cleaver-Brooks Firetube Boilers 15 hp through 100 hp can support up to 1,000 lbs without additional support. Firetube boilers 125 hp through 800 hp can support up to 2,000 lbs without additional support.

Firetube sizes 250 hp through 800 hp can be reinforced to support 3,000 lbs.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Model CB is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. For boiler sizes 50 – 800 horsepower, the allowable pressure range is –0.5" W.C. to

+0.5" W.C. The maximum pressure variation at any firing rate for the boiler is 0.5" W.C. For boiler sizes 15 – 40 horsepower, the allowable pressure range is –0.25" W.C. to +0.25" W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) 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.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - E. Size the openings by using the formula:
$$\text{Area (sq-ft)} = \text{cfm/fpm}$$
2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp

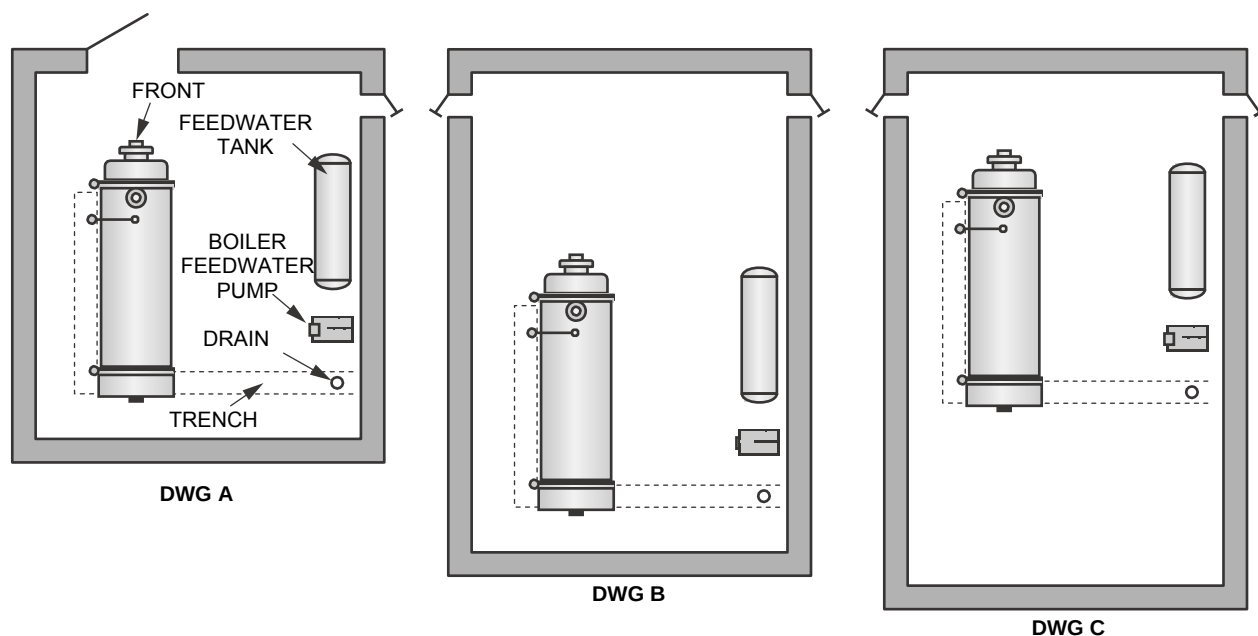
- C. Total recommended air, 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in boiler room (fpm).
- A. From floor to (7) foot height - 250 fpm.
- B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} / 250 = 3000 / 250 = 12$ Sq-ft total.
- Area/Opening: $12 / 2 = 6$ sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.

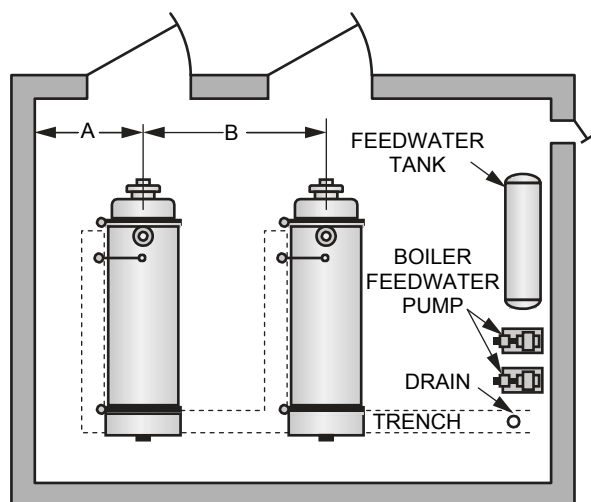
If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

3. A slightly longer boiler room (Dwg C) is obtained by allowing for possible future tube replacement from the rear of the boiler. Allowance for door swing at the front provides sufficient aisle and working space at the front.

Figure A6-17. Boiler Room Length (Typical Layout)

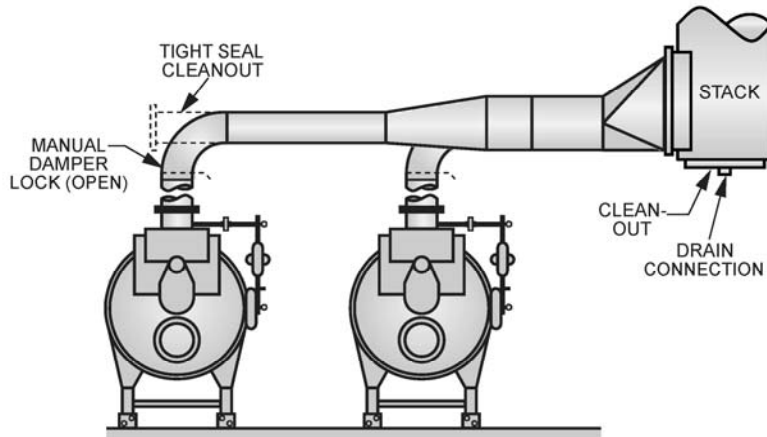


BOILER HP	15-40	50-100
Dimension A	75"	81"
Dimension B	103"	115"

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of: 42" - 15-100 hp
If space permits, this aisle should be widened.

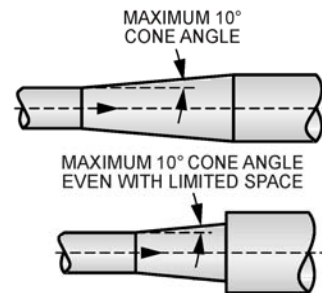
Figure A6-18. Boiler Room Width (Typical Layout)



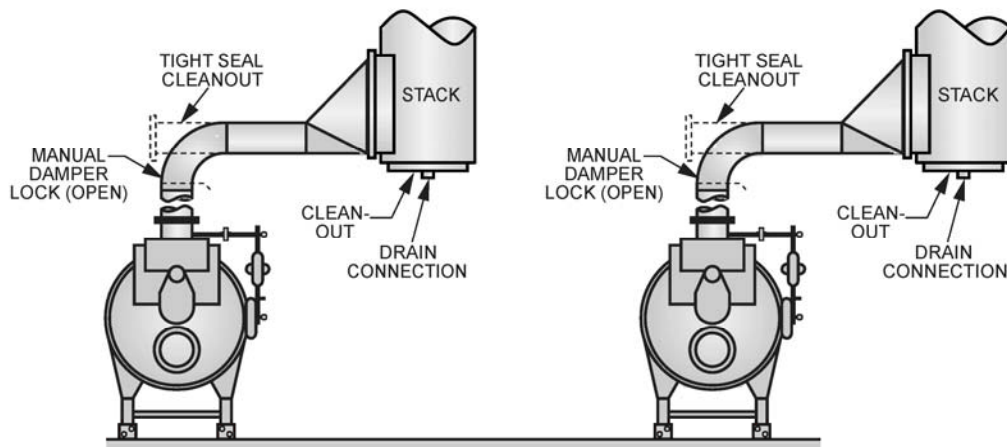
MULTIPLE BOILERS WITH A COMMON STACK

NOTE: These stack breaching arrangements for multiple boilers are typical and not intended for your specific design requirements. For additional information, review Section F, Stacks.

Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on your specific criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of stack and breeching design.



DETAIL OF TRANSITION PIECES



MULTIPLE BOILERS WITH INDIVIDUAL STACKS

Figure A6-19. Breeching Arrangement

Notes

SECTION A6
MODEL CB 15-100 HP

SAMPLE SPECIFICATIONS - STEAM

1.01 Boiler Characteristics (Steam)..... A6-36

1.02 General Boiler Design..... A6-36

1.03 Steam Boiler Trim A6-37

1.04 Burner and Controls..... A6-38

1.05 Efficiency Guarantee A6-44

1.06 Warranty A6-45

1.07 Shop Tests..... A6-45

1.08 Start-up Service A6-45

MODEL CB 15-100 HP

MODEL CB STEAM BOILER (15-100 HP, STEAM 15-350 PSIG)

The following sample specification is provided by Cleaver-Brooks to assist you in meeting your customer's specific needs and application.

A separate specification for steam boilers and hot water boilers is provided. Burner specifications and detailed control specifications for CB 780 Flame Safeguard control and the CB-HAWK Flame Safeguard control are included. See Section D, Controls, for additional information on control options.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.

1.01 Boiler Characteristics (Steam)

- A. The Steam Boiler shall be Cleaver-Brooks Model CB, Fuel Series _____ (100, 200, 400, 600, 700), _____ hp designed for _____ psig (15, 150, 200, or other psig steam). The maximum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 _____ oil and/or natural gas, _____ Btu/cu-ft. Electrical power available will be _____ Volt _____ Phase _____ Cycle.

1.02 General Boiler Design

- A. The boiler shall be a four pass horizontal firetube updraft boiler with five (5) square feet of heating surface per rated boiler horsepower. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls.

The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label, except in the case where 50 Hz has been selected.

1. The boiler shall be completely preassembled and fire tested at the factory.
The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
2. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, ASME CSD-1).
- B. Boiler Shell (Steam)
 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 2. Two lifting eyes shall be located on top of the boiler.
 3. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.

4. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
 5. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
 6. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The boiler shall be furnished with adequate handholes to facilitate boiler inspection and cleaning.
 7. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting:
 - 15-100 hp. 1000 lbs and shall contain a stack thermometer
 8. The boiler shell shall contain a chemical feed connection.
- C. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
- D. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
- E. The entire boiler base frame and other components shall be factory painted before shipment using a hard finish enamel coating.

1.03 Steam Boiler Trim

- A. Water Column
A water column shall be located on the right hand side of the boiler complete with gauge glass set and water column blowdown valves.
1. Feedwater Pump Control
The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feed water pump maintaining the boiler water level within normal limits.
 2. Low Water Cutoff
The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.
- B. Auxiliary Low Water Cutoff
Auxiliary low water cutoff manual reset shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.
- C. Steam Pressure Gauge
The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- D. Safety Valves
Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- E. Steam Pressure Controls
The steam pressure controls to regulate burner operation shall be mounted near the water column. Controls shall be a high limit (manual reset), operating limit (auto reset), and firing rate control (30-100 hp).

1.04 Burner and Controls**A. Mode of Operation**

Select one of the following:

- 15 and 20 hp. Burner operation shall be on-off principle.
- 30 and 40 hp. Burner operation shall be high-low-off principle. The burner shall always return to low fire position for ignition.
- 50 - 100 hp. Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.

B. Blower

1. Air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
2. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

C. Combustion Air Control

Select one of the following:

- 15 and 20 hp. Combustion air damper shall be manually set for proper air-fuel ratios.
- 30 and 40 hp. Combustion air damper shall be linked to damper motor. Auxiliary switch on the damper motor shall control high or low firing rate.
- 50 - 100 hp. Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.

D. Fuel Specification and Piping

Select one of the following fuel types:

- Fuel series 700 - Gas fired (4.4.1).
- Fuel series 100 - Light oil (No. 2) fired (4.4.2).
- Fuel series 200 - Light oil or gas fired (4.4.3).
- Fuel series 600 - No. 6 oil fired (4.4.4).
- Fuel series 400 - No. oil or gas fired (4.4.5).

1. Fuel Series 700 - Gas Fired

- a. Burner Type - The burner shall be integral with the front head of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel.
- b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
- c. Gas Burner Piping - Gas burner piping on all units shall include pressure regulator, primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low

water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock on butterfly valve shall be furnished at entrance to gas train. Select one of the following:

- 1) 15-50 hp. Burners equipped as shown above.
 - 2) 60-100 hp. High and low gas pressure switches shall be provided.
- d. Burner Turndown - Select one of the following:
- 1) 15 and 20 hp. Burner shall operate on the on/off principle.
 - 2) 30 and 40 hp. Burner shall operate on the high-low-off principle with a turndown of 3:1 when firing natural gas.
 - 3) 50-100 hp. Turndown range of burner shall be 4:1 when firing natural gas.
2. Fuel Series 100 - Light Oil Fired
- a. Burner Type - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil.
3. Oil Pilot - The oil pilot shall be air atomizing type with automatic electric ignition and include oil solenoid valve. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until flame has been established.
4. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Select one of the following:
- 15 hp through 40 hp. The oil pump shall be integral with the burner and belt driven from the blower motor.
 - 50 hp through 100 hp. Separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
5. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. Select one of the following:
- 50 hp through 100 hp. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner.
 - 70 hp through 100 hp. A low oil pressure switch shall be included in the oil piping.
6. Low Pressure Air Atomizing - Select one of the following:
- 15 hp through 40 hp. Belt driven air compressor, lubricating oil tank, oil level indicator, inlet air filter, air pressure gauge, and low atomizing air pressure switch.
 - 50 hp through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
7. Burner Turndown - Select one of the following:
- 15 and 20 hp. Burner shall operate on the on/off principle.
 - 30 and 40 hp. Burner shall operate on the high-low-off principle with a turndown of 3:1 when firing No. 2 oil.

- 50 hp through 100 hp. Turndown range shall be 4:1 when firing No. 2 oil.

E. Fuel Series 200 - Light Oil or Gas Fired

1. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas.
2. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Select one of the following:
 - 1) 15 hp through 40 hp. The oil pump shall be integral with the burner and belt driven from the blower motor.
 - 2) 50 hp through 100 hp. Separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
4. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. Select one of the following:
 - a. 50 hp through 100 hp. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner.
 - b. 70 hp through 100 hp. A low oil pressure switch shall be included in the oil piping.
5. Low pressure air atomizing. Select one of the following:
 - a. 15 hp through 40 hp. Belt driven air compressor, lubricating oil tank, oil level indicator, inlet air filter, air pressure gauge and low atomizing air pressure switch.
 - b. 50 hp through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
6. Gas Burner
 - a. Gas Burner Piping - gas burner piping on all units shall include pressure regulator, primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 15-50 hp. Burners equipped as shown above.
 - 2) 60-100 hp. High and low gas pressure switches shall be provided.
7. Burner Turndown
Select one of the following:

- 15 and 20 hp. Burner shall operate on the on/off principle.
- 30 and 40 hp. Burner shall operate on the high-low-off principle with a turndown of 3:1
- 50-100 hp. Turndown range of the burner shall be 4:1.

F. Fuel Series 600 - No. 6 Oil Fired

1. Burner Type - The burner shall be integral with the front head of the boiler and low pressure air atomizing type approved for operation with CS12-48, Commercial No. 6 Oil.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
3. Oil Pump - An oil pump set with a capacity of approximately twice the maximum burning rate shall be included.

A separate motor driven pump set shall be included shipped loose for location favorable to the oil storage tank.

4. Oil Burner Piping - A fuel oil controller combining all of the fuel oil controls into a single casing shall be provided. Oil pressure regulating devices, oil metering controls, solenoid shutoff valves, high and low oil temperature switches and necessary pressure and temperature gauges shall be included in this packaged assembly mounted on the front door of the boiler. A fuel strainer shall also be provided, mounted to the boiler. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. Flexible hoses shall be provided to allow easy removal of the nozzle for inspection when it is placed in the vice jaws located on the front door of the boiler.

The metering valve shall permit circulation of hot oil to the burner at all times. The burner drawer oil piping and nozzle shall be purged of oil on each shutdown.

For 70 through 100 hp, a low oil pressure switch shall be included in the oil piping.

5. Low Pressure Air Atomizing - Select one of the following:
 - a. 50 through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
6. Oil Preheat

The oil shall be preheated by a steam heater and electric heater, each with thermostatic control. Both heaters shall be installed in a single compact shell mounted, piped, and wired on the boiler. The thermostatic controls shall be set to cut-out the electric heater when steam is available. Select one of the following:

 - a. 50 through 100 hp. Electric preheater size shall be 5 kW.

G. Fuel Series 400 - No. 6 Oil or Gas Fired

1. Burner Type - The burner shall be integral with the front head of the boiler and shall be a combination of the low pressure atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 6 oil or natural gas.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

3. Oil Burner

- a. Oil Pump - An oil pump set with a capacity of approximately twice the maximum burning rate shall be included.
- b. Oil Burner Piping - A fuel oil controller combining all of the fuel oil controls into a single casing shall be provided. Oil pressure regulating devices, oil metering controls, solenoid shutoff valves, high and low oil temperature switches, and the necessary pressure and temperature gauges shall be included in this packaged assembly mounted on the front door of the boiler. A fuel strainer shall also be provided, mounted to the boiler. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. Flexible hoses shall be provided to allow easy removal of the nozzle for inspection when it is placed in the vice jaws located on the front door of the boiler. The metering valve shall permit circulation of hot oil to the burner at all times. The burner drawer oil piping and nozzle shall be purged of oil at each shutdown.

For 70 through 100 hp, a low oil pressure switch shall be included in the oil piping.

1. Low Pressure Air Atomizing - Select one of the following:

- a. 50 through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

2. Oil Preheat

The oil shall be preheated by a steam heater and electric heater, each with thermostatic control. Both heaters shall be installed in a single compact shell mounted, piped, and wired on the boiler. The thermostatic controls shall be set to cut-out the electric heater when steam is available.

- a. 50 through 100 hp. Electric preheater size shall be 5 kW.

3. Gas Burner

- a. Gas Burner Piping - Gas burner piping on all units shall include pressure regulator, primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as means for a tightness check of the primary shutoff valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:

- 1) 50 hp. Burner equipped as shown above.
- 2) 60 through 100 hp. High and low gas pressure switches shall be provided.

- b. Burner Turndown - Turndown shall be 4:1.

H. Boiler Flame Safeguard Controller and Control Panel

1. CB780E Flame Safeguard

- a. Boilers with CB780E Control - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and alpha-numeric "first out" fault indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The

sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, locking interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

- b. Control Panel - The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.

The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil and heavy oil fired boilers the panel will contain the fuel selector and/or oil heater selector switch.

The panel shall contain the following lights and switches:

Lights

- White - load demanded.
- White - fuel valve open.
- Red - low water.
- Red - flame failure.

Control Switches

- Burner On-Off.
- Manual-Automatic.
- Manual Firing Rate Control.

2. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
3. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
4. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.
5. Control Panel: The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, indicating lights and selector switches.

Panel shall have a removable sub-base for mounting the flame safeguard controller, and terminal blocks. For combination gas-oil and heavy oil fired boilers the panel will contain the fuel selector and/or oil heater selector switch.

6. Oil, heat, and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
7. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
8. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

1.05 Efficiency Guarantee

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve _____ fuel-to-steam efficiency at 100% firing rate when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

A. Fuel specification used to determine boiler efficiency:

1. Natural Gas

Carbon, % (wt) = 69.98

Hydrogen, % (wt) = 22.31

Sulfur, % (wt) = 0.0

Heating value, Btu/lb = 21,830

2. No. 2 Oil

Carbon, % (wt) = 85.8

Hydrogen, % (wt) = 12.7

Sulfur, % (wt) = 0.2

Heating value, Btu/lb = 19,420

3. No. 6 Oil

Carbon, % (wt) = 86.6

Hydrogen, % (wt) = 10.9

Sulfur, % (wt) = 2.09

Heating value, Btu/lb = 18,830

B. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.

C. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).

D. Any efficiency verification testing will be based on the stack loss method.

EXECUTION

1.06 Warranty

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

1.07 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

1.08 Start-up Service

After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.

- A. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

Notes

SECTION A6
MODEL CB 15-100 HP

SAMPLE SPECIFICATIONS - HOT WATER

1.01 Boiler Characteristics (Hot Water) A6-48

1.02 General Boiler Design..... A6-48

1.03 Hot Water Boiler Trim A6-49

1.04 Burner and Controls..... A6-49

1.05 Blower..... A6-49

1.06 Combustion Air Control..... A6-50

1.07 Fuel Specification and Piping A6-50

1.08 Efficiency Guarantee A6-56

1.09 Warranty A6-56

2.01 Shop Tests..... A6-57

MODEL CB HOT WATER BOILER (15-100 HP, 30 PSIG, 125 PSIG)

1.01 Boiler Characteristics (Hot Water)

- A. The Hot Water Boiler shall be Cleaver-Brooks Model CB, Fuel Series _____ (100, 200, 400, 600, 700), _____ hp designed for _____ psig (30, 125, or other psig hot water). The maximum water temperature will be _____ degree F, and the maximum system temperature drop will be _____ degree F.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 _____ oil and/or natural gas, _____ Btu/cu-ft. Electrical power available will be _____ Volt _____ Phase _____ Cycle.

1.02 General Boiler Design

- A. The boiler shall be a four pass horizontal firetube updraft boiler with five (5) square feet of heating surface per rated boiler horsepower. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls. The complete package boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label.
 - 1. The boiler shall be completely preassembled and fire tested at the factory.
The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
 - 2. The boiler shall be built to comply with the following insurance and codes _____ (Factory Mutual, ASME CSD-1).
- B. Boiler Shell (Hot Water)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 - 2. The hot water return and outlet connections shall be located on the top center line of the boiler. The boiler shall be designated to rapidly mix the return water with the boiler water. Forced internal circulation shall be used.
 - 3. A dip tube shall be included as an integral part of the water outlet.
 - 4. Two lifting eyes shall be located on top of the boiler.
 - 5. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
 - 6. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
 - 7. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
 - 8. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The shell must be furnished with adequate handholes to facilitate boiler inspection and cleaning.

9. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 1000 lbs and shall contain a stack thermometer
- C. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
- D. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
- E. The entire boiler based frame and other components shall be factory painted before shipment using a hard finish enamel coating.

1.03 Hot Water Boiler Trim

- A. Low Water Cutoff
A low water cutoff control (manual reset) shall be mounted on the top centerline of the boiler wired into the burner control circuit to prevent burner operation if boiler water falls below a safe level.
- B. Pressure and Temperature Gauges
Pressure and temperature gauges shall be mounted on the boiler with temperature sensing element located adjacent to the hot water outlet.
- C. Relief Valves
Water relief valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- D. Temperature Controls
Temperature controls to regulate burner operation shall be mounted on the unit with temperature sensing elements located adjacent to the hot water outlet. Controls shall be high limit (manual reset), operating limit (auto reset), and firing rate control (30-100 hp).

1.04 Burner and Controls

- A. Mode of Operation
Select one of the following:
 - 15 and 20 hp. Burner operation shall be on-off principle.
 - 30 and 40 hp. Burner operation shall be high-low-off principle. The burner shall always return to low fire position for ignition.
 - 50 - 100 hp. Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.

1.05 Blower

- A. Air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
- B. Maximum sound level of the boiler/burner package shall not exceed _____ dbA (when measured in accordance with ABMA Sound Test Standards).
- C. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

1.06 Combustion Air Control

Select one of the following:

- 15 and 20 hp. Combustion air damper shall be manually set for proper air-fuel ratios.
- 30 and 40 hp. Combustion air damper shall be linked to damper motor. Auxiliary switch on the damper motor shall control high or low firing rate.
- 50 - 100 hp. Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor (remove this sentence when a CB-HAWK Flame Safeguard is used).

1.07 Fuel Specification and Piping

Select one of the following fuel types:

- Fuel series 700 - Gas fired (4.4.1).
- Fuel series 100 - Light oil (No. 2) fired (4.4.2).
- Fuel series 200 - Light oil or gas fired (4.4.3).
- Fuel series 600 - No. 6 oil fired (4.4.4).
- Fuel series 400 - No. oil or gas fired (4.4.5).

A. Fuel Series 700 - Gas Fired

1. Burner Type - The burner shall be integral with the front head of the boiler and of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
3. Gas Burner Piping - Gas burner piping on all units shall include pressure regulator, primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock on butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - a. 15-50 hp. Burners equipped as shown above.
 - b. 60-100 hp. High and low gas pressure switches shall be provided.
4. Burner Turndown - Select one of the following:
 - a. 15 and 20 hp. Burner shall operate on the on/off principle.
 - b. 30 and 40 hp. Burner shall operate on the high-low-off principle with a turndown of 3:1 when firing natural gas.
 - c. 50-100 hp. Turndown range of burner shall be 4:1 when firing natural gas.

B. Fuel Series 100 - Light Oil Fired

1. Burner Type - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil.
 2. Oil Pilot - The oil pilot shall be air atomizing type with automatic electric ignition and include oil solenoid valve. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until flame has been established.
 3. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Select one of the following:
 - a. 15 hp through 40 hp. The oil pump shall be integral with the burner and belt driven from the blower motor.
 - b. 50 hp through 100 hp. Separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
 4. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. Select one of the following:
 - a. 50 hp through 100 hp. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner.
 - b. 70 hp through 100 hp. A low oil pressure switch shall be included in the oil piping.
 5. Low Pressure Air Atomizing - Select one of the following:
 - 15 hp through 40 hp. Belt driven air compressor, lubricating oil tank, oil level indicator, inlet air filter, air pressure gauge, and low atomizing air pressure switch.
 - 50 hp through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
 6. Burner Turndown - Turndown range of the burner shall be 4:1 when firing No. 2 oil. Select one of the following:
 - 15 and 20 hp. Burner shall operate on the on/off principle.
 - 30 and 40 hp. Burner shall operate on the high-low-off principle with a turndown of 3:1 when firing No. 2 oil.
 - 50 hp through 100 hp. Turndown range shall be 4:1 when firing No. 2 oil.
- C. Fuel Series 200 - Light Oil or Gas Fired
1. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas.
 2. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. Select one of the following:

- 1) 15 hp through 40 hp. The oil pump shall be integral with the burner and belt driven from the blower motor.
- 2) 50 hp through 100 hp. Separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
- b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. Select one of the following:
 - 1) 50 hp through 100 hp. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner.
 - 2) 70 hp through 100 hp. A low oil pressure switch shall be included in the oil piping.
 - 3) Low pressure air atomizing - Select one of the following:
 - 15 hp through 40 hp. Belt driven air compressor, lubricating oil tank, oil level indicator, inlet air filter, air pressure gauge and low atomizing air pressure switch.
 - 50 hp through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.
4. Gas Burner
 - a. Gas Burner Piping - gas burner piping on all units shall include pressure regulator, primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train.

Select one of the following:

 - 15-50 hp. Burners equipped as shown above.
 - 60-100 hp. High and low gas pressure switches shall be provided.
5. Burner Turndown - Select one of the following:
 - 15 and 20 hp. Burner shall operate on the on/off principle.
 - 30 and 40 hp. Burner shall operate on the high-low-off principle with a turndown of 3:1
 - 50-100 hp. Turndown range of the burner shall be 4:1.
6. Fuel Series 600 - No. 6 Oil Fired
 - a. Burner Type - The burner shall be integral with the front head of the boiler and low pressure air atomizing type approved for operation with CS12-48, Commercial No. 6 Oil.
 - b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall

include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

- c. Oil Pump - An oil pump set with a capacity of approximately twice the maximum burning rate shall be included.

A separate motor driven pump set shall be included shipped loose for location favorable to the oil storage tank.

- d. Oil Burner Piping - A fuel oil controller combining all of the fuel oil controls into a single casing shall be provided. Oil pressure regulating devices, oil metering controls, solenoid shutoff valves, high and low oil temperature switches and necessary pressure and temperature gauges shall be included in this packaged assembly mounted on the front door of the boiler. A fuel strainer shall also be provided, mounted to the boiler. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. Flexible hoses shall be provided to allow easy removal of the nozzle for inspection when it is placed in the vice jaws located on the front door of the boiler.

The metering valve shall permit circulation of hot oil to the burner at all times. The burner drawer oil piping and nozzle shall be purged of oil on each shutdown.

For 70 through 100 hp, a low oil pressure switch shall be included in the oil piping.

- e. Low Pressure Air Atomizing

- 1) 50 through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

- f. Oil Preheat

The oil shall be preheated by a safety type water-to-water-to-oil preheating system in conjunction with an electric preheater, each with thermostatic control. Both heaters shall be mounted, piped, and wired on the boiler.

- 1) 50 through 100 hp. Electric preheater size shall be 5 kW.

7. Fuel Series 400 - No. 6 Oil or Gas Fired

- a. Burner Type - The burner shall be integral with the front head of the boiler and shall be a combination of the low pressure atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 6 oil or natural gas.
- b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.

8. Oil Burner

- a. Oil Pump - An oil pump set with a capacity of approximately twice the maximum burning rate shall be included.
- b. Oil Burner Piping - A fuel oil controller combining all of the fuel oil controls into a single casing shall be provided. Oil pressure regulating devices, oil metering controls, solenoid shutoff valves, high and low oil temperature switches, and the necessary pressure and temperature gauges shall be included in this packaged assembly mounted on the front door of the boiler. A fuel strainer shall also be provided, mounted to the boiler. A single tip retractable nozzle shall be used for the low pressure air atomizing burner.

Flexible hoses shall be provided to allow easy removal of the nozzle for inspection when it is placed in the vice jaws located on the front door of the boiler. The metering valve shall permit circulation of hot oil to the burner at all times. The burner drawer oil piping and nozzle shall be purged of oil at each shutdown.

For 70 through 100 hp, a low oil pressure switch shall be included in the oil piping.

9. Low Pressure Air Atomizing

- a. 50 through 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch.

10. Oil Preheat

The oil shall be preheated by a safety type water-to-water-to-oil preheating system in conjunction with an electric preheater, each with thermostatic control. Both heaters shall be mounted, piped, and wired on the boiler. Select one of the following:

- a. 50 through 100 hp. Electric preheater size shall be 5 kW.

11. Gas Burner

- a. Gas Burner Piping - Gas burner piping on all units shall include pressure regulator, primary gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The main gas valve(s) shall be wired to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as means for a tightness check of the primary shutoff valve. An additional plug cock or butterfly valve shall be furnished at entrance to gas train. Select one of the following:
 - 1) 50 hp. Burner equipped as shown above.
 - 2) 60 through 100 hp. High and low gas pressure switches shall be provided.
 - 3) Burner Turndown - Turndown shall be 4:1.

D. Boiler Flame Safeguard Controller and Control Panel

1. CB780E Flame Safeguard

- 2. 4.5.1.1 Boilers with CB780E Control - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

3. Control Panel: The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.

The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil and heavy oil fired boilers the panel will contain the fuel selector and/or oil heater selector switch.

The panel shall contain the following lights and switches:

- a. Lights
 - White - load demanded.
 - White - fuel valve open.
 - Red - low water.
 - Red - flame failure.
- b. Control Switches
 - Burner On-Off.
 - Manual-Automatic.
 - Manual Firing Rate Control.
4. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
5. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
6. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.
7. Control Panel: The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, indicating lights and selector switches.

Panel shall have a removable sub-base for mounting the flame safeguard controller, and terminal blocks. For combination gas-oil and heavy oil fired boilers the panel will contain the fuel selector and/or oil heater selector switch.
8. Oil, heat, and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
9. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
10. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

1.08 Efficiency Guarantee

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve _____ fuel-to-steam efficiency at 100% firing rate when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (add efficiency guarantees at 25%,

50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on the following conditions.

A. Fuel specification used to determine boiler efficiency:

1. Natural Gas

Carbon, % (wt) = 69.98

Hydrogen, % (wt) = 22.31

Sulfur, % (wt) = 0.0

Heating value, Btu/lb = 21,830

2. No. 2 Oil

Carbon, % (wt) = 85.8

Hydrogen, % (wt) = 12.7

Sulfur, % (wt) = 0.2

Heating value, Btu/lb = 19,420

3. No. 6 Oil

Carbon, % (wt) = 86.6

Hydrogen, % (wt) = 10.9

Sulfur, % (wt) = 2.09

Heating value, Btu/lb = 18,830

B. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.

C. Efficiencies are based on manufacturer's published radiation and convection losses. (For Cleaver-Brooks radiation and convection losses, see Boiler Efficiency Facts Guide, publication number CB-7767).

D. Any efficiency verification testing will be based on the stack loss method.

1.09 Warranty

A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

EXECUTION

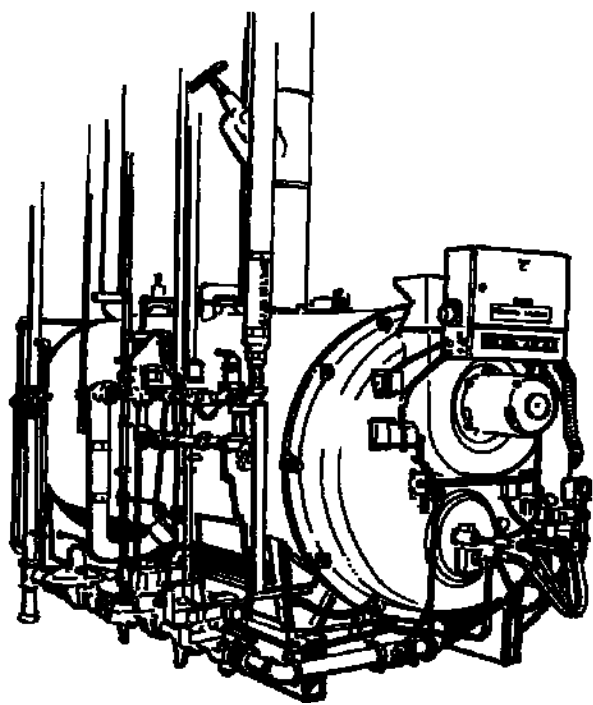
2.01 Shop Tests

- A. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.
- B. Start-up Service
 - 1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

Notes

MODEL CB-OHIO SPECIAL

100 - 225 HP
Steam
Dryback Integral Burner



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FEATURES AND BENEFITS

The Cleaver-Brooks Ohio Special Firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks specifically for operation in the state of Ohio, under the rules and regulations for unattended units. The unique design of the Ohio Special Boiler serves your steam needs and reduces unnecessary labor costs. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firetube boilers, the following features apply to the Ohio Specials.

Unique Dimple Tube Design:

- Ensures high gas turbulence and increased efficiency without turbulators, spinners, and other high maintenance devices.
- Dimple tubes also reduce the film coefficient on the gas side to transfer more heat, thus achieving greater output with less heating surface.

358 Square Feet of Heating Surface:

- The greatest amount offered in any packaged boiler for unattended steam boiler operation in Ohio - means long life and years of service at the high efficiencies.

Low Furnace Location:

- Furnace located well below water level with generous clearance from bottom of boiler, allowing proper circulation.
- Low furnace provides additional safety margin between furnace and water level.
- Reduces water carryover, producing drier steam.

PRODUCT OFFERING

Cleaver-Brooks Ohio Special Firetube boilers are available high pressure steam designs. Burners are available to fire natural gas, light oil, or a combination of oil and gas.

Ohio Special Boilers include:

- Four-pass dryback design (100 hp).
- Two-pass dryback design (125 - 225 hp).
- Two-pass wetback design (125 - 200 hp).
- 15 psig low pressure steam.
- 150, 200, and 250 psig high pressure steam
- Natural gas or light oil firing.

Available options: For option details, contact your local Cleaver-Brooks authorized representative. In summary, options include the following:

Boiler Options

- Drain valves.

- Additional screwed or flanged trappings.
- Surge load baffles.
- Seismic design.
- Blowdown valves.
- Non-return valves.
- Feedwater valves and regulators.
- Special doors, davited, hinged, left swing.
- Special base rails.
- Surface blowdown systems.
- Weather-proofing.

Burner/Control Options

- Special modulation controls.
- Low NOx equipment.
- Optional flame safeguard controller.
- Lead/lag system.
- Special insurance and code requirements (e.g., IRI, FM, CSD1).
- Remote contacts.
- Additional relay points and indicator lights.
- Main disconnect.
- Elapsed time meter.
- Voltmeter/micro-ammeter.
- NEMA enclosures.
- Low fired hold controls.
- Remote emergency shut-off (115V).
- Circuit breaker.
- Day/night controls.
- Special power requirements.

Fuel Options

- Automatic fuel changeover.
- Special gas pressure regulator.
- Oversized/undersized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Special pilot.
- Alternate fuel firing.
- Special oil pumps.

DIMENSIONS AND RATINGS

For dimension and rating information for Ohio Special boilers, refer to the following tables and illustrations:

- Table A8-1. Model CB Ohio Special Steam Boiler Ratings.
- Figure A8-1. Model CB Ohio Special Steam Boiler Dimensions.
- Figure A8-2. Space Required to Open Rear Head on Model CB Ohio Special Boilers

Equipped with Davits.

- Figure A8-3. Lifting Lug Locations, Model CB Ohio Special Boilers.
- Figure A8-4. Model CB Ohio Special Boiler Mounting Piers.

PERFORMANCE DATA

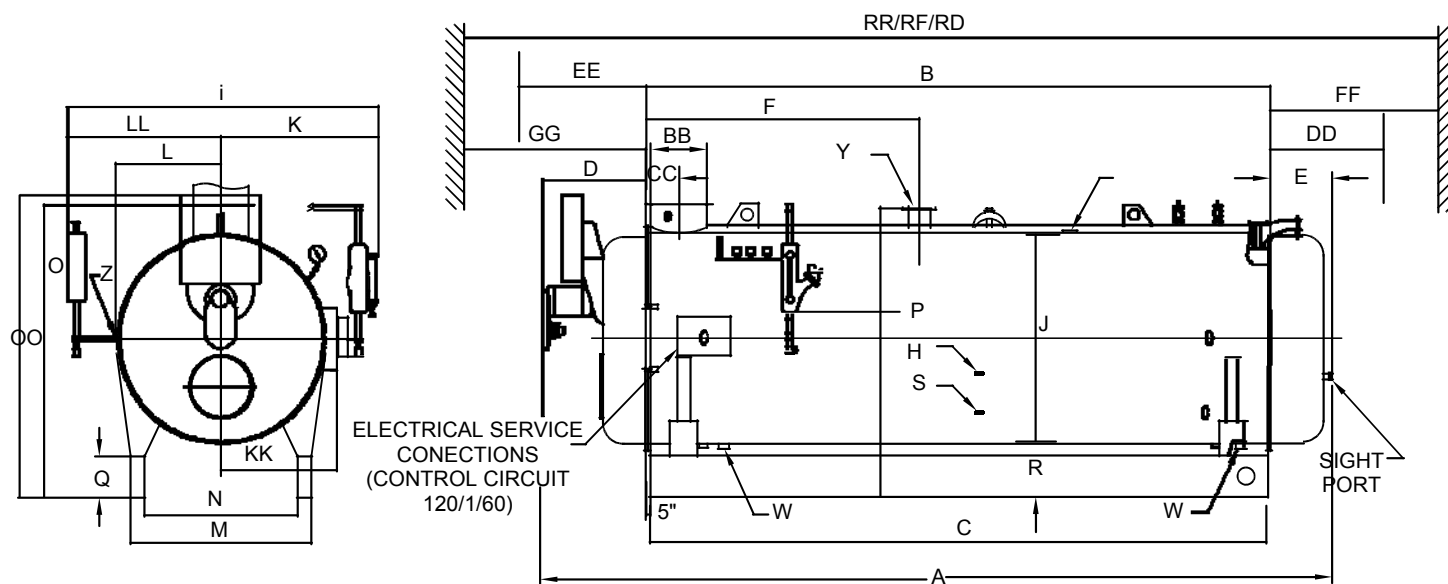
For efficiency and emission data for Ohio Special Boilers, contact your local Cleaver-Brooks authorized representative.

Table A8-1. Model CB Ohio Special Steam Boiler Ratings

BOILER HP	100S	125S	150S	175S	200S	225S
WEIGHT IN POUNDS						
Normal Water Capacity	4625	7000	7000	8500	8500	8500
Approx Wt -15 psig	7800	9300	9300	12600	12600	12600
Approx Wt -150 psig	8500	9900	9900	13500	13500	13500
Approx Wt - 200 psig	9000	10500	10500	14200	14200	14200
Water Capacity Flooded	5420	8673	8673	10485	10485	10485
RATINGS SEA LEVEL TO 3000 FT						
Steam - lbs/hr (212°F)	3450	4313	5175	6038	6900	7763
Btu Output (1000 Btu/hr)	3348	4184	5021	5858	6695	7531
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITIES						
Light Oil gph (140,000 Btu/gal)	30	37.4	44.8	52.5	59.8	67.5
Nat Gas CFH (1000 Btu/cu-ft)	4185	5230	6277	7323	8369	9415
Nat Gas -Therms/hr	41.9	52.3	62.8	73.2	83.7	94.2
POWER REQUIREMENTS - ELECTRIC (60 Hz)						
Blower Motor, hp (all models)	3	5	7-1/2	10	15	20
Oil Pump Motor, hp (No. 2 Oil)	1/3	1/2	1/2	1/2	1/2	1/2
Air Compressor Motor hp (Oil Fired Only)	2	Air Compressor Belt Driven From Blower Motor				

NOTES:

1. Standard Voltage is 230 or 460/3/60 Hz.
2. Burner control circuit Voltage is 115/1/60 Hz, 1/2 kVA load.
3. Side mounted air compressor (3 hp motor) recommended for 200S and 225S.



MODEL HP	DIM	100S	125S	150S	175S	200S	225S
LENGTH							
Overall	A	171-1/2	163-1/2	163-1/2	200-1/2	204-1/2	207-1/2
Shell	B	131	113	113	149	149	149
Base Frame	C	130	100	100	136	136	136
Front Head Extension (Approx)	D	22	31	31	32	36	39
Rear Head Extension	E	18-1/2	19-1/2	19-1/2	19-1/2	19-1/2	19-1/2
Flange to Nozzle (15 psig)	F	65-1/2	53	53	74.5	74.5	74.5
Flange to Nozzle (150 psig)	F	72.5	53	53	66	66	66

Figure A8-1. Model CB Ohio Special Steam Boiler Dimensions - Sheet 1 of 2

MODEL HP	DIM	100S	125S	150S	175S	200S	225S
WIDTH							
Overall	I	73	85	85	85	85	85
ID Boiler	J	48	60	60	60	60	60
Center to Water Column	K	39	45	45	45	45	45
Center to Outside Hinge	KK	29	35	35	35	35	35
Center to Lagging	L	27	33	33	33	33	33
Center to Auxiliary LWCO	LL	34	40	40	40	40	40
Base-Outside	M	37-5/8	52-1/2	52-1/2	52-1/2	52-1/2	52-1/2
Base-Inside	N	29-5/8	44-1/2	44-1/2	44-1/2	44-1/2	44-1/2
HEIGHT							
Overall	OO	78-3/4	86	86	86	86	86
Base to Vent Outlet	O	70	85	85	85	85	85
Base to Steam Outlet	P	66	77	77	77	77	77
Base Frame	Q	12	12	12	12	12	12
Base to Bottom Boiler	R	16	16	16	16	16	16
CONNECTIONS							
Chemical Feed	H	1	1	1	1	1	1
Feedwater, Right & Left	S	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
Auxiliary Connection	Z	1	1	1	1	1	1
Steam Nozzle (15 psig)A	Y	8 FLG	8 FLG	8 FLG	8 FLG	10 FLG	10 FLG
Steam Nozzle (150 psig)B	Y	4 FLG	4 FLG	4 FLG	4 FLG	4 FLG	4 FLG
Drain-Front & Rear (15 psig only)	W	1-1/2	1-1/2	1-1/2	2	2	2
Blowdown-Front & Rear (150 psig)	W	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
Surface Blow (150 psig only)	T	1	1	1	1	1	1
Vent Stack Dia. (Flanged)	BB	12	16	16	16	16	16
Flange to Center Vent	CC	7	9	9	9	9	9
CLEARANCES							
Rear Door Swing	DD	55	32	32	32	32	32
Front Door Swing	EE	55	67	67	67	67	67
Tube Removal, Rear	FF	123	103	103	139	139	139
Tube Removal, Front	GG	113	91	91	127	127	127
Min Room Length for Rear Tube Removal	RR	309	283	283	355	355	355
Min Room Length for Front Tube Removal	RF	299	236	236	308	308	308
Tube Removal thru Door	RD	241	212	212	248	248	248

NOTE: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.

A. Flanged 150 psig ANSI

B. Flanged 300 psig ANSI

Figure A8-1. Model CB Ohio Special Steam Boiler Dimensions - Sheet 2 of 2

BOILER HP	DIMENSION (INCHES)				
	A	B	C	D	E
CB 100S	27	48	38	60	26
CB 125S thru 225S	33	55	45	68	32

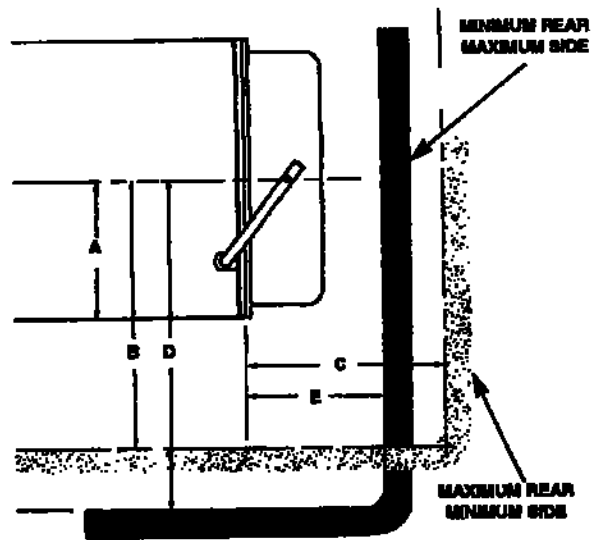


Figure A8-2. Space Required to Open Rear Head on Model CB Ohio Special Boilers Equipped with Davits

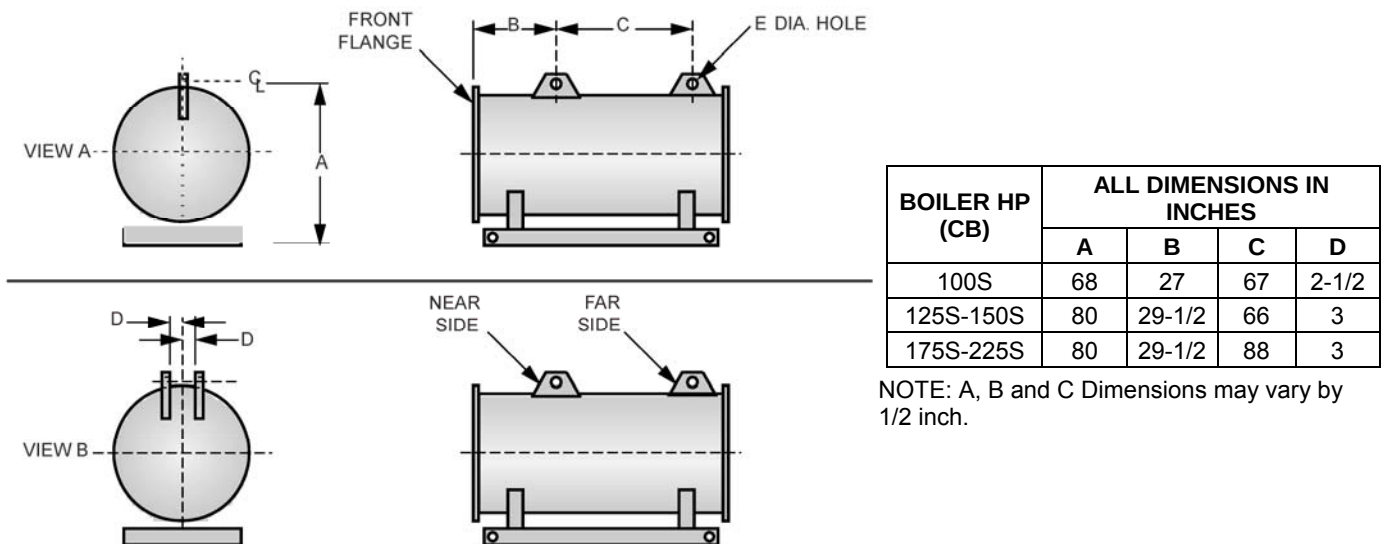
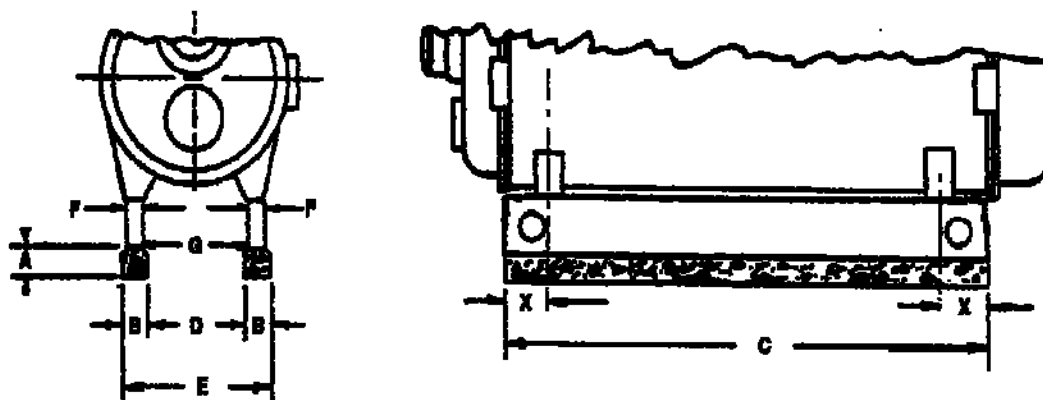


Figure A8-3. Model CB Ohio Special Boilers Lifting Lug Location



BOILER HP	A	B	C	D	E	F	G	X
CB 100S	6	8	130	26	42	4	29-5/8	8-1/4
CB 125S, 150S	6	9	100	39-1/2	57-1/2	4	44-1/2	10-1/4
CB 175S, 200S, 225S	6	9	136	39-1/2	57-1/2	4	44-1/2	10-1/4

NOTES:

1. All numbers in table are in inches.
2. 6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

Figure A8-4. Model CB Ohio Special Boiler Mounting Piers

ENGINEERING DATA

The following engineering information is provided for the Ohio Special Boilers. Ohio Special boilers are designated by an "S" following the horsepower number. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

Table A8-2 shows heating surfaces for Model CB Ohio Special Boilers.

Table A8-3 shows steam volume and disengaging area for Model CB Ohio Special Boilers.

Table A8-4 lists quantity and outlet size for safety valves supplied on Model CB Ohio Special Boilers.

Table A8-5 gives recommended steam nozzle sizes based on 4000-5000 fpm steam velocity. Model CB Ohio Special Firetube Boilers.

Table A8-6 shows recommended non-return valve sizes for Model CB Ohio Special Firetube Boilers.

Table A8-2. Model CB Ohio Special Boilers Heating Surface

BOILER HP	HEATING SURFACE (SQ-FT)	
	FIRESIDE	WATERSIDE
100S	350	388
125S-150S	358	386
175S, 200S, 225S	358	384

Table A8-3. Model CB Ohio Special Boilers Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA SQ-IN	
	HIGH PRESSURE ^A	LOW PRESSURE ^B	HIGH PRESSURE ^A	LOW PRESSURE ^B
100S	14.3	23.7	4367	4975
125S, 150S	28.4	38.9	5086	5473
175S, 200S, 225S	38.5	52.7	6899	7423

NOTES: Based on normal water level.

A. Based on 150 psig design pressure.

B. Based on 15 psig design pressure.

Table A8-4. Model CB Ohio Special Boilers Steam Boiler Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		100 PSIG STEAM		125 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100S	1	2-1/2	1	2	1	2	1	1-1/2	1 1-1/2		1 1-1/4	
125S	1	2-1/2	1	2-1/2	2	(1) 2 (1) 1-1/2	1	2	1	1-1/2	1 1-1/2	
150S	1	3	1	2-1/2	1	2-1/2	1	2	1	1-1/2	1 1-1/2	
175S	1	3	1	2-1/2	1	2-1/2	1	2 1/2				1-1/2
200S	1	3	2	2 1		2-1/2	1	2-1/2	1	2 1/2		
225S	2	2-1/2	2	2 1		2-1/2	1	2-1/2	1	2 1/2		

NOTE:

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

**Table A8-5. Model CB Ohio Special Firetube Boilers
Recommended Steam Nozzle Size
(To Maintain 4000 to 5000 fpm Nozzle Velocity)**

OPERATING PRESSURE PSIG	BOILER HP					
	100S	125S	150S	175S	200S	225S
15	8	8	8	8	10	10
30	6	6	6	6	8 8	
40	6	6	6	6	6 8	
50	4	6	6	6	6 6	
75	4	4	4	6	6 6	
100	4	4	4	4	6 6	
125	4	4	4	4	4 4	
150	2.5	3	3	4	4 4	
200	2.5	2.5	3	3	4 4	

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity. Spool pieces (300 psig flanges) are available in the following sizes (in inches): 3x2-1/2x30, 4x3x30, 6x4x36, 8x6x48, and 10x8x48.

Table A8-6. Model CB Ohio Special Firetube Boilers Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LB/HR)	OPERATING PRESSURES (PSIG)						
		50	75	100	125	150	175	200
100S	3450	2-1/2	2-1/2	NA	NA NA NA	NA		NA
125S	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA
150S	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA
175S	6038	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA
200S	6900	3*	3	3 3 3			2-1/2	2-1/2
225S	7736	3	3 3 3 3				2-1/2	2-1/2

NOTE:

Valve sizes (300# flanges) given in inches).

Standard non-return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output); selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative. For high turndown applications see Boiler Book Section I3, Table I3-2.

*Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

**NOTE: FAN ROTATION IS CLOCKWISE
WHEN VIEWED FROM FRONT OF BOILER.**

Table A8-7. Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
100S	80
125S-150S	87
175S-225S	118

NOTE: Quantity of water removed from boiler by lowering normal water line 4"

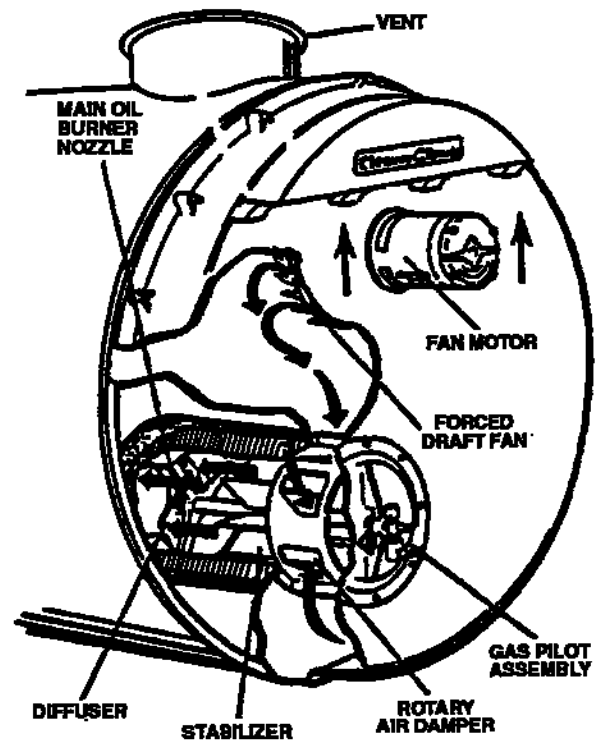


Figure A8-5. Secondary Air Flow Diagram

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

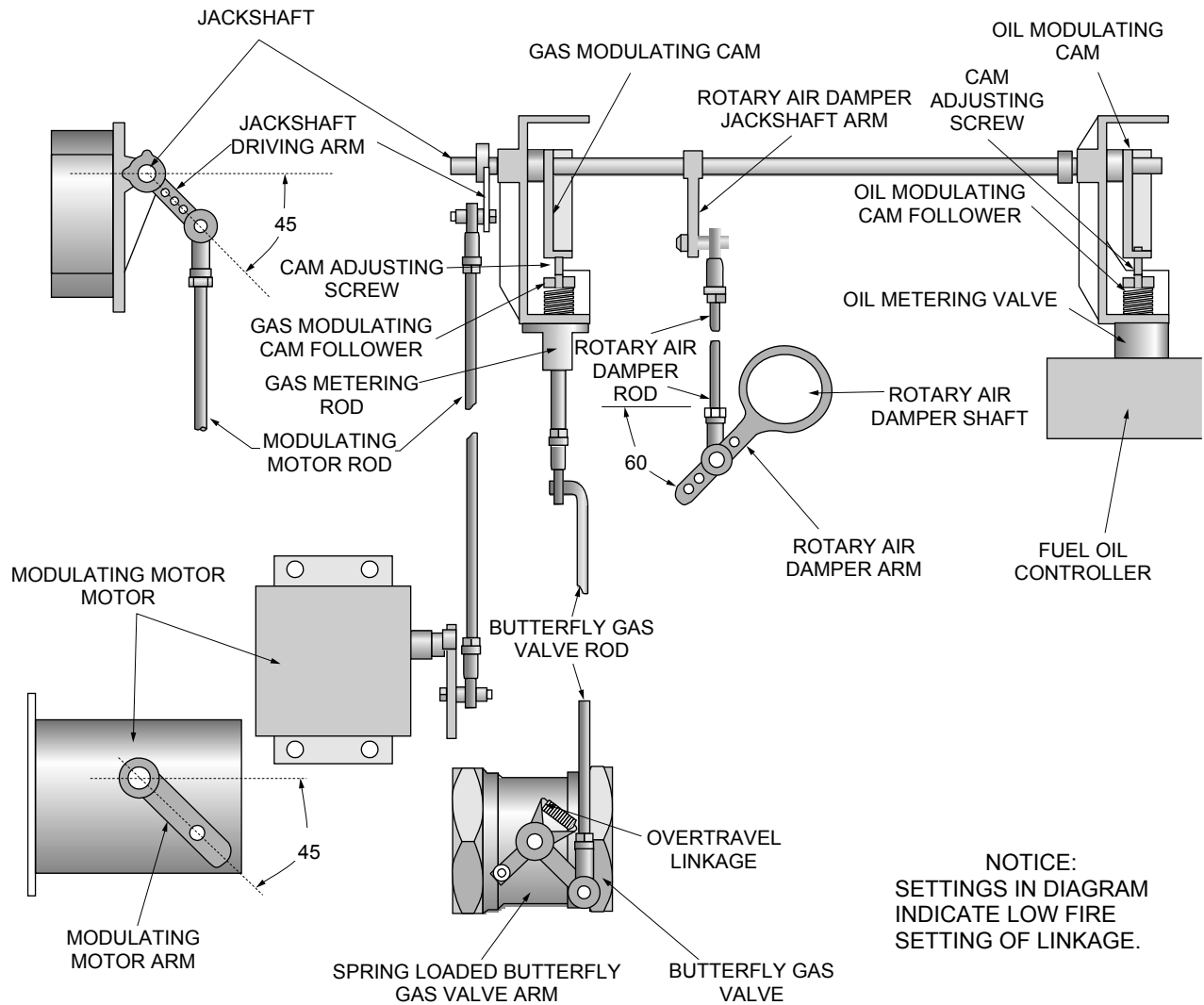


Figure A8-6. Complete Linkage Assembly, Combination Gas and Oil

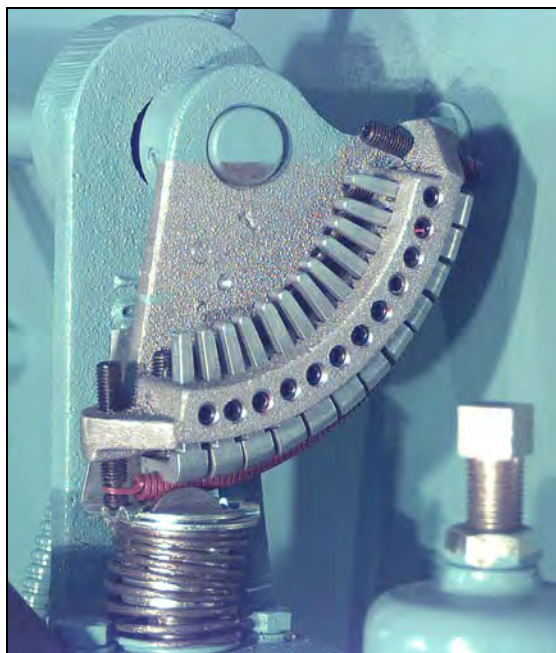


Figure A8-7. Gas Modulating Cam

Table A8-8. Gas pressure requirements, CB Ohio Special

Boiler HP	Gas Train Size (In.)	Min. Pressure	Max. Pressure PSI
100	1.5	14" WC	2
	2	9" WC	1
125	1.5	19" WC	2
	2	13" WC	1
150	1.5	25" WC	3
	2	17" WC	2
175	1.5	35" WC	3
	2	21" WC	2
200	1.5	45" WC	3
	2	30" WC	2
	2.5	24" WC	1.5
225	1.5	56" WC	3
	2	37" WC	2.5
	2.5	31" WC	2
300	2	4.4 PSI	6.5

Table is based on Siemens gas train, which includes a regulating actuator.

STANDARD

OVERSIZE

Burner Information

The Ohio Special Firetube Boiler encompasses an integral front head that includes the burner, combustion air fan, and controls as part of the boiler package design.

The integral front head provides for burner/boiler design as a single unit maximizing the compatibility between the boiler and burner.

Figure A8-5 shows secondary air flow in the Ohio Special Firetube Boiler. The rotary air damper design provides standard turn down of 4:1.

Figure A8-6 shows a typical linkage assembly. The single point linkage layout allows for easy adjustment and maximum repeatability of air/fuel ratios. Included on all Ohio Special Boilers is an adjustable CAM assembly shown in Figure A8-8.

Gas-Fired Burners

Table A8-8 shows regulated gas pressure requirements for gas trains for CB Ohio Special Firetube Boilers.

Table A8-9 shows minimum required gas pressure altitude conversion.

Table A8-10 shows maximum gas consumption for natural gas and propane vapor.

Figure A8-8 shows typical gas train components, and Figure A8-9 shows typical gas train piping layouts for multiple boiler applications.

Figure A8-10 shows standard gas train sizes and locations for Model CB Ohio Special Firetube Boilers.

Oil-Fired Burners

Fuel oil consumption information is shown on the boiler rating sheets in the Dimensions and Rating Section.

Figure A8-11 shows the oil connection sizes and locations for Ohio Special Boilers firing No. 2 oil.

Figures A8-12 through A8-15 show typical oil systems and layouts.

Boiler Room Information

Figure A6-16 shows typical boiler room length requirements.

Figure A6-17 shows typical boiler room width requirements.

Stack Support Capabilities

100 hp Ohio Special Boilers can support up to 1,000 lbs without additional support.

125-225 hp Ohio Special Boilers can support up to 2,000 lbs without additional support.

**Table A8-9. Minimum Required Gas Pressure
Altitude Conversion**

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

Oz/sq-in x 1.732 = Inches WC.

Inches WC x 0.0361 = psig.

Oz/sq-in x 0.0625 = psig.

Psig x 27.71 = Inches WC.

Psig x 16.0 = Oz/sq-in.

**Table A8-10. Maximum Gas Consumption,
Natural Gas and Propane**

BOILER HP	TYPE OF GAS AND HEAT CONTENT	
	NATURAL GAS 1000 (Btu/cu-ft)	PROPANE GAS 2550 (Btu/cu-ft)
100S	4185	1640
125S	5230	2050
150S	6280	2465
175S	7350	2870
200S	8370	3280
225S	9415	3690

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - E. Size the openings by using the formula:
Area (sq-ft) = cfm/fpm
2. Amount of air required (cfm).
 - A. Combustion air - rated bhp x 8 cfm/bhp.
 - B. Ventilation air - rated bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
 - A. From floor to (7) foot height - 250 fpm.
 - B. Above (7) foot height - 500 fpm.

C. Duct from air supply to boiler - 1000 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 200 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $200 \times 10 = 2000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} / 250 = 2000 / 250 = 8$ Sq-ft total.
- Area/Opening: $8 / 2 = 4$ sq-ft/opening (2 required).

Notice

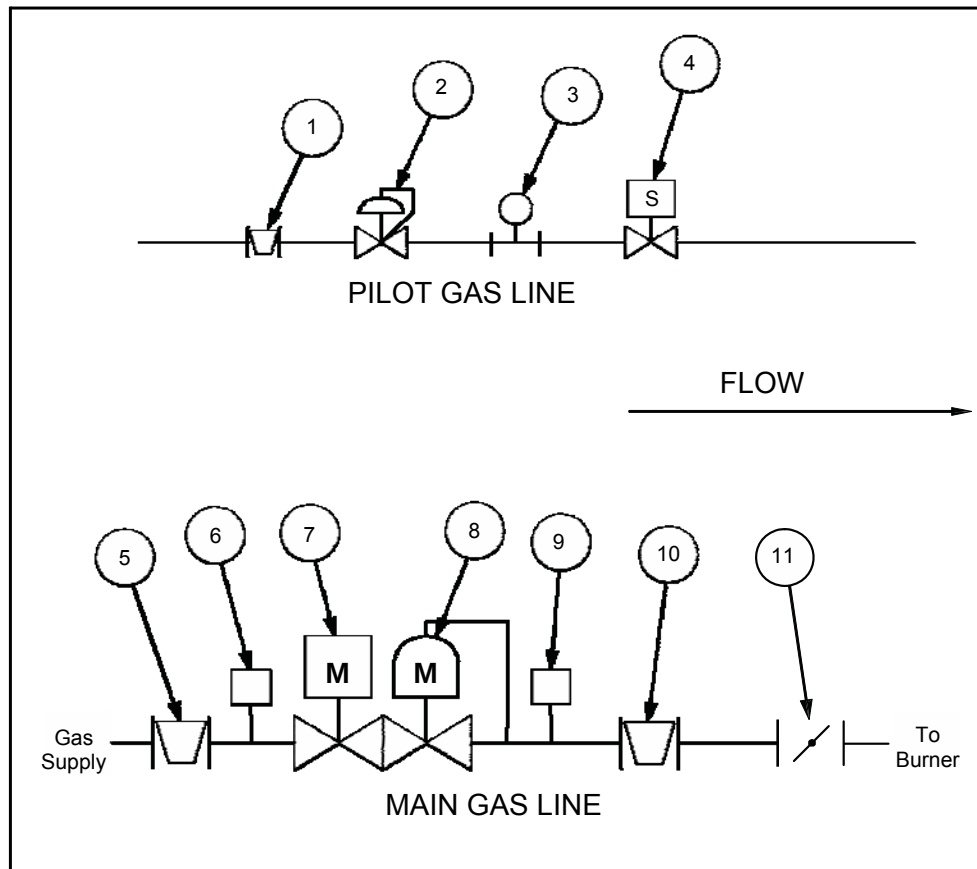
Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Ohio Special is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is -0.25" W.C. to +0.25" W.C.

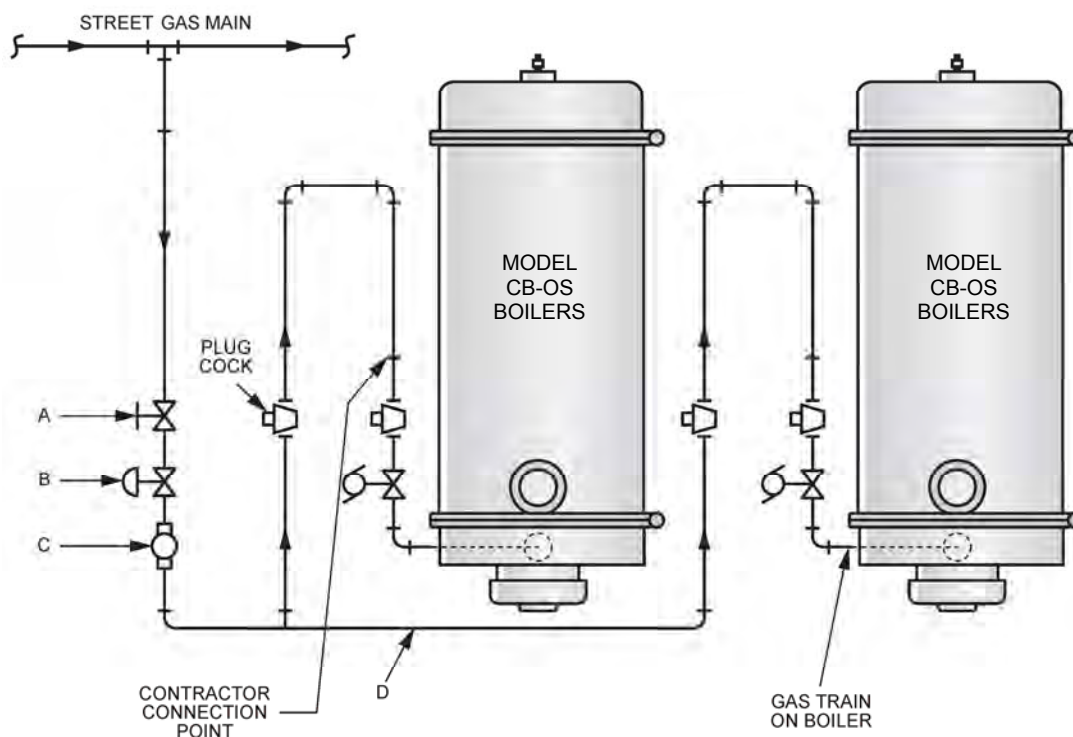
For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.



ITEM	DESCRIPTION	UL		FM		CSD-1	
		100S	125S - 225S	100S	125S - 225S	100S	125S - 225S
1	Pilot Shut Off Cock	X	X	X	X	X	X
2	Pilot Pressure Regulator	X	X	X	X	X	X
3	Pilot Pressure Gauge	X	X	X	X	X	X
4	Gas Pilot Valve	X	X	X	X	X	X
5	Manual Shut Off Valve	X	X	X	X	X	X
6	Low Gas Pressure Switch	X	X	X	X	X	X
7	Main Gas Valve w/o POC		X		X		X
8	Regulating Gas Valve w/ POC	X	X	X	X	X	X
9	High Gas Pressure Switch	X	X	X	X	X	X
10	Manual Shut Off Valve	X	X	X	X	X	X
11	Butterfly Valve	X	X	XX		X	X

Figure A8-8. Model CB Ohio Special Gas Train Components

This figure illustrates the basic gas valve arrangement on Cleaver-Brooks boilers and shows the contractor's connection point. The valves and controls between the contractor connection point and the gas main in the street are representative of a typical installation. Actual requirements may vary depending on local codes or local gas company requirements which should be investigated prior to preparation of specifications and prior to construction.



- A. Utilities service valve.
- B. Utilities service regulator.
- C. Gas meter.
- D. Piping from meter to boiler.

The size of the gas line from the meter to the gas pressure regulator at the boiler can be very important if gas pressures are marginal. The gas line sizing is dependent on:

1. Gas pressure at outlet of gas meter (C)
2. Rate of gas flow required, CFH
3. Length of pipe run (D)
4. Pressure required at contractor connection point.

The local gas utility will advise the pressure that is available at the outlet of their meter.

Figure A8-9. Typical Gas Piping Layout

BOILER HP	MODEL CB	
	CONNECTION SIZE (IN.) (NPT)	LOCATION DIMENSION "A" (IN.)
100S	1 1/2	46 1/2
125S-200	1 1/2	52
225S	2	55

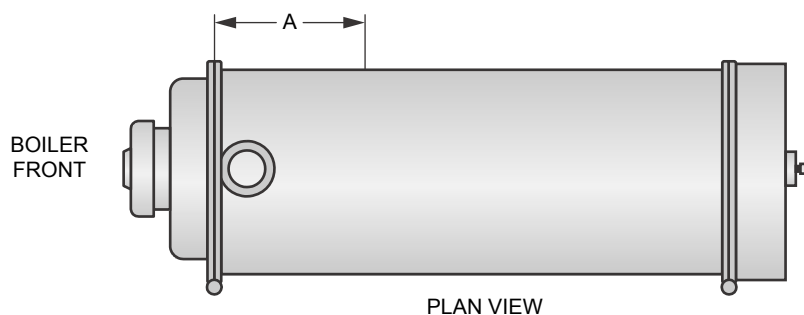
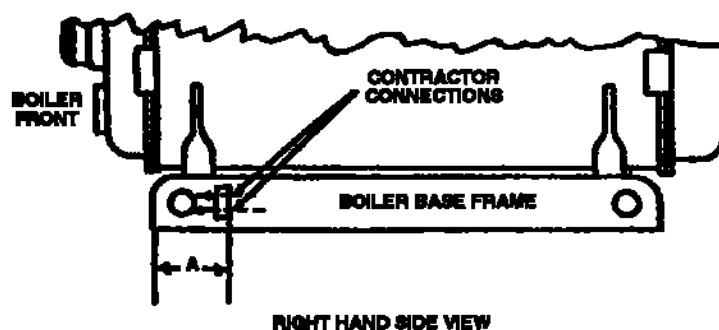


Figure A8-10. Model CB Ohio Special Firetube Boilers Standard Gas Train Connection Size and Location



BHP	SUPPLY AND RETURN CONN SIZES (IN.) (NPT)	A (IN.)	RECOMMENDED OIL LINE ^A SIZES (STANDARD PIPE) (IN.-IPS)		
			STORAGE TANK TO BOILER OR PUMP CONNECT	PUMP TO BOILER	RETURN LINE TO TANK
100S	3/4	11-1/2	1	1	1
125S-225S	3/4	12-1/2	1	1	1

NOTES: See No. 2 Oil Line Sizing Instruction for systems with other conditions

A. For suction line condition with a maximum of 10 Feet of lift and a total of 100 feet of suction line.

Figure A8-11. CB Ohio Special Boilers, No. 2 Oil Connection Size, Location and Recommended Line Sizes

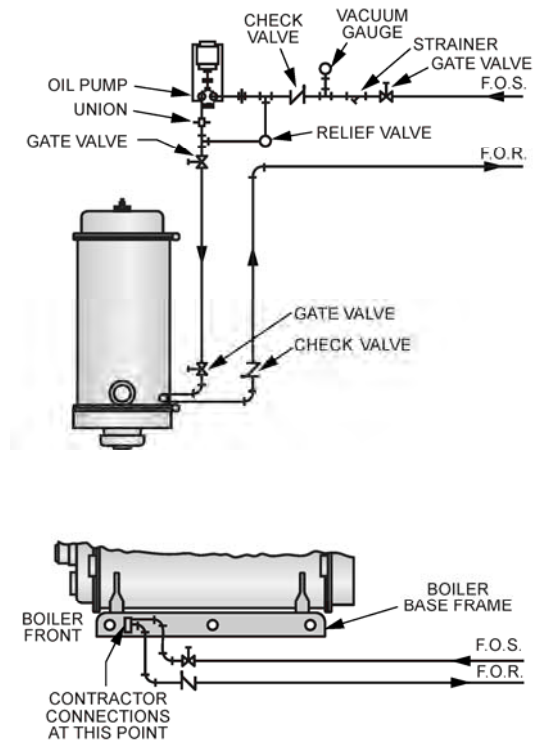
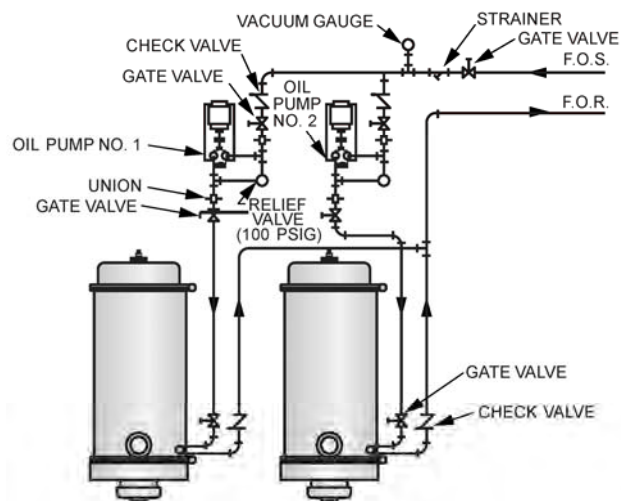


Figure A8-12. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump



USE LAYOUT FOR: MODEL CB . . 100S - 225S

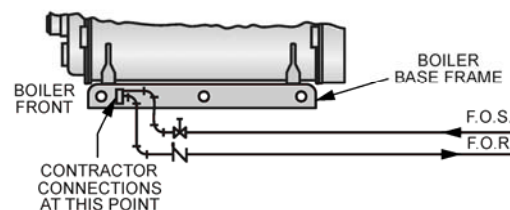


Figure A8-13. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

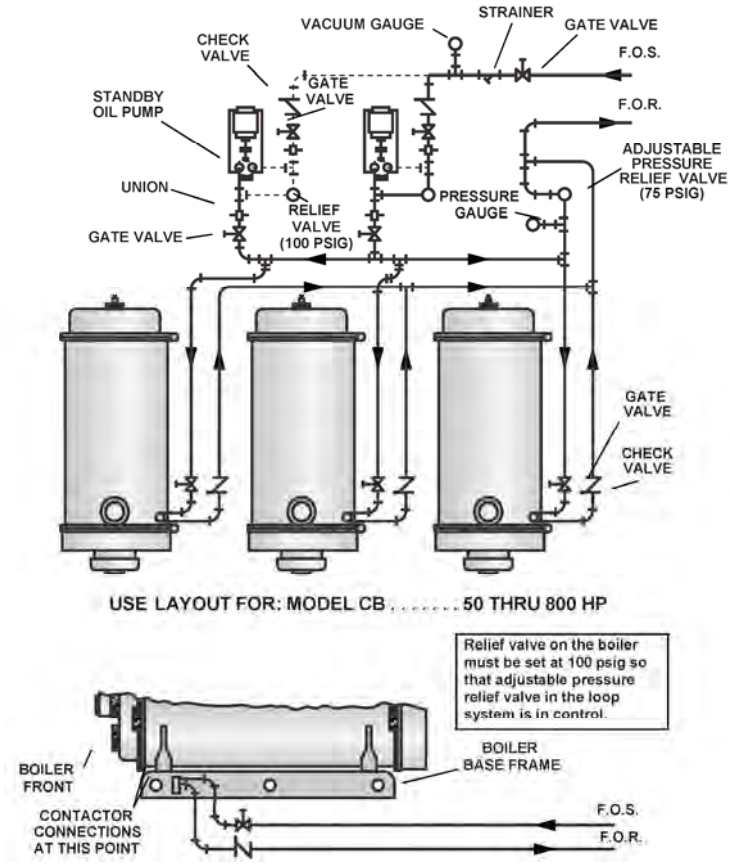


Figure A8-14. No. 2 Oil Piping, Multiple Boiler Installation

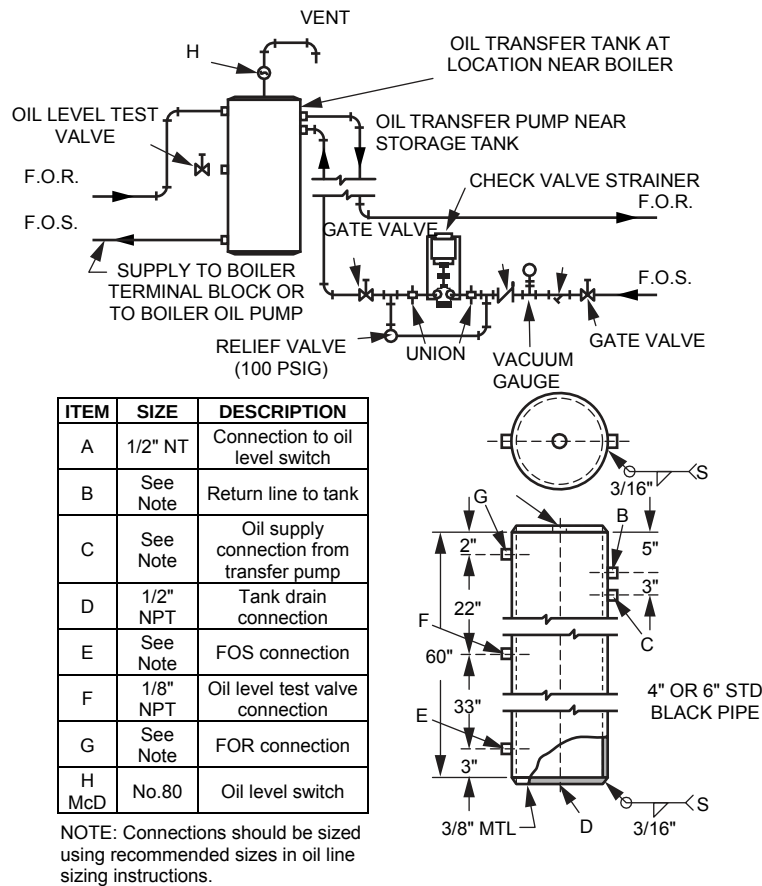
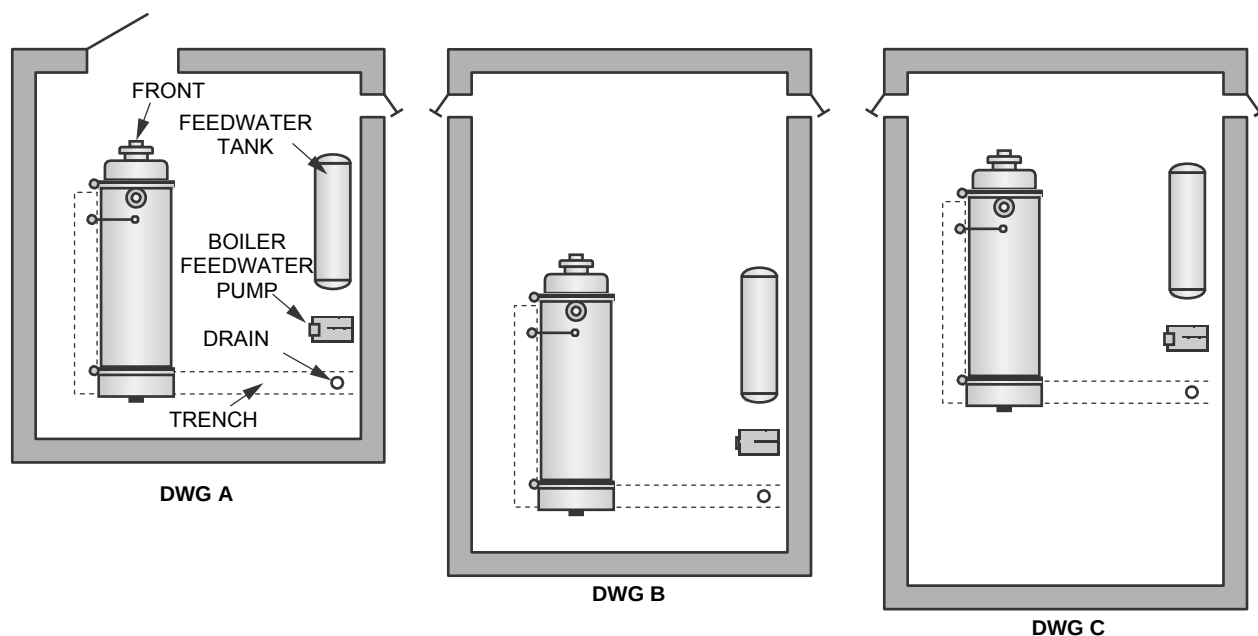


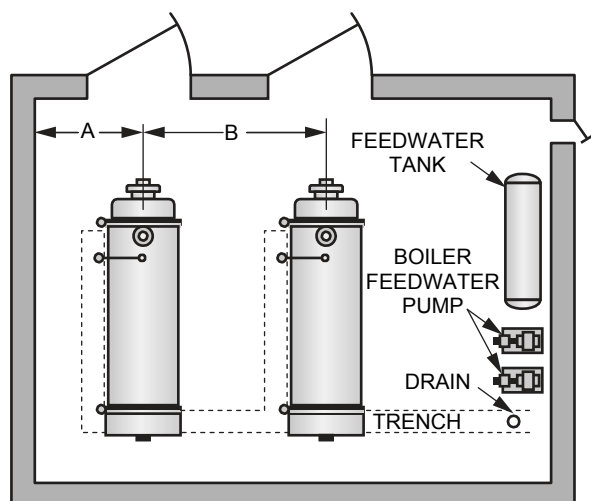
Figure A8-15. No. 2 Oil Piping

(For elevated boiler room locations using an oil transfer pump and tank)



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear. If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.
2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear. If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.
3. A slightly longer boiler room (Dwg C) is obtained by allowing for possible future tube replacement from the rear of the boiler. Allowance for door swing at the front provides sufficient aisle and working space at the front.

Figure A8-16. Boiler Room Length (Typical Layouts), Model CB Ohio Special



BOILER HP	100S	125S – 225S
Dimension A	78"	82"
Dimension B	105"	115"

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of: 42" If space permits, this aisle should be widened.

Figure A8-17. Boiler Room Width (Typical Layout), Model CB Ohio Special

Notes

SECTION A8
MODEL CB OHIO SPECIAL STEAM BOILER

(100-225 hp, Steam 15, 150, 200, or 250 psig)

SAMPLE SPECIFICATION

PART 1 GENERAL.....A8-28

 1.01 BOILER CHARACTERISTICS (STEAM).....A8-28

PART 2 PRODUCTS.....A8-28

 2.01 GENERAL BOILER DESIGN.....A8-28

 2.02 STEAM BOILER TRIM A8-29

 2.03 BURNER.....A8-30

 2.04 EFFICIENCY GUARANTEE A8-34

 2.05 WARRANTY A8-34

PART 3 EXECUTION.....A8-34

MODEL CB OHIO SPECIAL STEAM BOILER (100-225 HP, STEAM 15, 150, 200, OR 250 PSIG)

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.

PART 1 GENERAL

1.01 BOILER CHARACTERISTICS (STEAM)

- A. The Steam Boiler shall be Cleaver-Brooks Model CB Ohio Special Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (15 or _____ psig steam). The maximum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS12-48 No. 2 oil and/or natural gas, _____ Btu/cu-ft. Electrical power available shall be _____ Volt _____ Phase _____ Cycle and 115/1/60 for the control circuit.

PART 2 PRODUCTS

2.01 GENERAL BOILER DESIGN

- A. The boiler shall be a multi-pass horizontal firetube updraft boiler with 350 square feet of total heating surface for the 100 hp and 358 square feet of total heating surface for the 125-225 hp boilers. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls. The complete packaged boiler is built as a unit with Underwriters Laboratories listed controls.
 - 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent, steam, and blowdown connections.
- B. Boiler Shell (Steam)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished the purchaser.
 - 2. Two lifting eyes shall be located on top of the boiler.
 - 3. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.

4. Rear refractory and insulation shall be contained in the formed door which must swing open for inspection of brick work.
5. The boiler tubes shall not include swirlers, turbulators, or other add-on devices.
6. Front and rear tube sheets and all tubes must be fully accessible for inspection and cleaning when the doors are swung open. The boiler shall be furnished with adequate handholes to facilitate boiler inspection and cleaning.
7. For boilers 125 horsepower and over, a manhole shall be provided.
8. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting:
 - 100 hp 1000 lbs. and shall contain a stack thermometer.
 - 125-225 hp 2000 lbs. and shall contain a stack thermometer.
9. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
10. The boiler insulation shall consist of a 2 inch fiberglass blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
11. The entire boiler base frame and other components shall be factory painted before shipment using a hard-finish enamel coating.

2.02 STEAM BOILER TRIM

- A. Low Water Cutoff/Feedwater valve (pump) control (150-250 psig design)
LWCO/Pump control shall be a CB LEVEL MASTER water level control system comprising a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows: The electronic controller shall be mounted in the common control panel (see 2.4 below) and operate in ambient temperatures from 32 degrees F to 125 degrees F. The pressure chamber shall be boiler mounted and operate to pressures of 250 PSIG and the level sensor shall operate to pressures of 250 PSIG and temperatures to 400 degrees F. The pressure-containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase- 60 Hz. All wiring shall be in compliance with the National Electrical Code.

The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/menu switch and the following features:

- a. Continuous Level Indication
- b. Low Water Cutoff & Alarm
- c. High Water Alarm
- d. Low & High Water Warning
- e. Full Modulating Control of Modulating Feedwater Control Valve
- f. Continuous Monitoring of Float Operation
- g. Column Blowdown Detection and Reminder
- h. Auto or Manual Reset

- i. Real Time Clock
 - j. Alarm Annunciation
 - k. Alarm History Files with Time Stamp
 - l. Water Column Blowdown Record
 - m. Auxiliary Low Water Cutoff Check
 - n. RS 232 Interface
 - o. Maximum Contacts Rating 15 amps Resistive Load
- B. Low Water Cutoff/Feedwater Pump Control (15 psig design)
A water column shall be located on the right hand side of the boiler complete with gauge glass set, and water column blowdown valves. The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feedwater pump maintaining the boiler water level within normal limits. The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.
- C. Auxiliary Low Water Cutoff
Auxiliary low water cutoff shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.
- D. Steam Pressure Gauge
The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- E. Safety Relief Valves
Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- F. Steam Pressure Controls
The steam pressure control to regulate burner operation shall be mounted near the water column.

2.03 BURNER

- A. Mode of Operation
Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.
- B. Forced Draft Blower
1. All air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
 2. Maximum sound level of the boiler/burner package shall not exceed _____ dBA (when measured in accordance with ABMA Sound Test Standards).
 3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.
- C. Combustion Air Control
Combustion air damper and cam operated fuel metering valves shall be operated by a single damper control motor that regulates the fire according to load demand. Single point positioning controls shall be provided to regulate operation of the damper control motor.

D. Fuel Specification and Piping

Refer to the following fuel series specifications:

- Fuel series 700 - gas fired.
- Fuel series 100 - light oil fired.
- Fuel series 200 - light oil or gas fired.

E. Fuel Series 700 - Gas Fired

1. Burner Type - The burner shall be integral with the front head of the boiler and of high radiantannular gas entry on 125-225 hp. and multi-port type gas entry on 100 hp. The burner shall be approved for operation on natural gas fuel.
2. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
3. Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The valve is spring return to start or stop the gas burner and to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly shutoff valve shall be furnished at entrance to gas train. Select one of the following:
 - 100 hp High and low gas pressure switches shall be provided.
4. 125-225 hp High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
5. Burner Turndown - Turndown range of the burner shall be 4:1 when firing natural gas.
 - a. Fuel Series 100 - Light Oil Fired
 - b. Burner Type - The burner shall be integral with the front head of the boiler, and shall be a low pressure air atomizing type approved for operation with CS12-48, Commercial No. 2 oil.
 - c. Oil Pilot - The oil pilot shall be air atomizing type with automatic electric ignition and include oil solenoid valve. An electronic detector shall monitor the pilot so that the primary oil valve cannot open until flame has been established.
 - d. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. A separate motor driven pump set, shipped loose to be installed in a location favorable to the oil storage tank, shall be provided.
 - e. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - f. Low Pressure Air Atomizing - Select one of the following:

- 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch shall be provided.
 - 125 hp-225 hp. Belt driven air compressor, lubricating air tank, oil level indicator, inlet air filter, air pressure gauge, and low atomizing air pressure switch shall be provided.
6. Burner Turndown - Turndown range of the burner shall be 4:1 when firing No. 2 oil.
- F. Fuel Series 200 - Light Oil or Gas Fired
1. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and high radiant annular gas entry on 125-225 hp and multi-port type for gas entry on 100 hp. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas.
 2. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. A separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - c. Low pressure Air Atomizing - Select one of the following:
 - 100 hp. Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch shall be provided.
 - 125-225 hp. Belt driven air compressor, lubricating air tank, oil level indicator, inlet air filter, air pressure gauge and low atomizing air pressure switch shall be provided.
 - d. Gas Burner
 - 1) Gas Burner Piping - gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The valve is spring return to start or stop the gas burner and to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly shutoff valve shall be furnished at entrance to gas train. Select one of the following:
 - 100 hp High and low gas pressure switches shall be provided.

- 125-225 hp High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.

e. Burner Turndown - Turndown range of the burner shall be 4:1.

G. Boiler Flame Safeguard Controller and Control Panel

1. CB780E Flame Safeguard Controller

Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E.

Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

- a. Control Panel - The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.

The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers, the panel shall contain the fuel selector switch.

b. Lights

- White - load demand.
- White - fuel valve open.
- Red - low water.
- Red - flame failure.

c. Control Switches

- Burner On-Off.
- Manual-Automatic.
- Manual Firing Rate Control.

- d. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.

- e. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.

- f. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2. Control Panel

- a. The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 1A rating that includes a neoprene dust seal and a Yale cabinet key type lock.
- b. The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.
- c. Panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers the panel shall contain the fuel selector switch.
- d. Oil, heat, and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
- e. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
- f. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.04 EFFICIENCY GUARANTEE

- A. The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of _____ percent from 25 to 100 percent of rating when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil.

2.05 WARRANTY

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

PART 3 EXECUTION

A. Shop Tests

The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

B. Start-up Service

1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and timing the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

MODEL CBLE OHIO SPECIAL

300HP
15 or 150 psig Steam
Dryback Integral Burner



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FEATURES AND BENEFITS

The Cleaver-Brooks Ohio Special CBLE 300S firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks specifically for operation in the state of Ohio, under the rules and regulations for unattended units. The unique design of the Ohio Special Boiler serves your steam needs and reduces unnecessary labor costs. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks firetube boilers, the following features apply to the CBLE 300S.

2-Pass Dryback Design

AluFer Tubes:

- Ensures increased efficiency without turbulators, spinners, and other high maintenance devices.
- Achieves greater output with less heating surface.

358 Square Feet of Heating Surface:

- The greatest amount offered in any packaged boiler for unattended steam boiler operation in Ohio - means long life and years of service at the high efficiencies.

Integral NTI Burner:

- Low emissions to <30 ppm.
- Full modulation with 5:1 turndown.

PRODUCT OFFERING

The Cleaver-Brooks CBLE Ohio Special firetube boilers are available in 15 and 150 psig steam designs. Burners are available to fire natural gas or a combination of light oil and gas.

For details on available options, contact your local Cleaver-Brooks authorized representative. Options may include the following:

Boiler Options

- Drain valves.
- Additional screwed or flanged trappings.
- Surge load baffles.
- Seismic design.
- Blowdown valves.
- Non-return valves.
- Feedwater valves and regulators.
- Special doors, davited, hinged, left swing.
- Special base rails.
- Surface blowdown systems.
- Weather-proofing.

Burner/Control Options

Special modulation controls.
Optional flame safeguard controller.



Special insurance and code requirements (e.g., IRI, FM, CSD1).

Remote contacts.

Additional relay points and indicator lights.

Main disconnect.

Elapsed time meter.

Voltmeter/micro-ammeter.

NEMA enclosures.

Low fired hold controls.

Remote emergency shut-off (115V).

Circuit breaker.

Day/night controls.

Special power requirements.

Fuel Options

- Special gas pressure regulator.
- Oversized/undersized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Special pilot.
- Special oil pumps.

DIMENSIONS AND RATINGS

For dimension and rating information for the Ohio Special CBLE 300S, refer to the following tables and illustrations:

- Table A12-1. Model CBLE Ohio Special Steam Boiler Ratings.
- Figure A12-1. Model CBLE Ohio Special Steam Boiler Dimensions.
- Figure A12-2. Space Required to Open Rear Head on Model CBLE Ohio Special Boilers Equipped with Davits.
- Figure A12-3. Lifting Lug Locations, Model CBLE Ohio Special Boilers.
- Figure A12-4. Model CBLE Ohio Special Boiler Mounting Piers.

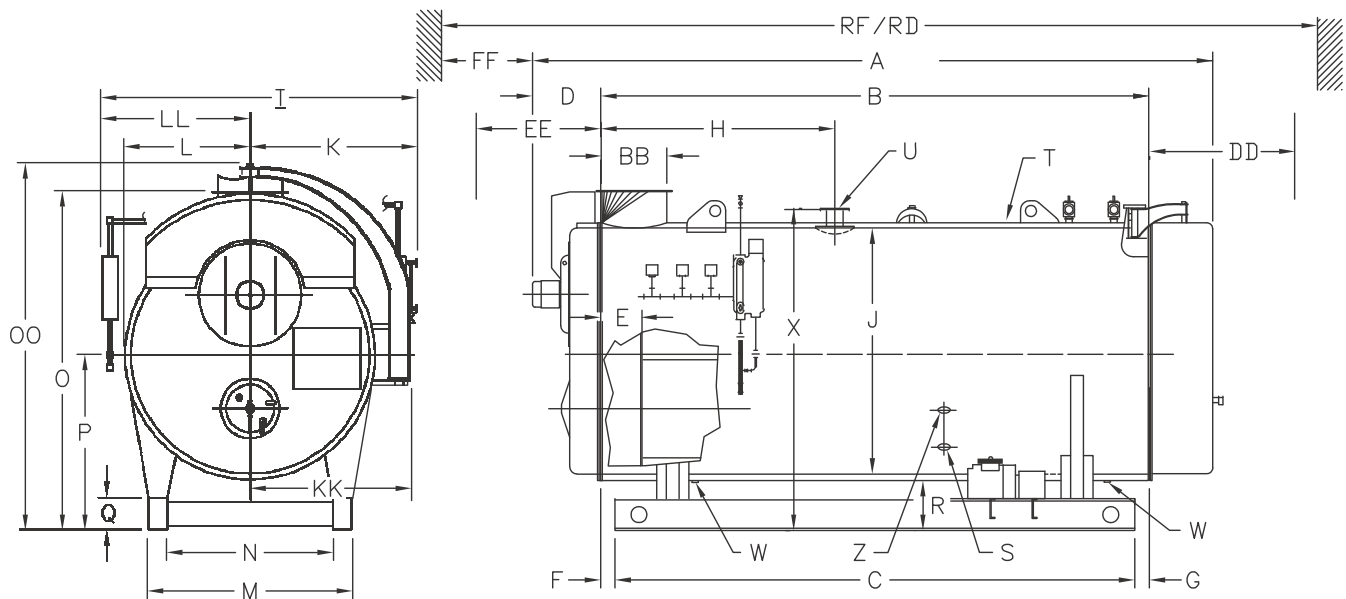
Table A12-1. Model CBLE Ohio Special Steam Boiler Ratings

BOILER H.P.	300
RATINGS - SEA LEVEL TO 700 FT.	
Rated Capacity (lbs-steam/hr from and at 212 °F)	10350
Btu Output (1000 Btu/hr)	10042
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY	
Light Oil gph (140,000 Btu/gal)	89.7
Gas CFH (1000 Btu)	12552
Gas (Therm/hr)	125.5
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)	
Blower Motor hp (30 ppm) ^A	25
Oil Pump Motor, No. 2 Oil	3/4
Air Compressor Motor hp (No. 2 Oil firing Only)	5
BOILER DATA	
Heating Surface sq-ft. (Fireside)	358

NOTES:

A. Blower motor size for boiler operating pressures 125 psig and less - contact your local Cleaver-Brooks authorized representative for higher pressures and altitude.

Figure A12-1. Model CBLE Ohio Special Steam Boiler Dimensions



BOILER H.P.	DIM	300
LENGTHS		
Overall Length	A	181
Shell	B	135.62
Base Frame	C	122.62
Front Head Extension	D	26
Shell Extension	E	15
Shell Ring Flange to Base	F	0.5
Rear Ring Flange to Base	G	12.5
Shell Flange to Steam Nozzle	H	80
WIDTHS		
Overall Width	I	87
I.D. Boiler	J	67
Center to Water Column	K	45
Center to Outside Davit/Hinge	KK	41.5
Center to Lagging	L	36.5
Center to Auxiliary LWCO	LL	42
Base Outside	M	50.75
Base Inside	N	42.75
HEIGHTS		
Overall Height	OO	102
Base to Vent Outlet	O	93
Base to Boiler Centerline	P	50
Height of Base Frame	Q	12
Base to Bottom of Boiler	R	16
Base to Steam Outlet	X	89.5

BOILER CONNECTIONS		
Feedwater Inlet (Both Sides)	S	2
Surface Blowoff (150 lb only)	T	1
Steam Nozzle 15 lb (See Note "A")	U	12
Steam Nozzle 150 lb (See Note "B")	U	6
Blowdown-Front & Rear (15 lb)	W	2
Blowdown-Front & Rear (150 lb)	W	1.5
Chemical Feed	Z	1
VENT STACK		
Vent Stack Diameter (Flanged)	BB	20
MINIMUM CLEARANCES		
Rear Door Swing	DD	40
Front Door Swing	EE	78
Tube Removal - Front Only	FF	109.62
MINIMUM BOILER ROOM LENGTH		
DOOR SWING AND TUBE REMOVAL		
Thru Window or Door	RD	253.62
Front of Boiler	RF	300.62
WEIGHTS IN LBS		
Normal Water Weight	-	7,100
Approx. Shipping Weight - (150psig)	-	16,400

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified

All Connections are Threaded Unless Otherwise Indicated:

NOTE "A": ANSI 150 psig Flange

NOTE "B": ANSI 300 psig Flange

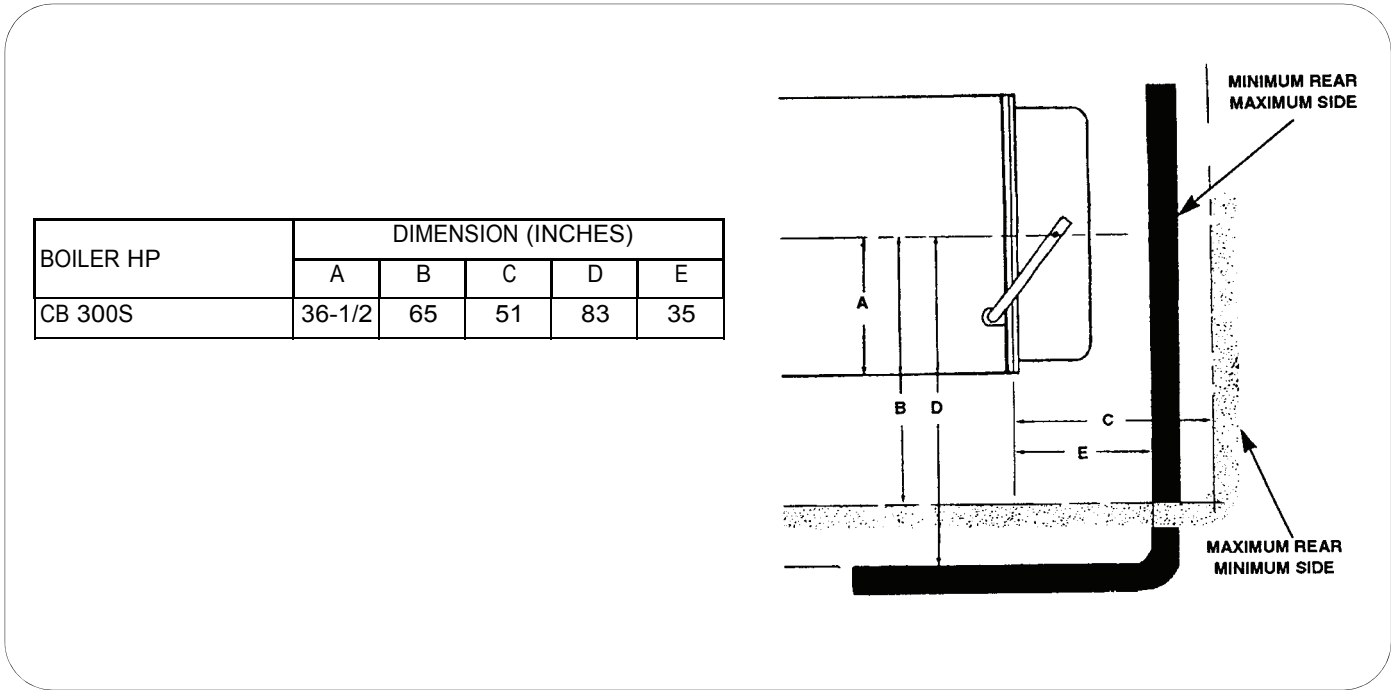


Figure A12-2. Space Required to Open Rear Head on Model CBLE Ohio Special Boilers Equipped with Davits

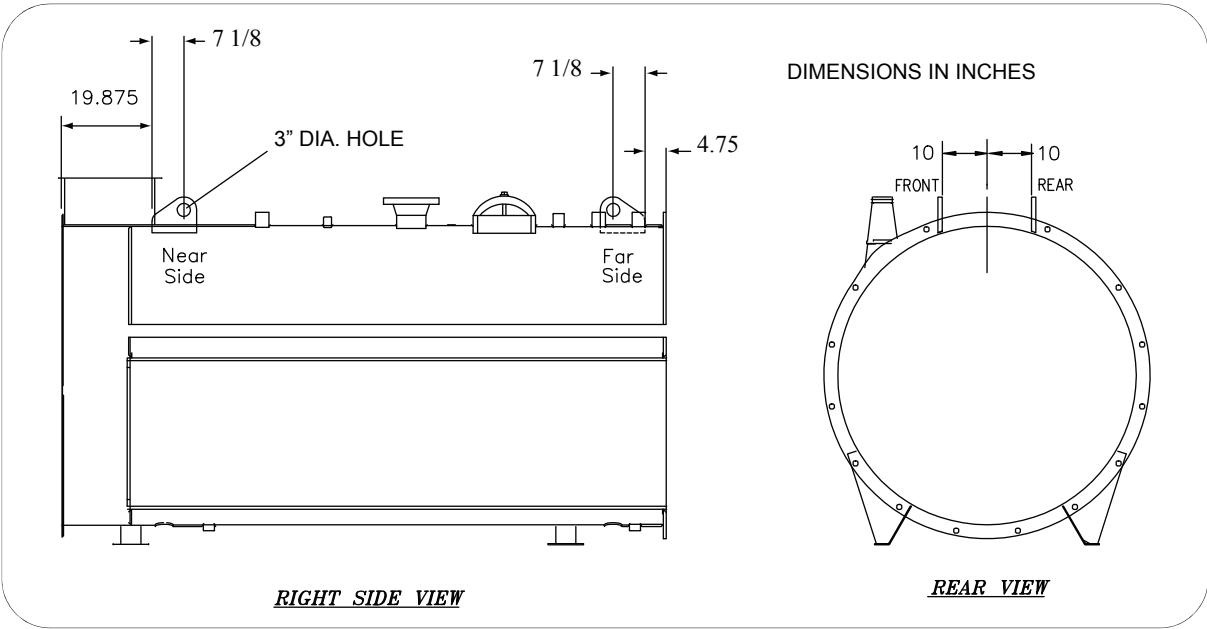
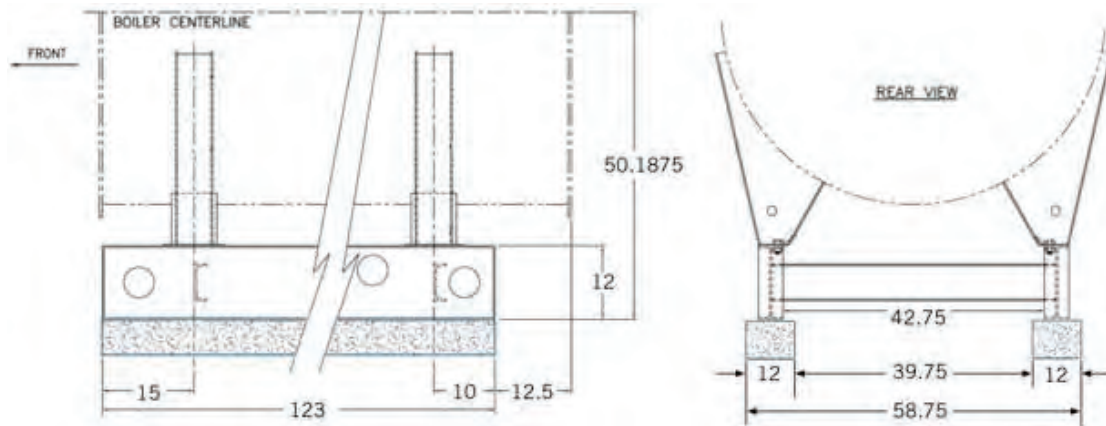


Figure A12-3. Model CBLE Ohio Special Boilers Lifting Lug Location



6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

Dimensions are in inches.

Figure A12-4. Model CBLE Ohio Special Boiler Mounting Piers

PERFORMANCE DATA

For efficiency and emission data for Ohio Special Boilers, contact your local Cleaver-Brooks authorized representative.

ENGINEERING DATA

The following engineering information is provided for the CBLE 300S.

Boiler Information

Table A12-2 shows steam volume and disengaging area for Model CBLE Ohio Special Boilers.

Table A12-3 lists quantity and outlet size for safety valves supplied on Model CBLE Ohio Special Boilers.

Table A12-4 shows recommended non-return valve sizes for Model CBLE Ohio Special Boilers.

Table A12-5 gives recommended steam nozzle sizes based on 4000-5000 fpm steam velocity.

Table A12-6 shows blowdown tank sizing information.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table A12-2. Model CBLE Ohio Special Boilers Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT	STEAM RELIEVING AREA SQ-IN
300S	48.4	6952

NOTES: Based on normal water level.

Table A12-3. Model CBLE Ohio Special Boilers Steam Boiler Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
300S	1	3"	1	2"
	1	2-1/2"	1	1-1/2"

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

Table A12-4. Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LB/HR)	OPERATING PRESSURES (PSIG)			
		50	75	100	125
300S	10350	4	4	4	3*

NOTE:

Valve sizes (300# flanges) given in inches.

Standard non-return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output); selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative. For high turndown applications see Boiler Book Section I3, Table I3-2.

*Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table A12-5. Model CBLE Ohio Special Recommended Steam Nozzle Size (For 4000 to 5000 fpm Nozzle Velocity)

OPERATING PRESSURE PSIG	RECOMMENDED STEAM NOZZLE SIZE
15	12
30	8
40	8
50	8
75	6
100	6
125	6

NOTES:

1. Steam nozzle sizes given in inches.

2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity. Spool pieces (300 psig flanges) are available in the following sizes (in inches): 3x2-1/2x30, 4x3x30, 6x4x36, 8x6x48, and 10x8x48.

Table A12-6. Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
300S	125

NOTE: Quantity of water removed from boiler by lowering normal water line 4"

Table A12-7. Gas pressure requirements

Boiler HP	Gas Train Size (In.)	Min. Pressure	Max. Pressure
300S	2	4.4 PSI	6.5

Table A12-8. Min. req. gas pressure altitude conversion

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

Oz/sq-in x 1.732 = Inches WC.

Inches WC x 0.0361 = psig.

Oz/sq-in x 0.0625 = psig.

Psig x 27.71 = Inches WC.

Psig x 16.0 = Oz/sq-in.



Burner Information

The CBLE Ohio Special encompasses an integral front head that includes the burner and combustion air fan as part of the boiler package design.

The integral front head provides for burner/boiler design as a single unit maximizing the compatibility between the boiler and burner.

Gas-Fired Burners

Table A12-7 gives gas pressure requirements.

Table A12-8 shows gas pressure altitude conversions

Figure A12-5 shows typical gas train components, and Figure A12-6 shows typical gas train piping layouts for multiple boiler applications.

Natural gas consumption information is shown on the boiler rating sheets in the Dimensions and Rating Section.

Oil-Fired Burners

Fuel oil consumption information is shown on the boiler rating sheets in the Dimensions and Rating Section.

Boiler Room Information

Figure A12-7 shows typical boiler room length requirements.

Figure A12-8 shows typical boiler room width requirements.

Stack Support Capabilities

300 hp Ohio Special Boilers can support up to 2,000 lbs without additional support.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - E. Size the openings by using the formula:

$$\text{Area (sq-ft)} = \text{cfm/fpm}$$

2. Amount of air required (cfm).
 - A. Combustion air - rated bhp x 8 cfm/bhp.

B. Ventilation air - rated bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.

3. Acceptable air velocity in Boiler Room (fpm).

A. From floor to (7) foot height - 250 fpm.

B. Above (7) foot height - 500 fpm.

C. Duct from air supply to boiler - 1000 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 200 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $200 \times 10 = 2000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} / 250 = 2000 / 250 = 8$ Sq-ft total.
- Area/Opening: $8 / 2 = 4$ sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Ohio Special is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C.

For additional information, please review Boiler Book Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver- Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

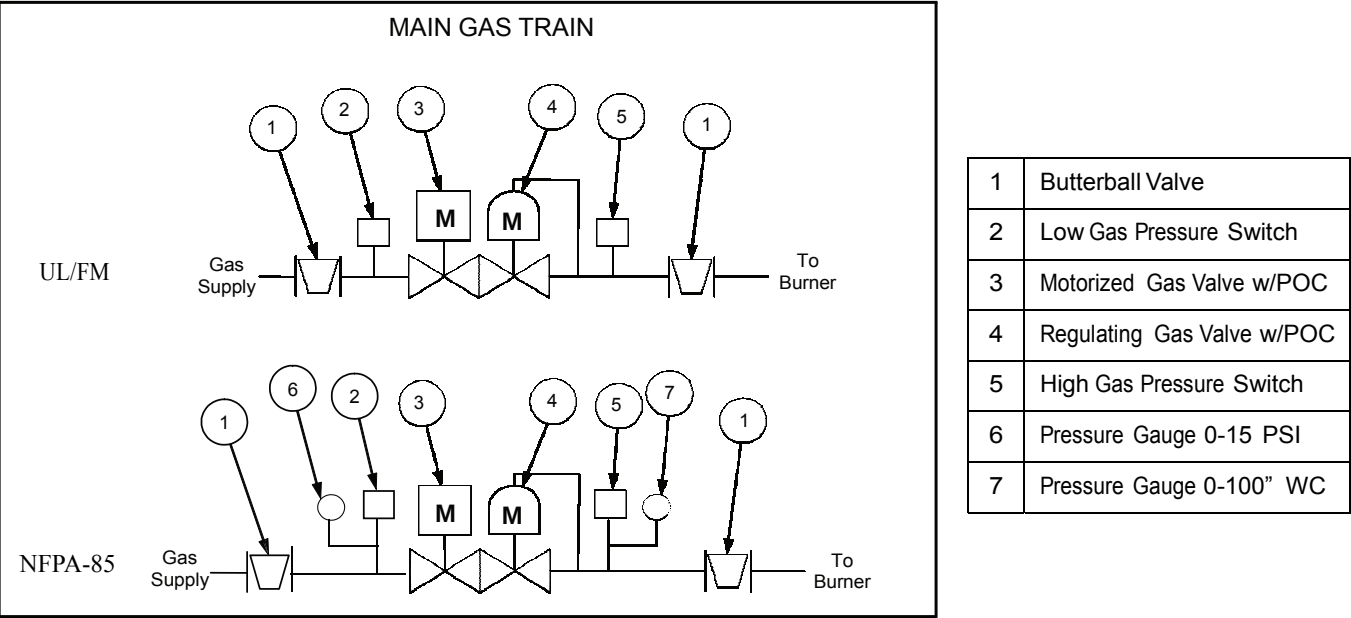
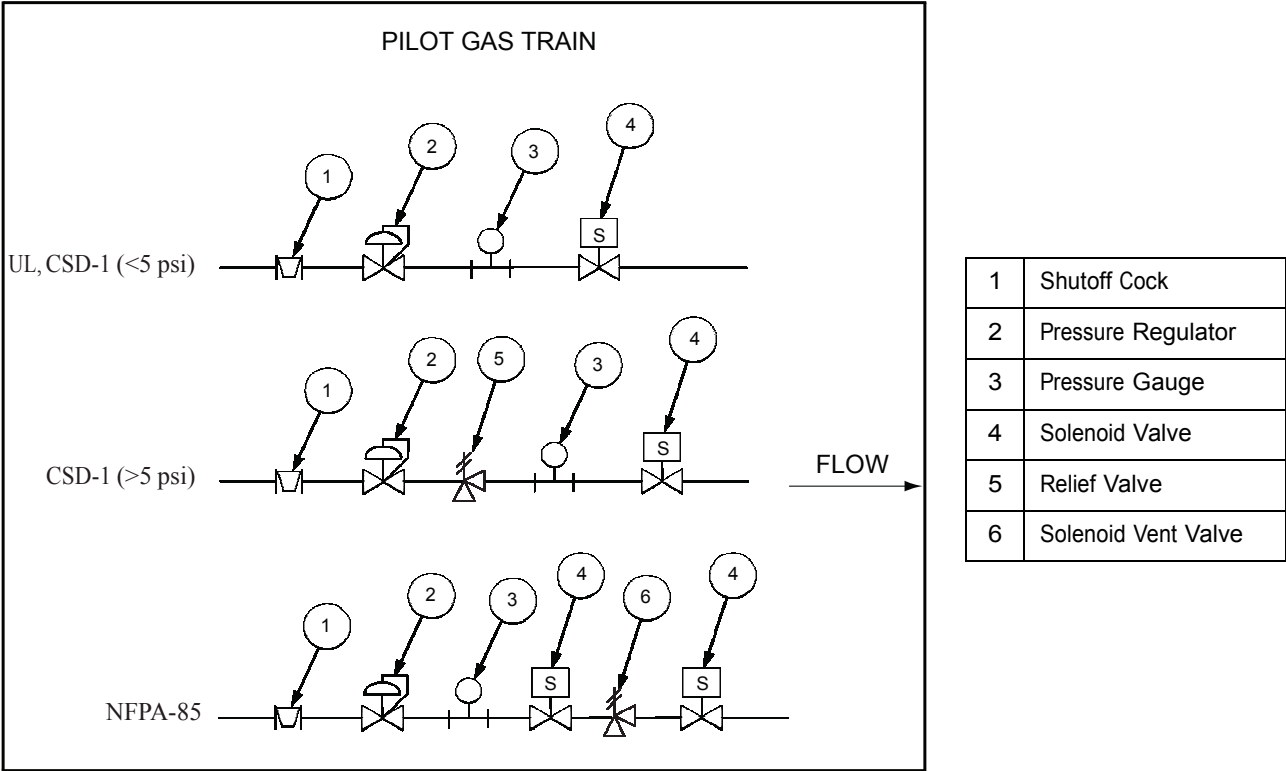
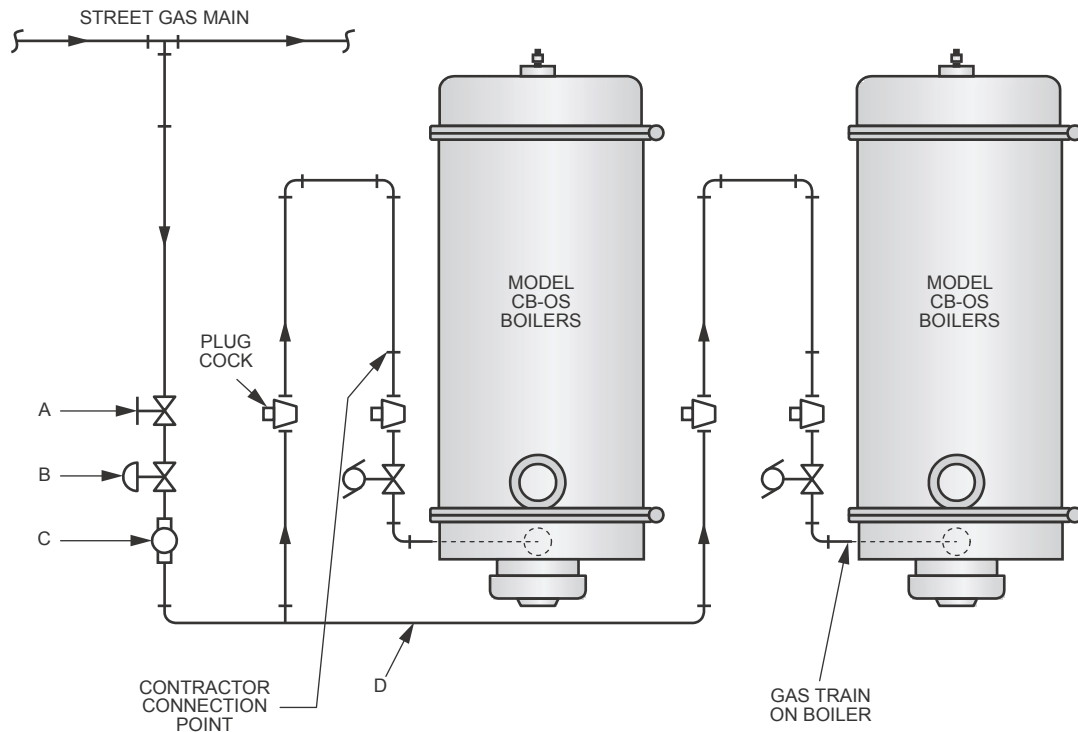


Figure A12-5. Model CBLE Ohio Special Gas Train Components

This figure illustrates the basic gas valve arrangement on Cleaver-Brooks boilers and shows the contractor's connection point. The valves and controls between the contractor connection point and the gas main in the street are representative of a typical installation. Actual requirements may vary depending on local codes or local gas company requirements which should be investigated prior to preparation of specifications and prior to construction.



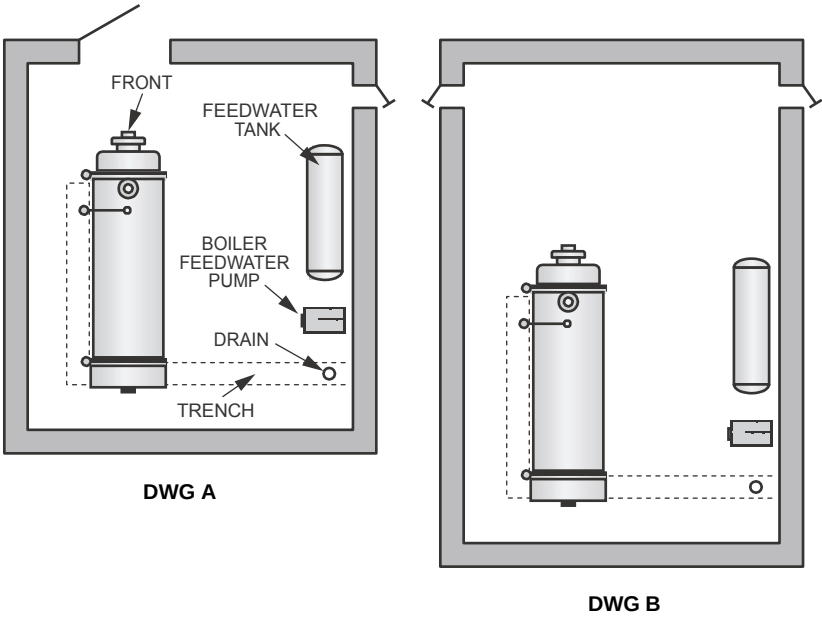
- A. Utilities service valve.
- B. Utilities service regulator.
- C. Gas meter.
- D. Piping from meter to boiler.

The size of the gas line from the meter to the connection point at the boiler can be very important if gas pressures are marginal. The gas line sizing is dependent on:

1. Gas pressure at outlet of gas meter (C)
2. Rate of gas flow required, CFH
3. Length of pipe run (D)
4. Pressure required at contractor connection point.

The local gas utility will advise the pressure that is available at the outlet of their meter.

Figure A12-6. Typical Gas Piping Layout



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear. If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.
2. Next shortest boiler room length (Dwg B) is obtained by allowing for possible future tube replacement from the front of the boiler. Allowance is only made for minimum door swing at the rear. If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

Figure A12-7. Boiler Room Length (Typical Layouts), Model CBLE Ohio Special

CBLE 300S	
Dimension A	91"
Dimension B	127"

- NOTES:
1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of 48". If space permits, this aisle should be widened.

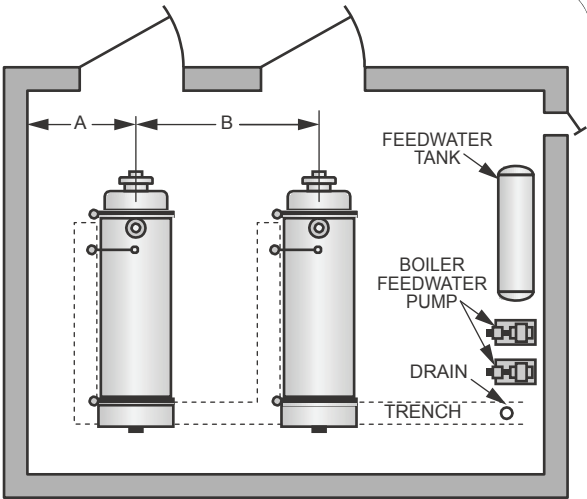


Figure A12-8. Boiler Room Width (Typical Layout), Model CBLE Ohio Special



Model CBLE Ohio Special

300 HP - 15 or 150 psig Steam
Sample Specification

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Warranty	A12- 20



Model CB Ohio Special Steam Boiler

300 HP 15 or 150 psig Steam

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.

PART 1 GENERAL

1.01 BOILER CHARACTERISTICS

- A. The Steam Boiler shall be Cleaver-Brooks Model CB Ohio Special Fuel Series ____ (200, 700), 300 HP designed for ____psig steam. The maximum operating pressure shall be ____psig.
- B. Electrical power available shall be ____Volt ____Phase ____Cycle and 115/1/60 for the control circuit.

PART 2 PRODUCTS

2.01 GENERAL BOILER DESIGN

- A. The boiler shall be a 2-pass horizontal firetube updraft boiler with 358 square feet of total heating surface. It shall be mounted on a heavy steel frame with integral forced draft burner and burner controls.
- B. Tubes shall be of extended heating surface design utilizing finned AluFer inserts.
- C. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent, and blowdown connections.
- D. Boiler Shell
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished the purchaser.
 - 2. Two lifting eyes shall be located on top of the boiler.
 - 3. Front and rear doors on the boiler shall be hinged or davited. Doors are to be sealed with fiberglass tadpole gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
 - 4. Rear refractory and insulation shall be contained in the formed door which must swing open for inspection.
 - 5. Front and rear tube sheets and all tubes must be fully accessible for inspection and cleaning when the doors are swung open. The boiler shall be furnished with adequate handholes to facilitate boiler inspection and cleaning.
 - 6. A manhole shall be provided.
 - 7. The exhaust gas vent shall be located near the front of the boiler on the top center line and shall be capable of supporting 2000 lbs. and shall be equipped with a stack temperature switch.
 - 8. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
 - 9. The boiler insulation shall consist of a 2 inch fiberglass blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.



10. The entire boiler base frame and other components shall be factory painted before shipment using a hard-finish enamel coating.

2.02 BOILER TRIM

A. Low Water Cutoff/Feedwater valve (pump) control (150 psig design)

LWCO/Pump control shall be a CB LEVEL MASTER water level control system comprising a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows: The electronic controller shall be mounted in the common control panel (see 2.4 below) and operate in ambient temperatures from 32 degrees F to 125 degrees F. The pressure chamber shall be boiler mounted and operate to pressures of 250 PSIG and the level sensor shall operate to pressures of 250 PSIG and temperatures to 400 degrees F. The pressure-containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase- 60 Hz. All wiring shall be in compliance with the National Electrical Code.

The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/menu switch and the following features:

- a. Continuous Level Indication
- b. Low Water Cutoff & Alarm
- c. High Water Alarm
- d. Low & High Water Warning
- e. Full Modulating Control of Modulating Feedwater Control Valve
- f. Continuous Monitoring of Float Operation
- g. Column Blowdown Detection and Reminder
- h. Auto or Manual Reset
- i. Real Time Clock
- j. Alarm Annunciation
- k. Alarm History Files with Time Stamp
- l. Water Column Blowdown Record
- m. Auxiliary Low Water Cutoff Check
- n. RS 232 Interface
- o. Maximum Contacts Rating 15 amps Resistive Load

B. Low Water Cutoff/Feedwater Pump Control (15 psig design)

A water column shall be located on the right hand side of the boiler complete with gauge glass set, and water column blowdown valves. The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feedwater pump maintaining the boiler water level within normal limits. The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.

C. Auxiliary Low Water Cutoff

Auxiliary low water cutoff shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used on this control.

D. Steam Pressure Gauge

The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.

E. Safety Relief Valves

Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.

F. Steam Pressure Controls



The steam pressure controls to regulate burner operation shall be mounted near the water column.

2.03 BURNER

A. Mode of Operation

Burner operation shall be full modulation principle. The burner shall always return to low fire position for ignition.

B. Forced Draft Blower

1. All air for combustion shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.
2. Maximum sound level of the boiler/burner package shall not exceed ____dBA (when measured in accordance with ABMA Sound Test Standards).
3. The impeller shall be cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

C. Combustion Air Control

Combustion air damper, cam operated fuel metering valves, and flue gas recirculation valve shall be operated by a single modulating motor that regulates firing rate according to load demand. Single point positioning controls shall be provided to regulate operation of the modulating motor.

D. Emissions

Burner shall be capable of <30 ppm NO_x and <50 ppm CO emissions when firing natural gas.

E. Fuel Series 700 - Gas Fired

1. Burner Type - The burner shall be integral with the front head of the boiler and shall be of the hypermix type. The burner shall be approved for operation on natural gas fuel.
2. Gas Pilot - The gas pilot shall be spark ignited interrupted type and shall be extinguished after main flame proving. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
3. Gas Burner Piping - Gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The valve is spring return to start or stop the gas burner and to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly shutoff valve shall be furnished at entrance to gas train.
4. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
5. Burner Turndown - Turndown range of the burner shall be 5:1 when firing natural gas.

F. Fuel Series 200 - Light Oil or Gas Fired

Note: Oil to be fired as a backup fuel only and should be limited to 150 hrs/yr. Sulphur content of the fuel oil used should not exceed

0.07% by weight. Oil should not be fired in a cold boiler.

1. Burner Type - The burner, integral with the front head of the boiler, shall be a combination of the low pressure air atomizing type for oil and hypermix type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 Oil or natural gas.



2. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include two manual shut-off valves, solenoid valve, pressure regulator and pressure gauge.
 3. Oil Burner
 - a. Oil Pump - An oil pump with a capacity of approximately twice the maximum burning rate shall be included. A separate motor driven pump set, shipped loose, to be installed in a location favorable to the oil storage tank, shall be provided.
 - b. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit. A fuel oil controller shall be provided to combine all of the fuel oil controls into a single casting which is mounted on the front door of the unit. A single tip retractable nozzle shall be used for the low pressure air atomizing burner. A low oil pressure switch shall be included in the oil piping.
 - c. Low pressure Air Atomizing - Separate air compressor module mounted on boiler base rail with low atomizing air pressure switch shall be provided.
 4. Gas Burner
 - a. Gas Burner Piping - gas burner piping on all units shall include pressure regulating gas shutoff valve, motor operated with proof of closure switch and plugged leakage test connection. The valve is spring return to start or stop the gas burner and to close automatically in the event of power failure, flame failure, low water or any safety shutdown condition. A lubricating plug cock or butterfly shutoff valve shall be provided as a means for a tightness check of the primary shut off valve. An additional plug cock or butterfly shutoff valve shall be furnished at entrance to gas train.
 - b. High and low gas pressure switches shall be provided. A second motorized safety shutoff valve, plus an additional plugged leakage test connection shall be provided.
 - c. Burner Turndown - Turndown range of the burner shall be 5:1 when firing natural gas.
- G. Boiler Flame Safeguard Controller and Control Panel
1. CB780E Flame Safeguard Controller - Each boiler shall be factory equipped with flame safeguard controller providing technology and functions equal to the Cleaver-Brooks Model CB780E. Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.

Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open (when proof of closure switch is furnished).

The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.

2. Control/Entrance Panel - A common enclosure shall house the control panel and the entrance panel. Enclosure shall be mounted at the side of the boiler in a location convenient to the operator. Enclosure shall consist of upper and lower sections divided by a partition with a separate hinged door for each section. Upper section (low voltage) will house boiler controls including flame safeguard, water level system controller, and Hawk ICS if so equipped. Lower panel section (high voltage) will house entrance panel.

The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches.

The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers, the panel shall contain the fuel selector switch.

- a. Lights
 - White - load demand.
 - White - fuel valve open.
 - Red - low water.
 - Red - flame failure.
- b. Control Switches
 - Burner On-Off.
 - Manual-Automatic.
 - Manual Firing Rate Control.
- c. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
- d. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
- e. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.04 EFFICIENCY GUARANTEE

- A. The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of ____percent from 25 to 100 percent of rating when burning natural gas and _____fuel-to-steam efficiency at 100% firing rate when burning oil.

2.05 WARRANTY

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

PART 3 EXECUTION

A. Shop Tests

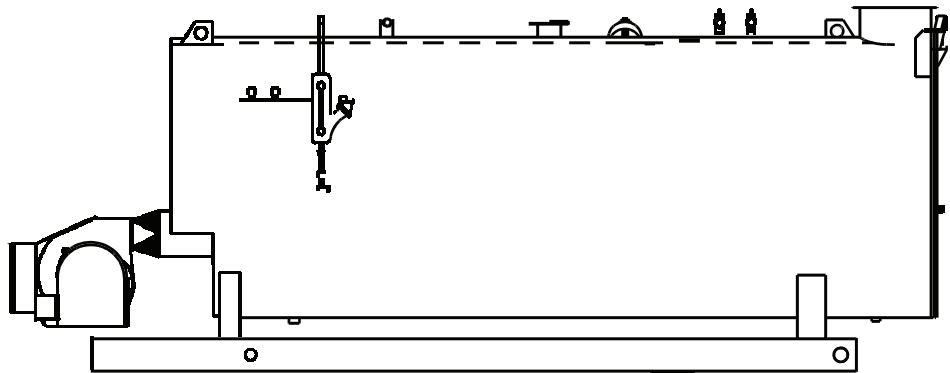
The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

B. Start-up Service

1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and timing the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

MODEL CEW OHIO SPECIAL

100 - 225 HP
Steam
Wet-back Packaged Burner



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FEATURES AND BENEFITS

The Model CEW Ohio Special Firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks specifically for operation in the state of Ohio, under the rules and regulations for unattended units. The unique design of the Ohio Special Boiler serves your steam needs and reduces unnecessary labor costs. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firetube boilers, the following features apply to the Model CEW Ohio Specials.

Less than 360 Square Feet of Heating Surface:

The greatest amount offered in any packaged boiler for unattended steam boiler operation in Ohio - means long life and years of service at the high efficiencies.

Front and Rear Doors:

- Davited, front and rear doors, all sizes.
- Provides access to front and rear tube sheet.
- Large rear access plug for turnaround and furnace access.
- Rear door completely covers and insulates rear tube sheet.

Natural Gas, No. 2 Oil, or Combination Burners Available:

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.

PRODUCT OFFERING

Cleaver-Brooks Model CEW Ohio Special Boilers are available in low pressure steam and high pressure steam designs. Burners are available to fire natural gas, No. 2 oil, or a combination of oil and gas. Standard product offering is:

- 100 - 225 hp.
- Three pass wetback design.
- 15 - 250 psig steam.
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks authorized representative for option details).

- Boiler Options:
 - Drain valves.
 - Additional screwed or flanged tappings.
 - Blowdown valves.
 - Non-return valves.
 - Feedwater valves and regulators.
 - Surface blowdown systems.
 - Surge load baffles.

- Seismic design.
- Burner/Control Options:
 - Flame safeguard controllers.
 - Lead/lag system.
 - Special insurance and code requirements (e.g., IRI, FM, CSD-1).
 - Alarm bell/silence switch.
 - Special motor requirements (TEFC, high efficiency).
 - Special indicating lights.
 - Main disconnect.
 - Elapsed time meter.
 - NEMA enclosures.
 - Low-fire hold control.
 - Remote emergency shut-off (115V).
 - Circuit breakers.
 - Day/night controls.
 - Special power requirements.
 - Stack thermometer.
- Fuel Options:
 - Gas strainer.
 - Gas pressure gauge.
 - Future gas conversion.
 - Oversized/undersized gas trains.

DIMENSIONS AND RATINGS

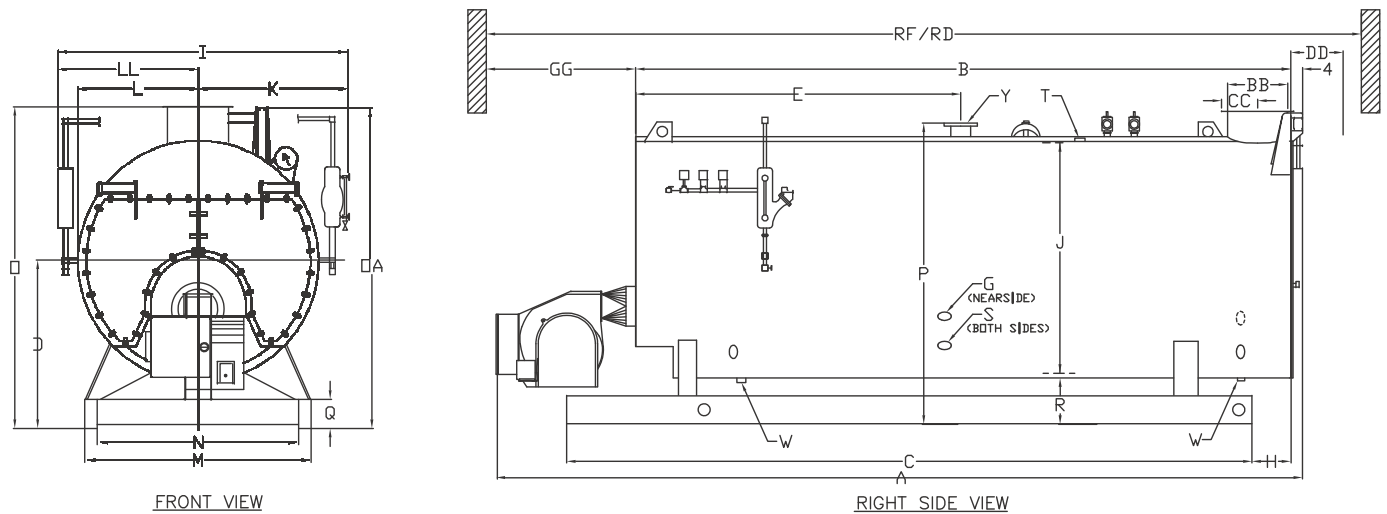
Dimensions and ratings for the Model CEW Ohio Special Boilers are shown in the following tables and illustrations. The information is subject to change without notice.

- Table A9-1. Model CEW Ohio Special Steam Boiler Ratings
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Table A9-1. Model CEW Ohio Special Steam Boiler Ratings

BOILER HP	100S	125S	150S	175S	200S	225S
RATINGS - SEA LEVEL TO 1000 FT						
Rated Capacity (lbs-steam/hr from and at 212 °F)	3450	4312	5175	6037	6900	7762
Btu Output (1000 Btu/hr)	3348	4184	5021	5858	6695	7532
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY						
Light Oil gph (140,000 Btu/gal)	29.9	37.4	44.8	52.3	59.8	67.2
Gas CFH (1000 Btu/ft ³)	4184	5230	6277	7323	8369	9415
Gas (Therm/hr)	41.8	52.3	62.8	73.2	83.7	94.1
POWER REQUIREMENTS — SEA LEVEL TO 1000 FT (60 HZ)						
Oil Pump Motor hp (oil firing only)	1/2	1/2	1/2	1/2	1/2	1/2
Blower Motor, hp (No. 2 oil & combination)	2	3	5	5	7.5	10
Blower Motor, hp	1-1/2	3	5	5	7-1/2	10
Air Comp. Motor, hp	2	2	2	3	3	3
WEIGHTS IN POUNDS						
Normal Water Capacity	7430	7430	7430	8293	8293	8293
Approx. Wt. -15 psig	10311	10311	10311	11150	11150	11150
Approx. Wt. -150 psig	12558	12558	12558	13515	13515	13515
Approx. Wt. -200 psig	13632	13632	13632	14465	14465	14465
Approx. Wt. -250 psig	15079	15079	15079	16029	16029	N/A
BOILER DATA						
Heating Surface sq-ft (Fireside)	354	354	354	358	358	358

NOTE: All fractional hp motors will be single phase voltage, integral hp motors will be 3-phase voltage.



BOILER HP	DIM	100S-150S	175S-225S
	(inches)		
LENGTHS			
Overall	A	207-1/2	228-1/2
Shell	B	157-3/8	170-3/8
Base Frame	C	174-7/8	196-1/2
Base Frame to Rear Flange	H	13-1/2	13-1/2
Flange to Steam Nozzle	E	63-7/8	56-1/4
WIDTHS			
Overall ^C	I	85	85
I. D. Boiler	J	60	60
Center to Water Column	K	45	45
Center to Lagging	L	33	33

Figure A9-1. Model CEW Ohio Special Steam Boiler Dimensions (Page 1 of 2)

BOILER HP	DIM	100S-150S	175S-225S
	(inches)		
Center to Auxiliary LWCO	LL	40	40
Base Outside	M	52-1/2	52-1/2
Base Inside	N	44-1/2	44-1/2
HEIGHTS			
Base to Boiler Centerline	D	46	46
Base to Vent Outlet	O	85	85
Base to rear Door Davit	OA	86-1/2	86-1/2
Base to Steam Outlet	P	82-3/8	82-3/8
Base Frame	Q	12	12
Base to Bottom Boiler	R	16	16
CONNECTIONS			
Chemical Feed	G	1	1
Feedwater Inlet (Both Sides)	S	1-1/2	1-1/2
Steam Nozzle (15 psig) ^A	Y	8	10
Steam Nozzle (150 psig) ^B	Y	4	4
Drain - Front & Rear (15 psig)	W	1-1/2	2
Blowdown - Front & Rear (150 psig)	W	1-1/2	1-1/2
Surface Blowoff (150 psig)	T	1	1
Surface Blowoff (15 psig)	T	1-1/2	1-1/2
Vent Stack Diameter (Flanged)	BB	16	16
Flange to Center Vent	CC	10-1/8	10-1/8
MISCELLANEOUS			
Rear Door Swing	DD	36	36
Tube Removal - Front Only	GG	124	137
Min. Boiler Room Length For Tube Removal Front	RF	318	344
Min. Boiler Room Length For Tube Removal Thru Door	RD	276	297

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for actual option requirements.

A. 150 psig Flange.

B. 300 psig Flange.

C. Overall width may increase with the addition of electrical options due to control panel mounting.

Figure A9-1. Model CEW Ohio Special Steam Boiler Dimensions (Page 2 of 2)

BOILER HP	DIMENSION (INCHES)				
	A	B	C	D	E
100S-225S	33	42	54	77	36

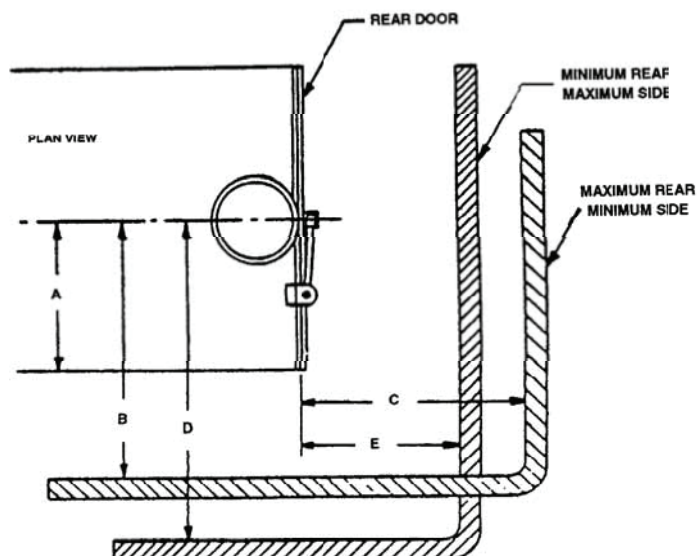
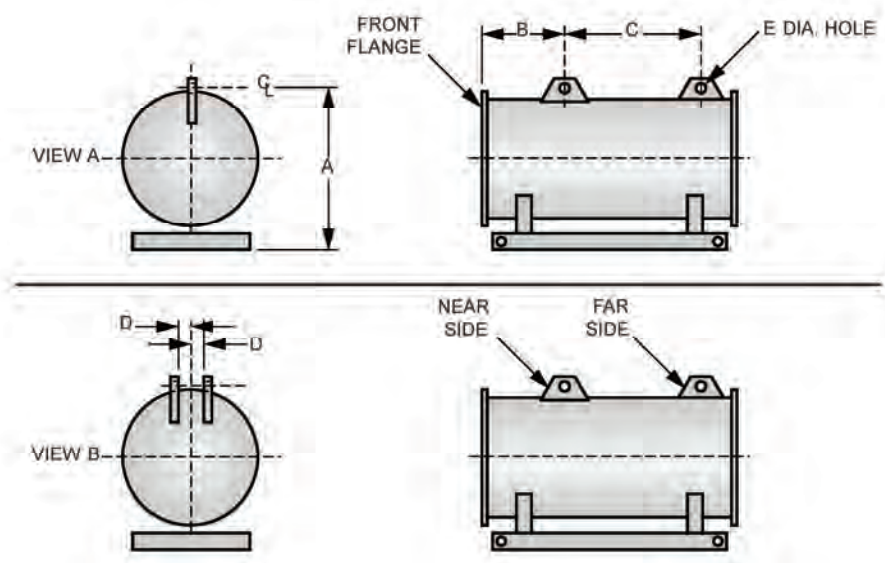
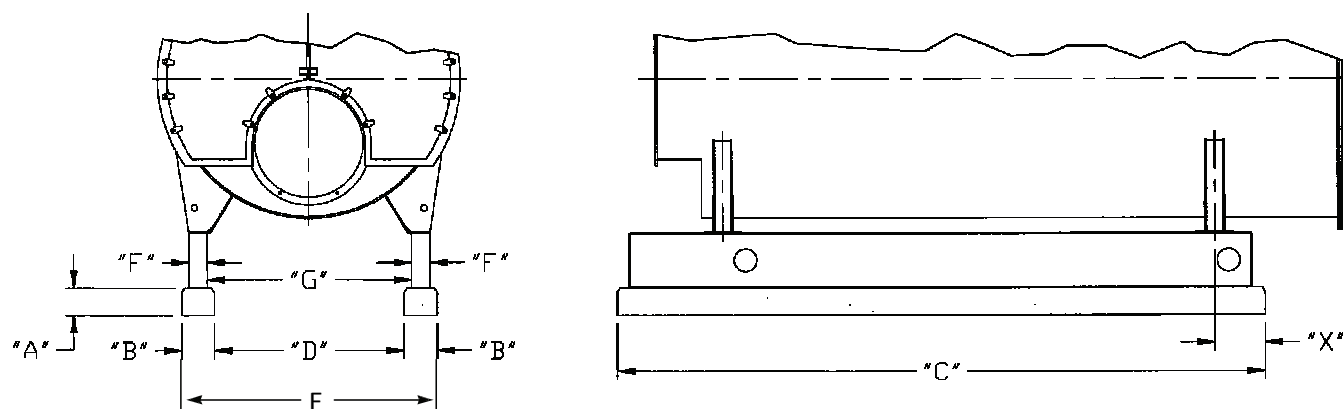


Figure A9-2. Space Required to Open Rear Head on Model CEW Ohio Special Boilers



BOILER HP	ALL DIMENSIONS IN INCHES					
		A	B	C	D	E
100S-150S	Steam	80	19	120-1/2	10	3
175S-225S	Steam	80	19	133-1/2	10	3

Figure A9-3. Model CEW Ohio Special Boilers Lifting Lug Location



BOILER HP	A	B	C	D	E	F	G	X
100S-150S	6	9	175	39-1/2	57-1/2	4	44-1/2	9-1/2
175S-225S	6	9	196-1/2	39-1/2	57-1/2	4	44-1/2	9-1/2

NOTE:

All dimensions are in inches.

6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the piping beneath the boiler and added height for washing down the area beneath the boiler.

Figure A9-4. Model CEW Ohio Special Boiler Mounting Piers

PERFORMANCE DATA

Contact your local Cleaver-Brooks authorized representative for efficiencies or additional information.

ENGINEERING DATA

The following engineering information is provided for Model CEW Ohio Special Boilers. Model CEW Ohio Special Boilers are designated by an "S" following the horsepower number. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

Table A9-2 shows steam volume and disengaging area for Model CEW Ohio Special boilers.

Table A9-3 lists quantity and outlet size for safety valves supplied on Model CEW Ohio Special boilers.

Table A9-4 gives recommended steam nozzle sizes on Model CEW Ohio Special Boilers.

Table A9-5 shows recommended non-return valve sizes for Model CEW Ohio Special Boilers.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table A10-6 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks Model CEW Ohio Special Boilers.

Burner/Control Information

Burner Characteristics

Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures.

Gas-Fired Burners

Table Table A9-7 shows correction factors for gas pressure at elevations over 700 ft above sea level.

Table Table A9-8 shows minimum and maximum gas pressure requirements for Standard, FM and IRI CEW Ohio Special Boiler gas trains upstream of the gas pressure regulator.

For oversized or undersized gas trains or altitude above 1,000 feet, contact your local Cleaver-Brooks authorized representative.

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Figure A9-5 shows a typical fuel oil supply arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Boiler Room Information

Figure A9-6 shows typical boiler room length requirements.

Figure A9-7 shows typical boiler room width requirements.

Stack Support Capabilities

100 - 225 hp Model CEW Ohio Special Boilers can support up to 2000 lbs without additional support.

100 - 225 hp Model CEW Ohio Special Boilers can be reinforced to support up to 3000 lbs.

Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - 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 by dust or dirt.
 - 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 unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than one (1) square foot.
 - E. Size the openings by using the formula:
$$\text{Area (sq-ft)} = \text{CFM/FPM}$$
2. Amount of air required (cfm).
 - A. Combustion Air = Rated bhp x 8 cfm/bhp.
 - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
 - A. From floor to (7) foot height - 250 fpm.

B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm/fpm} = 3000/250 = 12$ Sq-ft total.
- Area/Opening: $12/2 = 6$ sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the Model CEW Ohio Special is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C. and up to $+0.5''$ at high fire, when an economizer is used.

The maximum pressure variation at any firing rate for the boiler is $0.25''$ W.C.

For additional information, please review Section I4, General Engineering Data (Stacks) and Section F, Stacks. Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

Table A9-2. Model CEW Ohio Special Steam Volume and Disengaging Areas

VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
100S	1	2-1/2	1	1-1/2	1	1-1/2	1	1-1/4
125S	1	2-1/2	1	2	1	1-1/2	1	1-1/2
150S	1	3	1	2	1	1-1/2	1	1-1/2
175S	1	3	1	2	1	2	1	1-1/2
200S	1	2-1/2	1	2-1/2	1	2	1	2
225S	2	2-1/2	1	2-1/2	1	2	N/A	N/A

NOTE:

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

Valve requirements can vary with special pressure settings.

Table A9-3. Model CEW Ohio Special Steam Boiler Safety Valve Outlet Size

BOILER HP	STEAM VOLUME (CU-FT)		STEAM RELIEVING AREA (SQ-IN)	
	HIGH PRESSURE ^(A)	LOW PRESSURE ^(B)	HIGH PRESSURE ^(A)	LOW PRESSURE ^(B)
100S-150S	23.5	27.1	5990	6221
175S-225S	25.8	29.7	6566	6826

NOTE:

Based on normal water level.

Values are based on standard controls. Optional controls may result in different values.

A. Based on 150 psig design pressure.

B. Based on 15 psig design pressure.

Table A9-4. Model CEW Ohio Special Recommended Steam Nozzle Size

OPERATING PRESSURE PSIG	BOILER HP					
	100S	125S	150S	175S	200S	225S
15	8	8	8	8	10	10
30	6	6	6	6	8	8
40	6	6	6	6	6	8
50	4	6	6	6	6	6
75	4	4	4	6	6	6
100	4	4	4	4	6	6
125	4	4	4	4	4	4
150	2.5	3	3	4	4	4
200	2.5	2.5	3	3	4	4

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 FPM steam velocity.
3. All standard steam nozzle sizes for the 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.
4. For incremental operating pressures, see Table I3-1 Steam Systems Fundamentals

Table A9-5. Model CEW Ohio Special Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LB/HR)	OPERATING PRESSURES (PSIG)						
		50	75	100	125	150	175	200
100S	3450	2-1/2	2-1/2	NA	NA	NA	NA	NA
125S	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA
150S	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA
175S	6037	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA
200S	6900	3*	3	3	3	3	2-1/2	2-1/2
225S	7762	3	3	3	3	3	2-1/2	2-1/2

NOTE:

Valve sizes (300# flanges) given in inches).

Standard non-return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output); selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative. For high turndown applications see Boiler Book Section I3, Table I3-2.

*Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table A9-6. Model CEW Ohio Special Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
100S-150S	110
175S-225S	120

NOTE: Quantity of water removed from boiler by lowering normal water line 4".

Optional level controls can alter water quantities.

Table A9-7. Altitude Correction for Gas

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.30
3000	1.11	8000	1.35
4000	1.16	9000	1.40
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

inches WC x 0.577 = oz/sq-in.

oz/sq-in x 1.732 = inches WC.

i inches WC x 0.0361= psig.

oz/sq-in x 0.0625 = psig.

psig x 27.71 = Inches WC.

psig x 16.0 = oz/sq-in.

Table A9-8. Model CEW Ohio Special Minimum and Maximum Required Gas Pressure at Entrance to Standard, FM and IRI Gas Trains (Upstream of Gas Pressure Regulator)

BOILER HP	PIPE SIZE (Inches)	PRESSURE REQUIRED ("WC)					
		MAX 1 PSIG INLET, MIN SUPPLY PRESSURE ("WC)			MAX 10 PSIG INLET, MIN SUPPLY PRESSURE ("WC)		
		UL	FM	IRI	UL	FM	IRI
100S	2	14	14	15.5	19.5	19.5	21
125S	2	23.5	23.5	23.5	32.5	32.5	32.5
150S	2	22	22	22	27	27	27
175S	2-1/2	20.5	20.5	20.5	22.5	22.5	22.5
200S	2-1/2	25.5	25.5	25.5	28.5	28.5	28.5
225S	2-1/2	N/A	N/A	N/A	36	36	36

Note: For undersized or oversized gas trains or altitudes above 1,000 feet, contact your local Cleaver-Brooks representative.

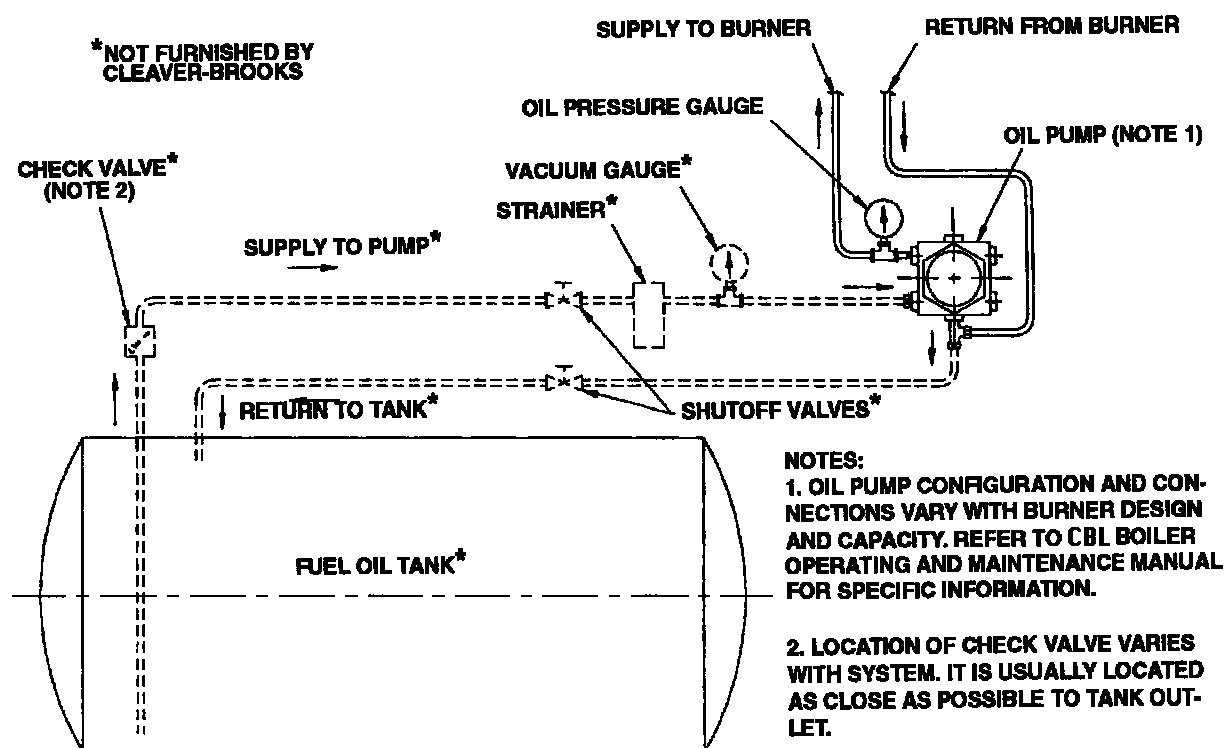
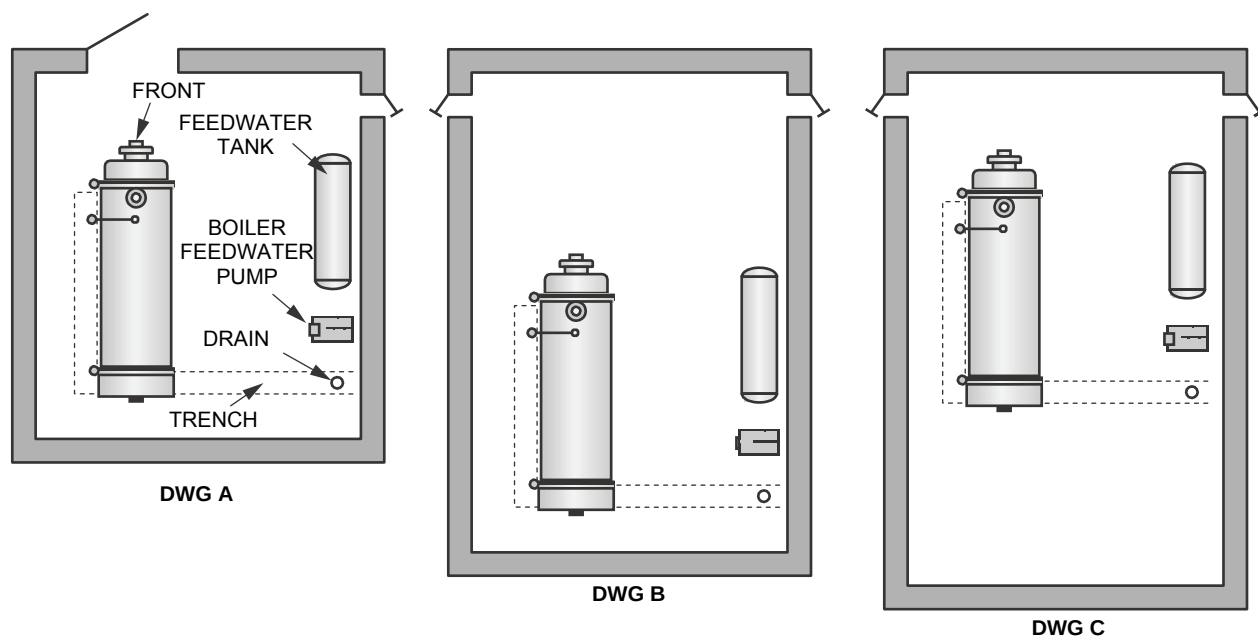


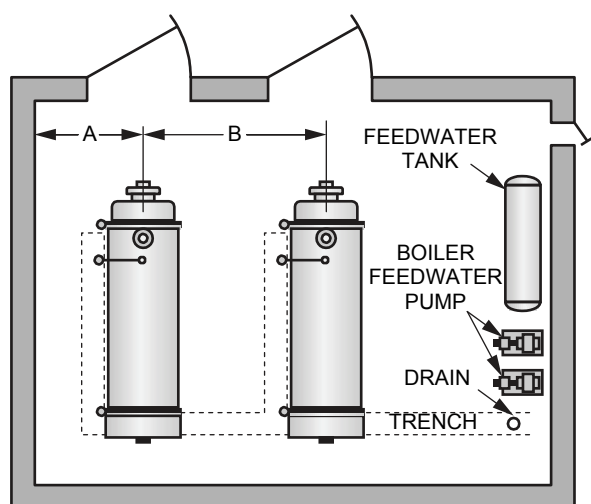
Figure A9-5. Typical Fuel Oil Supply Arrangement



1. Shortest boiler room length (Dwg A) is obtained by allowing for possible future tube replacement (from front or rear of boiler) through a window or doorway. Allowance is only made for minimum door swing at each end of the boiler. This arrangement provides sufficient aisle space at the front of the boiler but a "tight" space condition at the rear.

If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

Figure A9-6. Boiler Room Length (Typical Layouts)



BOILER HP	100S-225S
Dimension A (inches)	82
Dimension B (inches)	115

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a "clear" aisle of 42". If space permits, this aisle should be widened.

Figure A9-7. Boiler Room Width (Typical Layout)

Notes

SECTION A9
MODEL CEW OHIO SPECIAL

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MODEL CEW OHIO SPECIAL

The following sample specification is provided by Cleaver-Brooks to assist you in meeting your customer's specific needs and application.

The Sample Specifications are typically utilized as the base template for the complete boiler specification. Contact your local Cleaver-Brooks authorized representative for information on special insurance requirements, special code requirements, optional equipment, or general assistance in completing the specification.

PART 1 GENERAL

1.01 BOILER CHARACTERISTICS (STEAM)

100-225 HP, STEAM 15, 150, 200 OR 250 PSIG

- A. The Steam Boiler shall be Cleaver-Brooks Model CEW Ohio Special, Fuel Series _____ (100, 200, 700), _____ hp designed for _____ psig (15, 150, 250 psig steam). The maximum operating pressure shall be _____ psig.
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ horsepower when fired with CS 12-48 No. 2 oil and/or natural gas, _____ Btu/cu-ft. Electrical power available will be _____ Volt _____ Phase _____ Cycle and 115/1/60 for the control circuit.

PART 2 PRODUCTS

2.01 GENERAL BOILER DESIGN

- A. The boiler shall be a three pass wetback horizontal firetube updraft boiler with less than 358 square feet of total heating surface. It shall be mounted on a heavy steel frame with forced draft burner and burner controls. The complete packaged boiler is built as a unit with Underwriters Laboratories listed controls.
 - 1. The boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of water, steam, fuel, electrical, vent and blowdown connections.
- B. Boiler Shell (Steam)
 - 1. The boiler shell must be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
 - 2. Two lifting eyes shall be located on top of the boiler.
 - 3. Front and rear doors on the boiler shall be davited.
 - 4. The rear door shall be insulated with a blanket material and a steel covering to give the surface a hard durable finish.
 - 5. The boiler tubes shall not include turbulators, swirlers or other add-on appurtenances.
 - 6. The boiler shall be furnished with a manhole and handholes to facilitate boiler inspection and cleaning.

7. The exhaust gas vent shall be located near the rear of the boiler on the top center line and shall be capable of supporting 2000 lbs.
8. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
9. The boiler insulation shall consist of a 2 inch blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled, if required.
10. The entire boiler base frame and other components shall be factory painted before shipment using a hard finish enamel coating.

2.02 STEAM BOILER TRIM

- A. Water Column

A water column shall be located on the right hand side of the boiler complete with gauge glass set and water column blowdown valves.

 1. Feedwater Pump Control

The boiler feedwater pump control shall be included as an integral part of the water column to automatically actuate a motor driven feed water pump maintaining the boiler water level within normal limits.
 2. Low Water Cutoff

The low water cutoff shall be included as an integral part of the boiler feedwater control wired into the burner control circuit to prevent burner operation if the boiler water level falls below a safe level.
- B. Auxiliary Low Water Cutoff

The auxiliary low water cutoff shall be included, piped to the vessel, and wired to the burner control circuit. A manual reset device shall be used for this control.
- C. Steam Pressure Gauge

The steam pressure gauge shall be located at the front of the boiler and include cock and test connection.
- D. Safety Relief Valves

Safety valves of a type and size to comply with ASME Code requirements shall be shipped loose.
- E. Steam Pressure Controls

The steam pressure controls to regulate burner operation shall be mounted near the water column.

2.03 BURNER AND CONTROLS

- A. Mode of Operation

Burner operation shall be the full modulation principle. The burner shall always return to low fire position for ignition.
- B. Blower
 1. All air for combustion shall be supplied by a forced draft blower mounted on the burner, to eliminate vibration and reduce noise level.
 2. Maximum sound level of the boiler/burner package shall not exceed _____ dBA (when measured in accordance with ABMA Sound Test Standards).
 3. The impeller shall be fabricated aluminum with radial blade, carefully balanced, and directly connected to the blower motor shaft.
- C. Combustion Air Control

Combustion air damper and fuel control valve shall be operated by a single damper

control motor that regulates the flame according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor.

D. Fuel Specification and Piping

Select one of the following fuel types:

- Fuel series 700 - Gas fired (para 4.4.1).
- Fuel series 100 - Light oil (No. 2) fired (para 4.4.2).
- Fuel series 200 - Light oil or gas fired (para 4.4.3).

1. Fuel Series 700 - Gas Fired

- a. Burner Type - The burner shall be mounted at the front of the boiler and be of high radiant multi-port type for gas. The burner shall be approved for operation on natural gas fuel.
- b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one (1) shutoff valve, solenoid valve, and pressure regulator.
- c. Gas Burner Piping - Select one of the following:
 - 100 hp. Gas burner piping on all units shall include two (2) manual shutoff valves, gas pressure regulator, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valve shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 125 - 225 hp. Gas burner piping on all units shall include two (2) manual shutoff valves, gas pressure regulator, one (1) solenoid, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valve shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.

2. Fuel Series 100 - Light Oil Fired

- a. Burner Type - The burner shall be mounted at the front of the boiler, and shall be approved for operation with CS12-48, Commercial No. 2 oil.
- b. Gas Pilot - The gas pilot shall be a premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary gas valve cannot open until pilot flame has been established. The pilot train shall include one (1) shutoff valve, solenoid valve, and pressure regulator.
- c. Oil Pump - An oil pump with a capacity sufficient for the maximum burning rate shall be included. Pump shall be motor driven and shipped loose to be field installed near the oil storage tank. Oil pump motor starter shall also be provided.
- d. Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shutoff valves, atomizing air proving switch, low oil pressure switch, and pressure gauge all integrally mounted on the unit.
- e. Oil Atomization Type - Burner shall be a low pressure air atomizing type, including a "shipped loose" air compressor assembly.

3. Fuel Series 200 - Light Oil or Gas Fired

- a. Burner Type - The burner, mounted at the front of the boiler, shall be a combination of low pressure air atomizing type for oil and high radiant multi-port type for gas. The burner shall be approved for operation with either CS12-48 Commercial No. 2 oil or natural gas.
 - b. Gas Pilot - The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until pilot flame has been established. The pilot train shall include one (1) manual shutoff valve, solenoid valve, and pressure regulator.
 - c. Oil Burner
 - 1) Oil Pump - An oil pump with a capacity sufficient for the maximum burning rate shall be included. Pump shall be motor driven and shipped loose to be field installed near the oil storage tank. Oil pump motor starter shall also be provided.
 - 2) Oil Burner Piping - Fuel oil piping on the unit shall include oil pressure regulating device, oil metering controls, two (2) solenoid oil shutoff valves, atomizing air proving switch, low oil pressure switch and pressure gauge all integrally mounted on the unit.
 - 3) Oil Atomization Type - Burner shall be a low pressure air atomizing type, including a "shipped loose" air compressor assembly.
 - d. Gas Burner Piping - Select one of the following:
 - 100 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valve shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
 - 125 - 225 hp. Gas burner piping on all units shall include two (2) manual shut-off valves, gas pressure regulator, one (1) solenoid, one (1) motorized gas valve with proof of closure switch, two (2) plugged leakage test connections, and high and low gas pressure switches. The gas valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any abnormal shutdown condition.
- E. Control Panel and Flame Safeguard Controller
1. Control Panel

A factory prewired control panel shall be supplied with the boiler/burner package. Panel will be mounted on the burner.
 2. The panel will have a NEMA 1A rating and contain the flame safeguard controller, burner motor starter, air compressor motor starter, control circuit transformer and fuses, selector switches, indicating lights and terminal strips. Lights shall indicate load demand, flame failure, low water, and fuel valve open.
 3. The panel shall contain fuse protection for the burner motor and air compressor motor.
 4. The flame safeguard controller shall be a CB110 flame monitor with EPD170 program module. Flame detector shall be ultra-violet type.

2.04 EFFICIENCY GUARANTEE

- A. The boiler must be guaranteed to operate at a minimum fuel-to-steam efficiency of _____ percent at 100 percent of rating when burning natural gas and _____ fuel-to-steam efficiency at 100% firing rate when burning oil (Contact your local Cleaver-Brooks authorized representative for efficiency details).

2.05 WARRANTY

- A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 12 months from date of start-up or 18 months from date of shipment, whichever comes first.

PART 3 EXECUTION

- A. Shop Tests
 - 1. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.
- B. Start-up Service
 - 1. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator at no additional costs.
 - a. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

ELECTRIC RESISTANCE BOILERS
STEAM OR HOT WATER



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This section contains information on the complete line of Cleaver-Brooks electric boilers with kilowatt output ratings from 12 to 3,375 kW. Electric boilers are typically utilized for applications where stringent environmental regulations and boiler space requirements are critical.

FEATURES AND BENEFITS

In applications where electric power is more economically available than fossil fuels, or where fossil fuel combustion and the handling of combustion by-products are unacceptable, electric boilers offer a viable alternative.

Compact Design	Electric boilers are typically one-quarter to one-half the size of fuel fired boilers with similar BTU per hour output. The smaller footprint reduces the overall boiler room space.
No Stack Requirements	With no products of combustion to contend with, installation costs are reduced by the elimination of stack requirements. This means the unit can be located anywhere in the building and the exterior of the building is not compromised with an unsightly stack, particularly helpful in tall or high rise buildings.
Emissions	Because there is no combustion, electric boilers are 100% emission free. This is beneficial in meeting total emissions of the project site or in areas where fuel combustion emissions are not tolerated.
Quiet Operation	Elimination of combustion noise and minimal moving parts results in extremely quiet operation, virtually no noise emissions. Very beneficial in applications such as hospitals, nursing homes, schools, and the like.
High Efficiency	With minimum radiation losses and not having the losses associated with combustion equipment the electric boiler will provide nearly 100% efficiency at all operating points.
Ease of Maintenance	The absence of high maintenance combustion equipment and the use of solid state control devices reduce the complexity and number of moving parts. Electric elements are easily accessible and replaceable either individually or in flange mounted groups. Pressure vessel components are not subjected to thermal stresses induced by high temperature differentials and cycling encountered with fossil fuel combustion.
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 stamped accordingly. Each unit is tested and certified in accordance with UL or cUL and the Label is affixed attesting to meeting the latest UL requirements for packaged electric boilers.
Progressive Sequencing Modulation	By individually controlling the heating the heating elements with solid state digital step controllers, only the amount of heat required in response to the system demand is achievable. Virtually unlimited input control is available with optional solid state analog current controllers, which reduces on/off cycling, excellent load tracking, and reduced operating costs.

Designed For Heating Applications Electric boilers are able to withstand virtually any return water temperature. With combustion by-products and high temperature differentials eliminated, condensation and thermal shock do not limit return water temperatures.

Because of the design characteristics, the electric boiler is well suited for applications utilizing indoor/outdoor reset controls, radiant floor heating, snow melt systems, and ground source heat pump systems

For potable water applications, the IWH can be used with the optional epoxy lining or with the optional stainless steel trim.

PRODUCT OFFERING

Information in this section applies to electric resistance steam or hot water boiler sizes ranging from 12 kW through 3375 kW for operation on 208, 240, 380, 480, 575 or 600 volts, three phase power supplies. Installation is for indoor use only.

The complete package has been tested and certified in accordance with U.L. and is approved, listed, and bears the U.L. label (U.S.A. and Canada) for electric resistance boilers. For Canada, each vessel is registered in each Province and the relative CRN number is attached to the boiler.

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

Refer to Table B4-1 as a quick reference guide to the boiler models and sizes provided.

Standard Equipment – Steam Boilers

Equipment described below is for the standard steam electric boilers offering:

A. Model CR and S Boiler

1. Each boiler is designed and constructed in accordance with the A.S.M.E. Code; UL listed, and are mounted on an integral steel frame. Fiberglass insulation (2" thickness) is covered with a preformed, sectional steel painted jacket, factory installed.
2. Trim and Controls:
 - a. Manual Reset High Pressure Cutoff.
 - b. Probe Aux. Low Water Cutoff, MR.
 - c. Aux. Auto High Pressure Cutoff.
 - d. For S/CR-120 through 161:
 - 1-Step (1) on/off pressure switch.
 - 2-Step (2) on/off pressure switch.
 - e. For Models S/CR 162 and greater:
 - Solid state electronic proportional pressure control with progressive step control with adjustable span and inter-stage time delay.
 - f. Primary Low Water Cutoff and On/Off Pump Controller.
 - g. Bottom and Water Column Blowdown Valves.
 - h. Feedwater Stop and Check Valves.

- i. A.S.M.E Pressure Relief Valve(s).
 - j. Steam Pressure Gauge w/test cock.
 - k. Sight Gauge with drain and guards.
 3. Model CR Boilers include an integral Feedwater Tank and Feedwater Pump Assembly piped and wired.
 4. Electric Equipment
 - a. Main Control Panel. Panel door key lock is standard on all S Models 422 and 480.
 - b. Lugs for the primary power supply, top of panel ingress as standard.
 - c. Fuses for each contactor, 200,000 Amps interrupting capacity (AIC).
 - d. Contactors duty rated @ 500,000 cycles.
 - e. Pilot lights for "Control Power On", "High Pressure", "Low Water", and "Steps".
 - f. 67 watts per square inch (WSI) or 78 WSI @ 600V Incoloy 800 heating elements.
 - g. Control Circuit Step-down Transformer with primary and secondary fuses and secondary control power switch.
 - h. Terminal strip for control wiring and external customer connections.
 5. Vessel Inspection Openings:
 - S/CR120 to S/CR 162: Element Flange.
 - S/CR200 to S/CR302: 3" Half Coupling.
 - S361 and larger: 12" x 16" Manway.
- B. Model HSB Boiler
1. Each boiler is designed and constructed in accordance with the A.S.M.E. Code; UL listed, and are mounted on an integral steel frame. Fiberglass insulation (2" thickness) is covered with a preformed, sectional steel painted jacket, factory installed.
 2. Trim and Controls:
 - a. Manual Reset High Pressure Cutoff.
 - b. Probe Aux. Low Water Cutoff, MR.
 - c. Aux. Auto High Pressure Cutoff.
 - d. Solid state electronic proportional pressure control with progressive step control with adjustable span and inter-stage time delay.
 - e. Primary Low Water Cutoff and On/Off Pump Controller.
 - f. Bottom and Water Column Blowdown Valves.
 - g. Feedwater Stop and Check Valves.
 - h. A.S.M.E Pressure Relief Valve(s).
 - i. Steam Pressure Gauge w/test cock.
 - j. Sight Gauge with drain and guards.
 3. Electric Equipment
 - a. Main Control Panel with panel door key lock.

- b. Lugs for the primary power supply, top of panel ingress as standard.
 - c. Fuses for each contactor, 200,000 Amps interrupting capacity (AIC).
 - d. Contactors duty rated @ 500,000 cycles.
 - e. Pilot lights for "Control Power On", "High Pressure", "Low Water", and "Steps".
 - f. 75 watts per square inch (WSI) "Incoloy-800" heating elements.
 - g. Control Circuit Step-down Transformer with primary and secondary fuses and secondary control power switch.
 - h. Terminal strip for control wiring and external customer connections.
4. Vessel Inspection Openings:
- HSB-301 to HSB-302: 3" Half Coupling.
 - HSB-361 and larger: 12" x 16" Manway.

Standard Equipment – Water Boilers

Equipment described below is for the standard hot water electric boilers offering:

A. Model WB Boiler

1. The Model WB boiler is designed and constructed in accordance with the A.S.M.E. Code; UL listed, and are mounted on an integral steel frame. Fiberglass insulation (2" thickness) is covered with a preformed, sectional steel painted jacket, factory installed.
2. Trim and Controls:
 - a. Manual Reset High Temperature Cutoff.
 - b. Probe Low Water Cutoff, auto reset.
 - c. Aux. Auto High Temperature Cutoff.
 - d. For WB-120:
 - 1-Step (1) on/off temperature switch.
 - 2-Step (2) on/off temperature switch.
 - 3-Step (1) 3-stage electronic temperature control.
 - 4-Step (1) 4-stage electronic temperature control.
 - e. For Models WB 121 and above:
 - Solid state electronic proportional temperature control with progressive step control with adjustable span and inter-stage time delay.
 - f. Bottom drain valve.
 - g. A.S.M.E Pressure Relief Valve(s).
 - h. WB120: Separate Pressure and temperature gauge.
 - i. WB-121 and above: Separate Pressure Gauge and Digital Temperature Readout.
3. Electric Equipment
 - a. Main Control Panel. Panel door key lock is standard on WB Models > 930kW.
 - b. Lugs for the primary power supply, top of panel ingress as standard.
 - c. Fuses for each contactor, 200,000 Amps interrupting capacity (AIC).
 - d. Contactors duty rated @ 500,000 cycles.

- e. Pilot lights for "Control Power On", "High Temperature", "Low Water", and "Steps".
 - f. 75 watts per square inch (WSI) "Incoloy-800" heating elements.
 - g. Control Circuit Step-down Transformer with primary and secondary fuses and secondary control power switch.
 - h. Terminal strip for control wiring and external customer connections.
4. Vessel Inspection Openings:
- WB-120 to WB-200: Element Flange.
 - WB-201 to WB-243: 3" Half Coupling.
 - WB-361 and larger: 12" x 16" Manway.
- B. Model IWH Heater
- 1. The Model IWH water heater is designed and constructed in accordance with the A.S.M.E. Code; UL listed, and are mounted on an integral steel frame. Fiberglass insulation (2" thickness) is covered with a preformed, sectional steel painted jacket, factory installed.
 - 2. Trim and Controls:
 - a. Manual Reset High Temperature Cutoff.
 - b. Water Flow Switch - shipped loose.
 - c. Aux. Auto High Temperature Cutoff.
 - d. Stage Controls for 15 - 240 kW:
 - 1-Step (1) on/off temperature switch.
 - 2-Step (2) on/off temperature switch.
 - 3-Step (1) 3-stage electronic temperature control.
 - 4-Step (1) 4-stage electronic temperature control.
 - 1) For 270 kW and greater:
 - Solid state electronic proportional temperature control with progressive step control with adjustable span and inter-stage time delay.
 - e. Bottom drain valve.
 - f. A.S.M.E Pressure Relief Valve(s).
 - g. Pressure and Temperature gauges.
3. Electric Equipment
- a. Lugs for the primary power supply, top of panel ingress as standard.
 - b. Fuses for each contactor, 200,000 Amps interrupting capacity (AIC).
 - c. Contactors duty rated @ 500,000 cycles.
 - d. Pilot lights for "Control Power On", "High Temperature", "Low Water", and "Steps".
 - e. 75 watts per square inch (WSI) "Incoloy-800" heating elements.
 - f. Control Circuit Step-down Transformer with primary and secondary fuses and secondary control power switch.
 - g. Terminal strip for control wiring and external customer connections.

4. Vessel Inspection Openings:

Element Flange.

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

- Output step enable/disable toggle switches.
- Additional Pilot Lights.
- Alarm relays for remote annunciation.
- Alarm Horn with silence switch.
- Safety Door Interlock.
- Outdoor reset control.
- Time Clock.
- Ammeter.
- Voltmeter.
- Kilowatt hour meter.
- Ground Fault Detection.
- Pneumatic control interface (3-15 or 6 - 30 psig to 0 - 145 ohms.)
- Load limiting module.
- Auxiliary Low Water Cutoff.
- Preheat Switch for elements.
- Manual Disconnect Switches.
- Shunt Trip for disconnect switches.
- Main Power Door Interlock (standard with switchgear below 600 AMPS).
- Blowdown Separators.
- Water Softener.
- Chemical Feed Systems.
- SCR controls
- Local/Remote control
- BMS interface
- Return water baffle
- Conductivity control

Optional choices also available for nozzles, inspection hand holes, and valves.

Table B4-1. Standard product offering

Product Type	Boiler Model	Output (kW)	Element Density (W/sq in)	Water Content (gallons)	Design Pressure (psig)	Notes
Hot water boilers	WB	12 - 3360	75	16 - 500	160, 200, 250	1
Steam boilers	S	12 - 2250	67 or 78@600V	16 - 595	15, 150, 200, 250	1
	CR	12 - 563	67 or 78@600V	16 - 115	15, 150, 200, 250	1, 2
	HSB	1560 - 3375	75	180 - 790	15, 150, 200, 250	1
Instantaneous Water Heaters	IWH	15 - 360	75	135 - 360*	160	1

Notes: 1. Heating elements are of Incolloy-800 construction
 2. Model CR identical to Model S but has integral condensate return tank and pump.
 A. 'Water content' not applicable. Flow rate in GPM is listed.

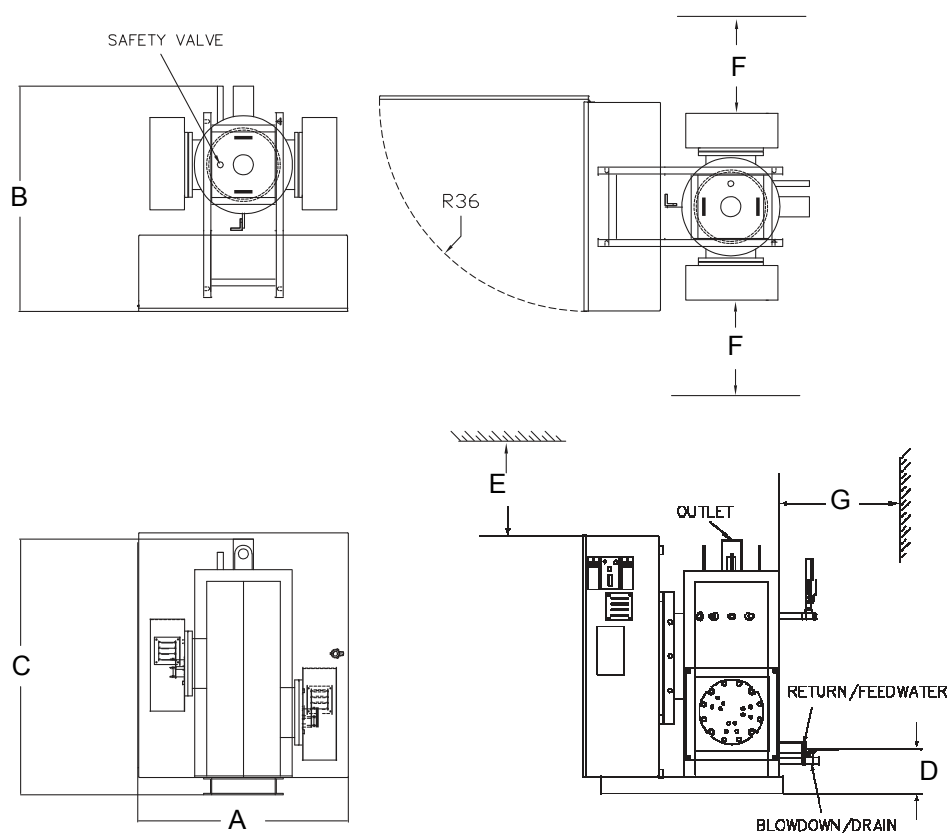
DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Electric Boilers are shown in **Figures B4-1 through B4-5** including the various pipe connections sizes for supply and return water, drain, and steam supply.

Specific ratings of each model are noted in **Tables B4-2 through B4-14**. These tables provide the ampacity at the various supply voltages, element ratings, and contactors employed in the standard models.

Altitude

Because the electric boiler does not require combustion air, installation of the boiler at any elevation is possible without derating or providing special devices for altitude correction normally associated with fuel combustion. Thus the ratings shown are for all elevations.



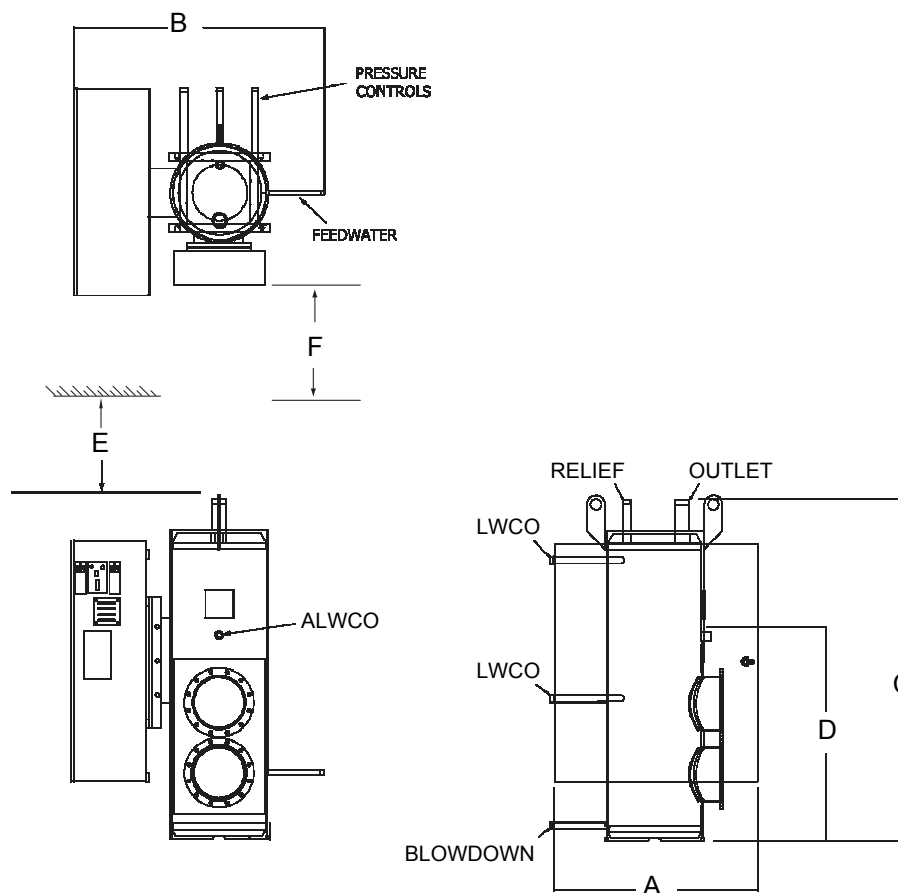
MODEL NO	CONNECTION SIZE (NPT)			DIMENSIONS (IN.)				CLEARANCES			APPROXIMATE WEIGHTS (LBS.)	
				WIDTH	DEPTH	HEIGHT	INLET	TOP	SIDES	REAR	SHIPPING	OPERATING
	SUPPLY	RETURN	DRAIN	A	B	C	D	E	F	G		
WB-120	2	2	3/4	25	36	45	8	12	16	12	450	580
WB-121	3	3	3/4	32	36	45	8	12	16	12	500	630
WB-122	3	3	3/4	32	36	61	8	12	16	12	800	1005
WB-201	4 *	4 *	1-1/4	38	44	71	19	18	16	18	1400	2040
WB-202	4 *	4 *	1-1/4	38	48	71	19	18	16	18	1500	2140
WB-241	6 *	6 *	1-1/2	44	54	75	21	18	25	18	2200	3200
WB-242	6 *	6 *	1-1/2	48	60	75	21	18	25	18	2400	3400
WB-243	6 *	6 *	1-1/2	48	60	83	21	18	25	18	2800	3980
WB-361	6 *	6 *	1-1/2	56	74	75	24	24	30	24	3300	5260
WB-362	8 *	8 *	1-1/2	60	74	92	24	24	30	24	3600	6220
WB-363	8 *	8 *	2	72	76	104	24	24	30	36	4200	7280
WB-421A	10 *	10 *	2	76	76	104	24	24	33	36	5800	9300
WB-422A	10 *	10 *	2	76	95	111	24	24	33	36	6500	10500

NOTES: Dimensional heights are for the boiler only. Control panel size varies based on the number of steps and optional equipment.

A. These models normally supplied with 2 control cabinets for 2 power supplies.

*These are flange connections; 150# ANSI.

Figure B4-1. Model WB Dimensions

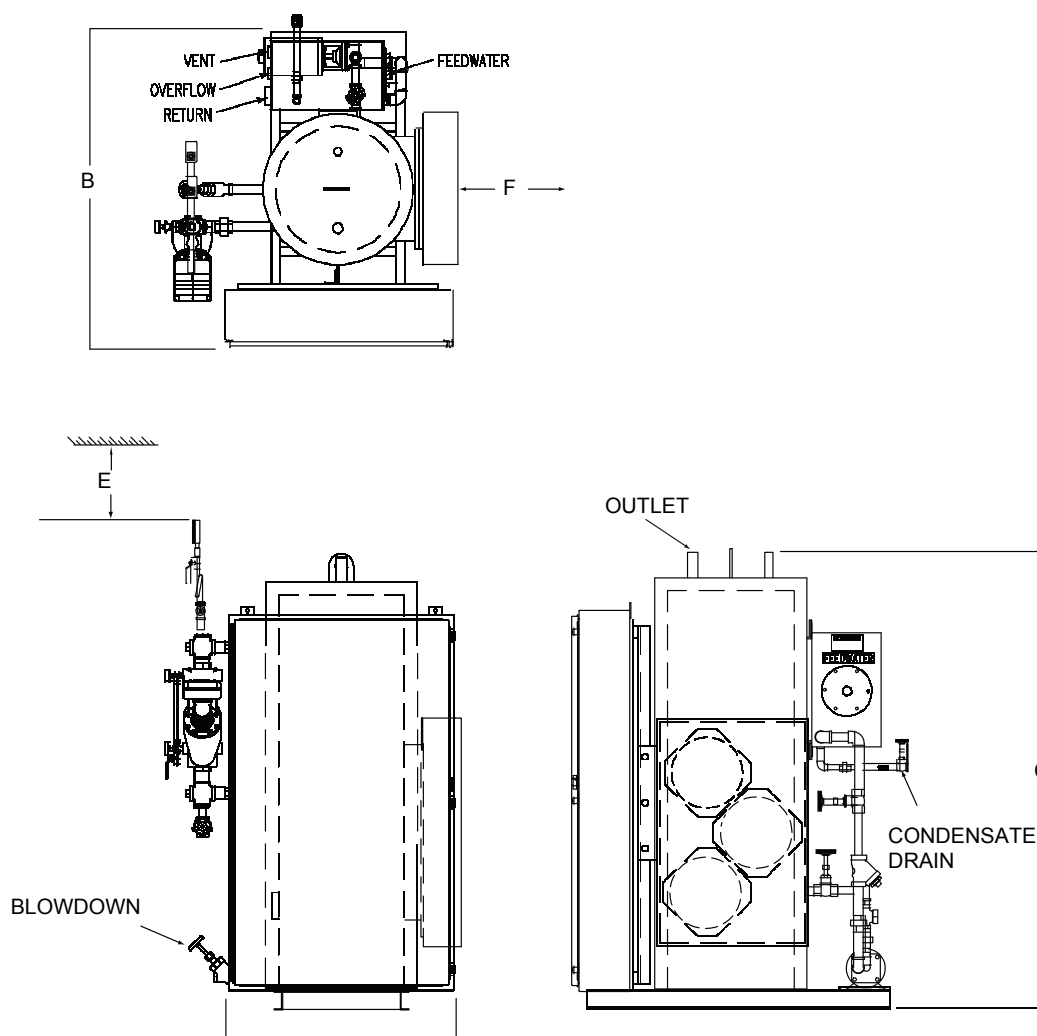


MODEL NO	CONNECTION SIZE (NPT)					DIMENSIONS (IN.)				CLEARANCES		APPROXIMATE WEIGHTS (LBS.)	
	BLOWDOWN		STEAM OUTLET*		FEED-WATER	WIDTH	DEPTH	HEIGHT	LWCO	TOP	SIDES	SHIPPING	OPERATING
	15 PSIG	150 PSIG	15 PSIG	150 PSIG		A	B	C	D	E	F		
S-120	3/4	3/4	1-1/2	1-1/4	1/2	38	38	58	18	12	16	600	675
S-161	3/4	3/4	2	1-1/4	1/2	44	42	69	35	12	20	750	880
S-162	3/4	3/4	2	2	1/2	44	42	69	35	12	20	800	930
S-200	1	1	3 flg	2	3/4	46	47	76	42	12	20	1150	1480
S-241	1-1/4	1	4 flg	2	3/4	43	58	78	42	12	20	1400	1900
S-242	1-1/4	1	4 flg	2	3/4	43	58	78	42	12	20	1600	2000
S-301	1-1/2	1	6 flg	3 flg	3/4	49	62	94	50	15	20	2100	3000
S-302	1-1/2	1	6 flg	3 flg	3/4	49	66	94	50	15	20	2200	3300
S-361	1-1/2	1	8 flg	4 flg	3/4	56	72	79	41	18	36	2900	4000
S-362	1-1/2	1	8 flg	4 flg	3/4	56	78	94	52	18	36	3200	4800
S-421	1-1/2	1	8 flg	4 flg	1	62	84	82	44	18	36	4150	5800
S-422	1-1/2	1	8 flg	4 flg	1	62	84	94	52	18	36	4500	6700
S-480	2	1-1/4	10 flg	6 flg	1	72	90	104	52	18	36	5450	8000

NOTES: Dimensional heights are for the boiler only. Control Panel size varies based on the number of steps and optional equipment.

* Steam Outlet is MPT connection unless otherwise noted.

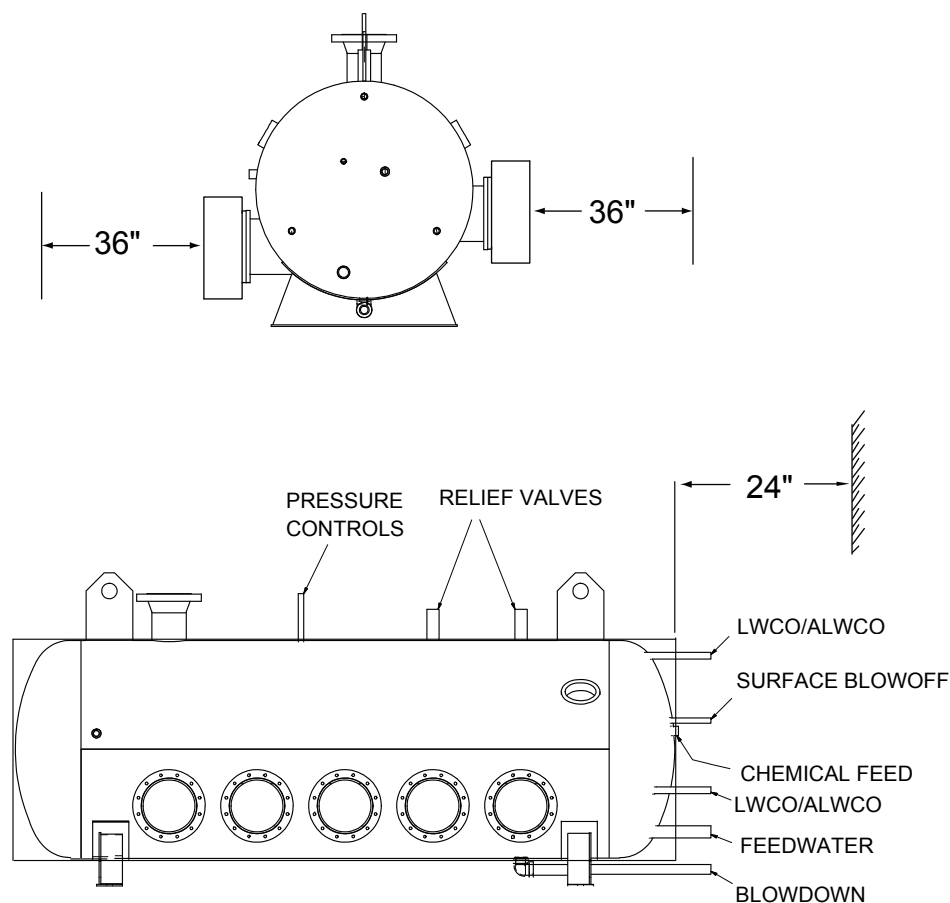
Figure B4-2. Model S Dimensions



MODEL NO	CONNECTION SIZE (NPT)						DIMENSIONS (IN.)				CLEARANCES		APPROXIMATE WEIGHTS (LBS.)	
	BLOWDOWN		STEAM OUTLET*		COND. RETURN	OVER-FLOW	WIDTH	DEPTH	HEIGHT	LWCO	TOP	SIDES	SHIPPING	OPERATING
	15 PSIG	150 PSIG	15 PSIG	150 PSIG			A	B	C	D	E	F		
CR-120	3/4	3/4	1-1/2	1-1/4	3/4	3/4	40	46	58	18	12	16	850	950
CR-161	3/4	3/4	2	1-1/4	1	1	44	50	69	35	12	20	1050	1200
CR-162	3/4	3/4	2	2	1	1	44	50	69	35	12	20	1150	1280
CR-200	1	1	3 flg	2	1-1/4	1-1/4	48	54	76	42	12	20	1650	2030
CR-241	1-1/4	1	4 flg	2	1-1/2	1-1/2	43	58	78	42	12	20	2000	2600
CR-242	1-1/4	1	4 flg	2	1-1/2	1-1/2	43	58	78	42	12	20	2200	2700

* Steam Nozzle connection is MPT unless noted otherwise

Figure B4-3. Model CR Dimensions

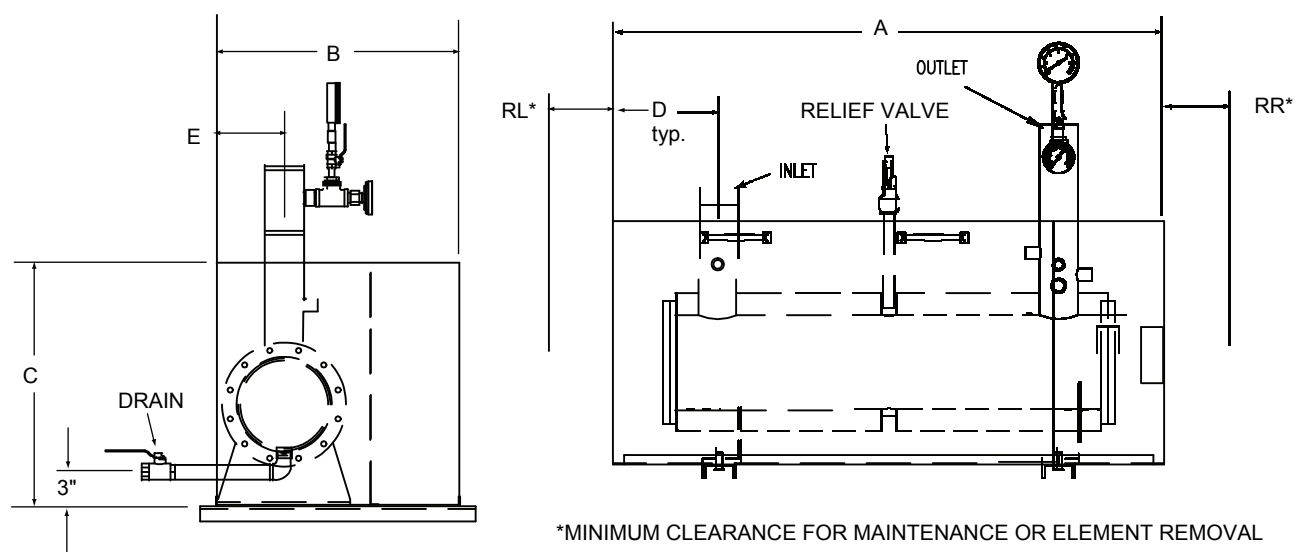


MODEL NO	CONNECTION SIZE (NPT)*					DIMENSIONS (IN.)				CLEARANCES		APPROXIMATE WEIGHTS (LBS.)	
	BLOWDOWN		STEAM OUTLET*		FEED-WATER	WIDTH	DEPTH	HEIGHT	LWCO	TOP	SIDES	SHIPPING	OPERATING
	15 PSIG	150 PSIG	15 PSIG	150 PSIG		A	B	C	D	E	F		
HSB-423	2	1-1/2	10	4	1	155	70	72	34	24	36	5700	8000
HSB-424	2	1-1/2	10	6	1	172	72	72	34	24	36	6400	9300
HSB-425	2	1-1/2	10	6	1	189	72	72	34	24	36	7100	10600

NOTES: Dimensional heights are for the boiler only. Control Panel size varies based on the number of steps and optional equipment.

* Steam Outlet is 150# ANSI Flange connection unless otherwise noted.

Figure B4-4. Model HSB Dimensions



MODEL NO	CONNECTION SIZE (NPT)			DIMENSIONS (IN.)					CLEARANCES			APPROXIMATE WEIGHTS (LBS.)	
				WIDTH	DEPTH	HEIGHT	INLET	INLET	LEFT	RIGHT	FRONT	SHIPPING	OPERATING
	SUPPLY	RETURN	DRAIN	A	B	C	D	E	RL	RR			
IWH-611	2	2	3/4	30	30	36	11	12	14	14	36	250	295
IWH-811	3	3	3/4	30	32	38	11	12	14	14	36	450	525
IWH-812	3	3	3/4	60	32	38	11	12	14	14	36	450	525
IWH-822	3	3	3/4	60	32	38	11	12	25	25	36	500	630
IWH-022	3 *	3 *	3/4	60	34	40	11	12	25	25	36	600	810

NOTES: Dimensional heights are for the boiler only. Control panel size varies based on the number of steps and optional equipment.

*For flow rates above 240 gpm, specify 4" flanged connections.

Figure B4-5. Model IWH Dimensions

Table B4-2. Model WB Ratings 208V, 240V Supplies

MODEL	Vessel Capacity (gallons)	Rated kW	MBTU/HR	ELEMENTS		# of CONTACTORS	NUMBER and kW of STEPS	3-PHASE AMPERES	
				Qty	kW			208 V	240 V
WB-120	16	12	41	3	4	1	1@12	34	30
		18	61	3	6	1	1@18	51	44
		24	82	6	4	2	1@24	68	59
		30	102	6	5	2	1@30	84	73
		36	123	6	6	2	1@36	101	87
		45	154	9	5	3	1@30,1@15	126	109
		54	184	9	6	3	1@36,1@18	151	131
		60	205	12	5	4	2@30	167	145
		72	246	12	6	4	2@36	201	174
WB-121	16	90	307	15	6	5	2@36,1@18	251	217
		108	368	18	6	6	3@36	301	261
		126	430	21	6	7	3@36,1@18	351	304
		144	491	24	6	8	4@36	401	347
		162	553	27	6	9	4@36,1@18	451	391
WB-122	25	180	614	30	6	10	5@36	501	434
		198	676	33	6	11	5@36,1@18	551	477
		216	737	36	6	12	6@36	601	521
		234	798	39	6	13	6@36,1@18	651	564
		252	860	42	6	14	7@36	701	607
		270	921	45	6	15	7@36,1@18	751	651
		288	983	48	6	16	8@36	801	694
B-201	78	324	1105	54	6	18	6@54	901	781
		360	1228	60	6	20	4@54,4@36	1001	868
		396	1350	66	6	22	6@54,2@36	1101	954
		432	1474	72	6	24	8@54	1201	1041

Table B4-3. Model WB Ratings 380V, 415V Supplies

MODEL	Vessel Capacity (gallons)	Rated kW	MBTU/ HR	ELEMENTS		# of CONTACTORS	NUMBER and kW of STEPS	3-PHASE AMPERES	
				Qty	kW			380 V	415 V
WB-120	16	15	51	3	5	1	1@15	23	21
		30	102	6	5	1	1@30	46	42
		45	154	9	5	2	1@15, 1@30	68	63
		60	205	12	5	2	2@30	91	83
		75	256	15	5	3	1@15, 2@30	114	104
WB-121	16	90	307	18	5	3	3@30	137	125
		105	358	21	5	4	1@15, 3@30	160	146
		120	409	24	5	4	4@30	182	167
		135	461	27	5	5	1@15, 4@30	205	188
		150	512	30	5	5	5@30	228	209
		165	563	33	5	6	1@15, 5@30	251	230
WB-122	25	180	614	36	5	6	6@30	273	250
		195	665	39	5	7	1@15, 6@30	296	271
		210	717	42	5	7	7@30	319	292
		225	768	45	5	8	1@15, 7@30	342	313
		240	819	48	5	8	8@30	365	334
		270	921	54	5	9	7@30, 1@60	410	376
WB-201	78	300	1024	60	5	10	6@30, 2@60	456	417
		330	1126	66	5	11	5@30, 3@60	501	459
		360	1228	72	5	12	4@30, 4@60	547	501
		390	1331	78	5	13	3@30, 7@60	593	543
WB-202	78	420	1433	84	5	14	2@30, 6@60	638	584
		450	1535	90	5	15	1@30, 7@60	684	626
		480	1638	96	5	16	8@60	729	668
		510	1740	51	10	17	3@30, 7@60	775	710
		540	1842	54	10	18	2@30, 8@60	820	751
WB-241	122	570	1945	57	10	19	1@30, 9@60	866	793
		600	2047	60	10	20	10@60	912	835
		630	2150	63	10	21	3@30, 9@60	957	876
		660	2252	66	10	22	2@30, 10@60	1003	918
		690	2354	69	10	23	1@30, 11@60	1048	960
		720	2457	72	10	24	12@60	1094	1002
		750	2559	75	10	25	11@60, 1@90	1140	1043
		780	2661	78	10	26	10@60, 2@90	1185	1085
		810	2764	81	10	27	9@60, 3@90	1231	1127
WB-242	122	840	2866	84	10	28	8@60, 4@90	1276	1169
		870	2968	87	10	29	7@60, 5@90	1322	1210
		900	3071	90	10	30	6@60, 6@90	1367	1252
		930	3173	93	10	31	5@60, 7@90	1413	1294
		960	3276	96	10	32	4@60, 8@90	1459	1336

Table B4-3. Model WB Ratings 380V, 415V Supplies (Continued)

MODEL	Vessel Capacity (gallons)	Rated kW	MBTU/ HR	ELEMENTS		# of CONTACTORS	NUMBER and kW of STEPS	3-PHASE AMPERES	
				Qty	kW			380 V	415 V
WB-243	142	990	3378	99	10	33	3@60, 9@90	1504	1377
		1020	3480	102	10	34	2@60, 10@90	1550	1419
		1050	3583	105	10	35	1@60, 11@90	1595	1461
		1080	3685	108	10	36	12@90	1641	1503
		1110	3787	111	10	37	5@60, 9@90	1687	1544
		1140	3890	114	10	38	4@60, 10@90	1732	1586
		1170	3992	117	10	39	3@60, 11@90	1778	1628
		1200	4094	120	10	40	2@60, 12@90	1823	1669
WB-362	315	1230	4197	123	10	41	1@60, 13@90	1869	1711
		1260	4299	126	10	42	14@90	1914	1753
		1290	4401	129	10	43	5@60, 11@90	1960	1795
		1320	4504	132	10	44	4@60, 12@90	2006	1836
		1350	4606	135	10	45	3@60, 13@90	2051	1878
		1380	4709	138	10	46	2@60, 14@90	2097	1920
		1410	4811	141	10	47	1@60, 15@90	2142	1962
		1440	4913	144	10	48	16@90	2188	2003
WB-363	370	1470	5016	147	10	49	5@60, 13@90	2233	2045
		1500	5118	150	10	50	4@60, 14@90	2279	2087
		1530	5220	153	10	51	3@60, 15@90	2325	2141
		1560	5323	156	10	52	2@60, 16@90	2370	2170
		1590	5425	159	10	53	1@60, 17@90	2416	2212
		1620	5527	162	10	54	18@90	2461	2254
		1650	5630	165	10	55	17@90, 1@120	2507	2296
		1680	5732	168	10	56	16@90, 2@120	2553	2337
		1710	5835	171	10	57	15@90, 3@120	2598	2379
		1740	5967	174	10	58	14@90, 4@120	2644	2421
		1770	6039	177	10	59	13@90, 5@120	2689	2463
		1800	6142	180	10	60	12@90, 6@120	2735	2504
WB-421	425	1830	6244	183	10	61	11@90, 7@120	2780	2546
		1860	6346	186	10	62	10@90, 8@120	2826	2588
		1890	6449	189	10	63	9@90, 9@120	2872	2629
		1920	6551	192	10	64	8@90, 10@120	2917	2671
		1950	6653	195	10	65	7@90, 11@120	2963	2713
		1980	6756	198	10	66	6@90, 12@120	3008	2755

Table B4-3. Model WB Ratings 380V, 415V Supplies (Continued)

MODEL	Vessel Capacity (gallons)	Rated kW	MBTU/ HR	ELEMENTS		# of CONTACTORS	NUMBER and kW of STEPS	3-PHASE AMPERES	
				Qty	kW			380 V	415 V
WB-422	500	2010	6858	201	10	67	5@90, 13@120	3054	2796
		2040	6960	204	10	68	4@90, 14@120	3100	2838
		2070	7063	207	10	69	6@90, 15@120	3145	2880
		2100	7165	210	10	70	2@90, 16@120	3191	2922
		2130	7268	213	10	71	1@90, 17@120	3236	2963
		2160	7370	216	10	72	18@120	3282	3005
		2190	7472	219	10	73	23@90, 1@120	3327	3047
		2220	7575	222	10	74	22@90, 2@120	3373	3089
		2250	7677	225	10	75	21@90, 3@120	3419	3130
		2280	7779	228	10	76	20@90, 4@120	3464	3172
		2310	7882	231	10	77	19@90, 5@120	3510	3214
		2340	7984	234	10	78	18@90, 6@120	3555	3256
		2370	8086	237	10	79	17@90, 7@120	3601	3297
		2400	8189	240	10	80	16@90, 8@120	3647	3339
		2430	8291	243	10	81	15@90, 9@120	3692	3381
		2460	8394	246	10	82	14@90, 10@120	3738	3422
		2490	8496	249	10	83	13@90, 11@120	3783	3464
		2520	8598	252	10	84	12@90, 12@120	3829	3506

Table B4-4. Model WB Ratings 480V, 600V Supplies Model	Vessel Capacity (gallons)	Rated kW	MBTU/HR	ELEMENTS		# of CONTACTORS	NUMBER and kW of STEPS	3-PHASE AMPERES	
				Qty	kW			480 V	600 V
WB-120	16	12	41	3	4	1	1 @ 12	15	13
		18	61	3	6	1	1 @ 18	22	18
		24	82	6	4	1	1 @ 24	30	24
		30	102	6	5	1	1 @ 30	37	29
		36	123	6	6	1	1 @ 36	44	35
		45	154	9	5	2	1 @ 45	55	44
		54	184	9	6	2	1 @ 54	66	53
		60	205	12	5	2	2 @ 30	73	58
WB-121	16	72	246	12	6	2	2 @ 36	87	70
		90	307	15	6	3	2 @ 36, 1 @18	109	87
		108	368	18	6	3	3 @ 36	131	105
		126	430	21	6	4	3 @36, 1 @18	152	122
		144	491	24	6	4	4 @ 36	174	139
		162	553	27	6	5	3 @36, 1 @54	196	157
		180	614	30	6	5	5 @ 36	212	174
		198	676	33	6	6	5 @36, 1@18	239	191
		216	737	36	6	6	6 @ 36	261	209
		234	798	39	6	7	6 @36, 1 @18	282	226
		252	860	42	6	7	7 @ 36	304	243

WB-201	78	270	921	45	6	8	7 @36, 1 @18	326	261
		288	983	48	6	8	8 @ 36	347	278
		324	1105	54	6	9	3 @72, 3 @36	391	313
		360	1228	60	6	10	2 @72, 6 @36	434	347
		396	1350	66	6	11	3 @72, 5 @36	477	382
		432	1474	72	6	12	4 @72, 4 @36	521	417
WB-202	78	468	1597	78	6	13	5 @72, 3 @36	564	451
		504	1720	84	6	14	6 @72, 2 @36	607	486
		540	1842	90	6	15	7 @72, 1 @36	651	521
		576	1965	96	6	16	8 @72	694	555
WB-241	122	600	2047	60	10	20	10 @ 60	723	579
		630	2150	63	10	21	3 @30, 9 @60	759	607
		660	2252	66	10	22	2 @30, 10 @60	795	636
		690	2354	69	10	23	1@30, 11 @60	831	665
		720	2457	72	10	24	12 @60	868	694
WB-242	122	750	2559	75	10	25	5 @90, 5 @60	904	723
		780	2661	78	10	26	6 @90, 4 @60	940	752
		810	2764	81	10	27	7 @90, 3 @60	976	781
		840	2866	84	10	28	8 @90, 2 @60	1012	810
		870	2968	87	10	29	9 @90, 1 @60	1048	838
		900	3071	90	10	30	10 @ 90	1084	868
		930	3173	93	10	31	7 @90, 5 @60	1120	896
WB-243	142	960	3276	96	10	32	8 @90, 4 @60	1157	925
		990	3378	99	10	33	9 @90, 3 @60	1193	954
		1020	3480	102	10	34	10 @90, 2 @60	1229	983
		1050	3583	105	10	35	11 @90, 1 @60	1265	1012
		1080	3685	108	10	36	12 @ 90	1301	1041
		1110	3787	111	10	37	9@90, 5@60	1337	1070
		1140	3890	114	10	38	10 @90, 4 @60	1373	1099
		1170	3992	117	10	39	11 @90, 3 @60	1409	1128
		1200	4094	120	10	40	12 @90, 2 @60	1446	1157

Table B4-4. Model WB Ratings 480V, 600V Supplies (Continued)

Model	Vessel Capacity (gallons)	Rated kW	MBTU/HR	ELEMENTS		# of CONTACTORS 480/600 V	NUMBER and kW of STEPS 480/600 V	3-PHASE AMPERES	
				Qty	kW			480 V	600 V
WB-361	235	1224	4176	102	12	34	10 @108, 2 @72	1474	1180
		1260	4299	105	12	35	11 @108, 1 @72	1518	1214
		1296	4422	108	12	36	12 @ 108	1561	1249
WB-362	315	1332	4545	111	12	37	9 @108, 5 @72	1605	1284
		1368	4668	114	12	38	10 @108, 4 @72	1648	1318
		1404	4790	117	12	39	11 @108, 3 @72	1691	1353
		1440	4913	120	12	40	12 @108, 2 @72	1735	1388
		1476	5036	123	12	41	13 @108, 1 @72	1778	1422
		1512	5159	126	12	42	14 @ 108	1821	1457
		1548	5282	129	12	43	11 @108, 5 @72	1865	1492
		1584	5405	132	12	44	12 @108, 4 @72	1908	1527
		1620	5527	135	12	45	13 @108, 3 @72	1951	1561
		1656	5650	138	12	46	14 @108, 2 @72	1995	1596
		1692	5773	141	12	47	15 @108, 1 @72	2038	1631
WB-363	370	1728	5896	144	12	48	16 @ 108	2081	1665
		1764	6019	147	12	49	13 @108, 5 @ 72	2125	1700
		1800	6142	150	12	50	14 @108, 4 @ 72	2168	1735
		1836	6264	153	12	51	15 @108, 3 @ 72	2211	1769
		1872	6387	156	12	52	16 @108, 2 @ 72	2255	1804
		1908	6510	159	12	53	17 @108, 1 @ 72	2298	1839
		1944	6633	162	12	54	18 @ 108	2342	1873
		1980	6756	165	12	55	15 @108, 5 @ 72	2385	1908
		2016	6879	168	12	56	16 @108, 4 @ 72	2428	1943
		2052	7001	171	12	57	17 @108, 3 @ 72	2472	1977
		2088	7124	174	12	58	18 @108, 2 @ 72	2515	2012
WB-421	425	2160	7370	180	12	60	20 @ 108	2602	2081
		2240	7643	168	13.3	56	16 @120, 4 @ 80	2698	2158
		2320	7916	174	13.3	58	18 @ 120, 2 @ 80	2794	2236
		2400	8189	180	13.3	60	20 @ 120	2891	2313
		2480	8462	186	13.3	62	2 @160, 18 @120	2987	2390
		2560	8735	192	13.3	64	4 @160, 16 @120	3083	2467
WB-422	500	2640	9008	198	13.3	66	6 @160, 14 @120	3180	2544
		2720	9281	204	13.3	68	8 @160, 12 @120	3276	2621
		2800	9554	210	13.3	70	10 @160, 10 @120	3372	2698
		2880	9827	216	13.3	72	12 @160, 8 @120	3469	2775
		3000	10236	225	13.3	75	15 @160, 5 @120	3613	2891
		3040	10372	228	13.3	76	16 @160, 4 @120	3661	2929
		3120	10509	234	13.3	78	18 @160, 2 @120	3758	3006
		3200	10645	240	13.3	80	20 @ 160	3854	3083
		3280	11191	246	13.3	82	2 @200, 18 @160	3950	3160
		3360	11464	252	13.3	84	4 @200, 16 @160	4047	3237

Table B4-5. Model S/CR Ratings 208V, 240V Supplies

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	ASME (Steam lbs/ hr)	ELEMENTS	# of CONTACTORS		NUMBER and kW of STEPS	3-PHASE AMPERES	
					Qty	kW	208/240 V	208/240 V	208 V	240 V
S-120 or CR-120	9	7	12	42	3	4	1	1 @ 12	34	30
			24	84	6	4	2	1 @ 24	68	59
			36	126	9	4	3	1 @ 36	101	88
			48	168	12	4	4	2 @ 24	134	116
S-161 or CR-161	23	16	60	210	9	6.7	3	1 @40, 1 @20	168	145
			80	280	12	6.7	4	2 @ 40	223	193
S-162 or CR-162	23	16	100	350	15	6.7	5	2 @40, 1 @20	279	242
			120	420	18	6.7	6	3 @ 40	334	290
			140	490	21	6.7	7	3 @ 40, 1 @ 20	390	338
S-200 or CR-200	48	26	160	560	24	6.7	8	4 @ 40	445	386
			180	630	27	6.7	9	4 @40, 1 @20	501	434
			200	700	30	6.7	10	5 @ 40	556	482
			220	770	33	6.7	11	5 @40, 1 @ 20	612	530
			240	840	36	6.7	12	6 @ 40	667	578
S-241 or CR-241	62	53	260	910	39	6.7	13	6 @40, 1 @ 20	723	626
			280	980	42	6.7	14	7 @ 40	778	675
			300	1050	45	6.7	15	7 @ 40, 1 @ 20	834	723
			320	1120	48	6.7	16	8 @ 40	889	771
S-242 or CR-242	62	53	340	1190	51	6.7	17	8 @ 40, 1 @ 20	945	819
			360	1260	54	6.7	18	2 @ 60, 6 @ 40	1000	867
			380	1330	57	6.7	19	3 @ 60, 5 @ 40	1056	915
			400	1400	60	6.7	20	4 @ 60, 4 @ 40	1111	963

Table B4-6. Model S/CR Ratings 380V, 415V Supplies

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rating kW	Steam lb./hr @ 212°F	No. of Elements Qty @ kW	# of CONTACTORS	No. of Steps @ kW	3-PHASE AMPERES	
								380 V	415 V
S-161 or CR-161	23	16	15	51	3 @ 5	1	1 @ 15	23	21
			30	102	6 @ 5	1	1@30	46	42
			45	154	9 @ 5	2	1@15, 1@30	68	63
			60	205	12 @ 5	2	2@30	91	83
S-162 or CR-162	23	16	75	256	15 @ 5	3	1@15, 2@30	114	104
			90	307	18 @ 5	3	3@30	137	125
			105	358	21 @ 5	4	1@15, 3@30	160	146
			120	409	24 @ 5	4	4@30	182	167
S-200 or CR-200	48	26	135	461	27 @ 5	5	1@15, 4@30	205	188
			150	512	30 @ 5	5	5@30	228	209
			165	563	33 @ 5	6	1@15, 5@30	251	230
			180	614	36 @ 5	6	6@30	273	250
S-241 or CR-241	62	53	210	717	21 @ 10	7	7@30	319	292
			240	819	24 @ 10	8	8@30	365	334
S-242 or CR-242	62	53	270	921	27 @ 10	9	7@30, 1@60	410	376
			300	1024	30 @ 10	10	6@30, 2@60	456	417
			330	1126	33 @ 10	11	5@30, 3@60	501	459
			360	1228	36 @ 10	12	4@30, 4@60	547	501
			390	1331	39 @ 10	13	3@30, 5@60	593	543
			420	1433	42 @ 10	14	2@30, 6@60	638	584
			450	1535	45 @ 10	15	1@30, 7@60	684	626
			480	1638	48 @ 10	16	8@60	729	668
S-301	110	53	510	1740	51 @ 10	17	3@30, 7@60	775	710
			540	1842	54 @ 10	18	2@30, 8@60	821	752
			570	1945	57 @ 10	19	1@30, 9@60	867	793
			600	2047	60 @ 10	20	10@60	912	835
			630	2150	63 @ 10	21	3@30, 9@60	958	877
			660	2252	66 @ 10	22	2@30, 10@60	1003	919
			690	2354	69 @ 10	23	1@30, 11@60	1049	960
			720	2457	72 @ 10	24	12@60	1094	1002
S-362	200	130	750	2559	75 @ 10	25	11@60, 1@90	1140	1044
			780	2661	78 @ 10	26	10@60, 2@90	1186	1086
			810	2764	81 @ 10	27	9@60, 3@90	1231	1127
			840	2866	84 @ 10	28	8@60, 4@90	1277	1169
			870	2968	87 @ 10	29	7@60, 5@90	1322	1211
			900	3071	90 @ 10	30	6@60, 6@90	1368	1253
			930	3173	93 @ 10	31	5@60, 7@90	1413	1294
			960	3276	96 @ 10	32	4@60, 8@90	1459	1336
S-421	210	180	990	3378	99 @ 10	33	3@60, 9@90	1505	1378
			1020	3480	102 @ 10	34	2@60, 10@90	1550	1420
			1050	3583	105 @ 10	35	1@60, 11@90	1596	1461
			1080	3686	108 @ 10	36	12@90	1641	1503

Table B4-6. Model S/CR Ratings 380V, 415V Supplies (Continued)

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rating kW	Steam lb./hr @ 212°F	No. of Elements Qty @ kW	# of CONTACTORS	No. of Steps @ kW	3-PHASE AMPERES	
								380 V	415 V
S-422	270	180	1110	3787	111 @ 10	37	5@60, 9@90	1687	1545
			1140	3890	114 @ 10	38	4@60, 10@90	1733	1586
			1170	3992	117 @ 10	39	3@60, 11@90	1778	1628
			1200	4094	120 @ 10	40	2@60, 12@90	1824	1670
			1230	4197	123 @ 10	41	1@60, 13@90	1869	1712
			1260	4299	126 @ 10	42	14@90	1915	1753
			1290	4401	129 @ 10	43	5@60, 11@90	1960	1795
			1320	4504	132 @ 10	44	4@60, 12@90	2006	1837
			1350	4606	135 @ 10	45	3@60, 13@90	2052	1879
S-480	360	235	1380	4709	138 @ 10	46	2@60, 14@90	2097	1920
			1410	4811	141 @ 10	47	1@60, 15@90	2142	1962
			1440	4913	144 @ 10	48	16@90	2188	2003
			1470	5016	147 @ 10	49	5@60, 13@90	2233	2045
			1500	5118	150 @ 10	50	4@60, 14@90	2279	2087
			1530	5220	153 @ 10	51	3@60, 15@90	2325	2129
			1560	5323	156 @ 10	52	2@60, 16@90	2370	2170
			1590	5425	159 @ 10	53	1@60, 17@90	2416	2212
			1620	5527	162 @ 10	54	18@90	2461	2254

Table B4-7. Model S/CR Ratings 480V Supplies

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	ASME (Steam lbs/ hr)	ELEMENTS		# of Contactors 480 V	NUMBER and kW of STEPS	3-PHASE AMPERES
					Qty	kW		480 V	480 V
S-120 or CR-120	9	7	12	42	3	4	1	1 @ 12	15
			24	84	6	4	1	1 @ 24	29
			36	126	9	4	1	1 @ 36	44
			48	168	12	4	2	2 @ 24	58
S-161 or CR-161	23	16	60	210	9	6.7	2	1 @40, 1 @20	73
			80	280	12	6.7	2	2 @ 40	97
S-162 or CR-162	23	16	100	350	15	6.7	3	2 @40, 1 @20	121
			120	420	18	6.7	3	3 @ 40	145
			140	490	21	6.7	4	3 @40, 1 @20	169
S-200 or CR-200	48	26	160	560	24	6.7	4	4 @ 40	193
			180	630	27	6.7	5	4 @40, 1 @20	217
			200	700	30	6.7	5	5 @ 40	241
			220	770	33	6.7	6	5 @40, 1 @20	265
			240	840	36	6.7	6	6 @ 40	289
S-241 or CR-241	62	53	260	910	39	6.7	7	6 @40, 1 @20	314
			280	980	42	6.7	7	7 @ 40	338
			300	1050	45	6.7	8	7 @40, 1 @20	362
			320	1120	48	6.7	8	8 @ 40	386
S-242 or CR-242	62	53	340	1190	51	6.7	9	8 @40, 1 @20	410
			360	1260	54	6.7	9	1 @80, 7 @40	434
			380	1330	57	6.7	10	1@80,6@40,1@60	458
			400	1400	60	6.7	10	2 @80, 6 @40	482
			420	1470	63	6.7	11	2@80,5@40,1@60	506
CR-242	62	53	440	1540	66	6.7	11	3 @80, 5 @40	530
			460	1610	69	6.7	12	3@80,4@40,1@60	554
			480	1680	72	6.7	12	4 @80, 4 @40	578
S-301	110	70	440	1540	66	6.7	11	3 @80, 5 @40	530
			460	1610	69	6.7	12	3@80,4@40,1@60	554
			480	1680	72	6.7	12	4 @80, 4 @40	578
S-302	140	90	500	1750	75	6.7	13	4 @80, 3 @40, 1@60	603
			520	1820	78	6.7	13	5 @80, 3 @40	627
			540	1890	81	6.7	14	5 @80, 2 @40, 1@60	651
			560	1960	84	6.7	14	6 @80, 2 @40	675
			580	2030	87	6.7	15	6 @80, 1 @40, 1@60	699
			600	2100	90	6.7	15	7 @80, 1 @40	723
			620	2170	93	6.7	16	7 @80, 1 @60	747
			640	2240	96	6.7	16	8 @ 80	771
			660	2310	99	6.7	17	6 @80, 3 @40, 1@60	795
			680	2380	102	6.7	17	7 @80, 3 @40	819
			700	2450	105	6.7	18	7 @80, 2 @40, 1@60	843
			720	2520	108	6.7	18	8 @ 80, 2 @40	867

Table B4-7. Model S/CR Ratings 480V Supplies (Continued)

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	ASME (Steam lbs/ hr)	ELEMENTS		# of Contactors	NUMBER and kW of STEPS	3-PHASE AMPERES
					Qty	kW	480 V	480 V	480 V
S-361	150	100	756	2646	63	12	21	9 @72, 3 @36	911
			792	2772	66	12	22	10 @72, 2 @36	954
			828	2898	69	12	23	11 @72, 1 @36	998
			864	3024	72	12	24	12 @ 72	1041
S-362	200	130	900	3276	75	12	25	12 @72, 1 @36	1084
			936	3402	78	12	26	13 @ 72	1128
			972	3528	81	12	27	13 @72, 1 @36	1171
			1008	3780	84	12	28	14 @ 72	1214
S-421	210	140	1044	3654	87	12	29	14 @72, 1 @36	1258
			1080	3780	90	12	30	15 @ 72	1301
			1116	3906	93	12	31	15 @72, 1 @36	1344
			1152	4032	96	12	32	16 @ 72	1388
			1188	4158	99	12	33	16 @72, 1 @36	1431
			1224	4284	102	12	34	17 @ 72	1474
			1260	4410	105	12	35	17 @72, 1 @36	1518
			1296	4536	108	12	36	18 @ 72	1560
S-422	270	180	1332	4662	111	12	37	18 @ 72, 1 @36	1605
			1368	4788	114	12	38	19 @ 72	1648
			1404	4914	117	12	39	19 @ 72, 1 @36	1691
S-480	360	235	1440	5040	120	12	40	20 @ 72	1735
			1476	5166	123	12	41	9 @108, 7 @72	1778
			1512	5290	126	12	42	10 @108, 6 @72	1821
			1548	5418	129	12	43	11 @108, 5 @72	1864
			1584	5540	132	12	44	12 @108, 4 @72	1908
			1620	5670	135	12	45	13 @108, 3 @72	1951
			1656	5790	138	12	46	14 @108, 2 @72	1995
			1692	5922	141	12	47	15 @108, 1 @72	2038
			1728	6050	144	12	48	16 @ 108	2081
			1764	6174	147	12	49	13@108, 5@72	2125
			1800	6300	150	12	50	14@108, 4@72	2168
			1836	6426	153	12	51	15@108, 3@72	2211
			1872	6552	156	12	52	16@108, 2@72	2254
			1908	6678	159	12	53	17@108, 1@72	2298
			1944	6804	162	12	54	18@108	2341

Table B4-8. Model S/CR Ratings 600V Supply

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	ASME (Steam lbs/ hr)	ELEMENTS		# of CONTACTORS 600 V	NUMBER and kW of STEPS 600 V	3-PHASE AMPERES 600 V
					Qty	kW			
S-120 or CR-120	9	7	19	66	3	6.3	1	1 @ 19	19
			38	131	6	6.3	1	1 @ 37	37
CR-120	9	7	56	197	9	6.3	2	1 @37, 1 @19	54
S-161	23	16	56	197	9	6.3	2	1 @37, 1 @19	54
			70	246	9	7.8	2	1 @47, 1 @23	68
			75	263	12	6.3	2	2 @ 37	73
			94	328	12	7.8	2	2 @ 47	91
CR-161	23	16	70	246	9	7.8	2	1 @47, 1 @23	68
			94	328	12	7.8	2	2 @ 47	91
S-162	23	16	117	410	15	7.8	3	2 @47, 1 @23	113
			141	492	18	7.8	3	3 @ 47	136
CR-162	23	16	164	574	21	7.8	4	3 @47, 1 @23	158
S-200	48	26	164	574	21	7.8	4	3 @47, 1 @23	158
S-200 or CR-200	48	26	188	656	24	7.8	4	4 @ 47	182
			211	738	27	7.8	5	4 @47, 1 @23	204
			234	820	30	7.8	5	5 @ 47	226
			258	902	33	7.8	6	5 @47, 1 @23	249
			281	984	36	7.8	6	6 @ 47	271
S-241 or CR-241	62	53	305	1066	39	7.8	7	6 @47, 1 @23	294
			328	1148	42	7.8	7	7 @ 47	316
			352	1230	45	7.8	8	7 @47, 1 @23	340
			375	1313	48	7.8	8	8 @ 47	362
S-242 or CR-242	62	53	398	1395	51	7.8	9	7 @47, 1 @70	384
			422	1477	54	7.8	9	1 @94, 7 @47	407
			445	1559	57	7.8	10	1 @94, 6 @47, 1@70	429
CR-242	62	53	469	1641	60	7.8	10	2 @94, 6 @47	452
			492	1724	63	7.8	10	2 @94, 5 @47, 1@70	474
			516	1805	66	7.8	11	3 @94, 5 @47	498
			539	1889	69	7.8	11	3 @94, 4 @47, 1@70	520
			563	1969	72	7.8	12	4 @94, 4 @47	543
S-301	110	70	469	1641	60	7.8	10	2 @94, 6 @47	452
			492	1724	63	7.8	10	2 @94, 5 @47, 1@70	474
			516	1805	66	7.8	11	3 @94, 5 @47	498
			539	1889	69	7.8	11	3 @94, 4 @47, 1@70	520
			563	1969	72	7.8	12	4 @94, 4 @47	543

Table B4-8. Model S/CR Ratings 600V Supply (Continued)

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	ASME (Steam lbs/ hr)	ELEMENTS		# of CONTACTORS 600 V	NUMBER and kW of STEPS	3-PHASE AMPERES
					Qty	kW		600 V	600 V
S-302	140	90	586	2054	75	7.8	12	4 @94, 3 @47, 1@70	565
			609	2133	78	7.8	13	5 @94, 3 @47	587
			633	2218	81	7.8	13	5 @94, 2 @47, 1@70	610
			656	2297	84	7.8	14	6 @94, 2 @47	632
			672	2355	87	7.8	14	6 @94, 1 @47, 1@70	648
			703	2461	90	7.8	15	7 @94, 1 @47	678
S-361	150	100	750	2625	48	15.6	16	6 @94, 4 @47	723
			797	2789	51	15.6	17	7 @94, 3 @47	768
			844	2953	54	15.6	18	8 @94, 2 @47	814
			891	3117	57	15.6	19	9 @94, 1 @47	859
			938	3281	60	15.6	20	10 @ 94	904
			984	3445	63	15.6	21	9 @94 3 @47	948
S-421	210	140	1031	3609	66	15.6	22	10 @94, 2 @47	994
			1078	3773	69	15.6	23	11 @94, 1 @47	1039
			1125	3938	72	15.6	24	12 @ 94	1084
			1172	4102	75	15.6	25	12 @94, 1 @47	1129
			1219	4266	78	15.6	26	13 @ 94	1175
			1266	4430	81	15.6	27	13 @94, 1 @47	1220
			1313	4594	84	15.6	28	14 @ 94	1265
			1359	4758	87	15.6	29	14 @94, 1 @47	1310
			1406	4922	90	15.6	30	15 @ 94	1355
			1453*	5086	93	15.6	31	15 @94, 1 @47	1400
			1500*	5250	96	15.6	32	16 @ 94	1445
			1547*	5414	99	15.6	33	16 @94, 1 @47	1491
			1594*	5578	102	15.6	34	17 @ 94	1536
			1641*	5742	105	15.6	35	17 @94, 1 @47	1581
S-480	360	235	1688*	5906	108	15.6	36	18 @ 94	1627
			1734	6070	111	15.6	37	17 @94, 3 @47	1671
			1781	6234	114	15.6	38	18 @94, 2 @47	1716
			1828	6398	117	15.6	39	19 @94, 1 @47	1761
			1875	6563	120	15.6	40	20 @ 94	1807
			1922*	6727	123	15.6	41	9 @ 141, 7 @94	1852
			1969*	6891	126	15.6	42	10 @141, 6 @94	1897
			2016*	7055	129	15.6	43	11 @141, 5 @94	1943
			2063*	7219	132	15.6	44	12 @141, 4 @94	1988
			2109*	7383	135	15.6	45	13 @141, 3 @94	2032
			2156*	7547	138	15.6	46	14 @141, 2 @94	2077
			2203*	7711	141	15.6	47	15 @141, 1 @94	2123
			2250*	7875	144	15.6	48	16 @ 141	2168

* High pressure only

Table B4-9. Model HSB Ratings 380V, 415V Supply

Model	Vessel Capacity (gallons)	Steam Space (gallons)	Rating kW	Steam lb./hr @ 212°F	No. of Elements Qty @ kW	# of CONTACTORS	No. of Steps @ kW	3-PHASE AMPERES	
								380 V	415 V
HSB-424	385	260	1650	5630	165 @ 10	55	5@60, 15@90	2507	2296
			1680	5732	168 @ 10	56	4@60, 16@90	2553	2337
			1710	5835	171 @ 10	57	3@60, 17@90	2598	2379
			1740	5937	174 @ 10	58	2@60, 18@90	2644	2421
			1770	6039	177 @ 10	59	1@60, 19@90	2689	2463
			1800	6142	180 @ 10	60	20@90	2735	2504

Table B4-10. Model HSB Ratings 480V Supply

MODEL #	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	Steam lb./hr @ 212°F	ELEMENTS		# of CONTACTORS	No. of Steps @ kW	3-PHASE AMPERES
					Qty	kW			
HSB-423	300	200	1560	5460	117	13.3	39	7 @120, 9 @80	1879
			1600	5600	120	13.3	40	8 @120, 8 @80	1927
			1640	5740	123	13.3	41	9 @120, 7 @80	1975
			1680	5880	126	13.3	42	10 @120, 6 @80	2025
			1720	6020	129	13.3	43	11 @120, 5 @80	2072
			1760	6160	132	13.3	44	12 @120, 4 @80	2120
			1800	6300	135	13.3	45	13 @120, 3 @80	2168
			1840	6440	138	13.3	46	14 @120, 2 @80	2216
			1880	6580	141	13.3	47	15 @120, 1 @80	2264
			1920	6720	144	13.3	48	16 @ 120	2313
HSB-424	385	260	1960	6860	147	13.3	49	1 @160, 15 @120	2361
			2000	7000	150	13.3	50	2 @160, 14 @120	2409
			2040	7140	153	13.3	51	3 @160, 13 @120	2457
			2080	7280	156	13.3	52	4 @160, 12 @120	2505
			2120	7420	159	13.3	53	5 @160, 11 @120	2553
			2160	7560	162	13.3	54	6 @160, 10 @120	2602
			2200	7700	165	13.3	55	7 @160, 9 @120	2650
			2240	7840	168	13.3	56	8 @160, 8 @120	2698
			2280	7980	171	13.3	57	9 @160, 7 @120	2746
			2320	8120	174	13.3	58	10 @160, 6 @120	2794
			2360	8260	177	13.3	59	11 @160, 5 @120	2843
			2400	8400	180	13.3	60	12 @160, 4 @120	2891
HSB-425	470	320	2440	8540	183	13.3	61	13 @160, 3 @120	2939
			2480	8680	186	13.3	62	14 @160, 2 @120	2987
			2520	8820	189	13.3	63	15 @160, 1 @120	3035
			2560	8960	192	13.3	64	16 @ 160	3083
			2600	9100	195	13.3	65	11 @160, 7 @120	3132
			2640	9240	198	13.3	66	12 @160, 6 @120	3180
			2680	9380	201	13.3	67	13 @160, 5 @120	3228
			2720	9520	204	13.3	68	14 @160, 4 @120	3276
			2760	9660	207	13.3	69	15 @160, 3 @120	3324
			2800	9800	210	13.3	70	16 @160, 2 @120	3372
			2840	9940	213	13.3	71	17 @160, 1 @120	3421
			2880	10080	216	13.3	72	18 @ 160	3469

Table B4-11. Model HSB Ratings 600V Supply

MODEL #	Vessel Capacity (gallons)	Steam Space (gallons)	Rated kW	Steam lb./hr @ 212°F	ELEMENTS		# of CONTACTORS	No. of Steps @ kW	3-PHASE AMPERES
					Qty	kW			
HSB-423	300	200	1734	6070	111	15.6	37	17 @94, 3 @47	1671
			1781	6234	114	15.6	38	18 @94, 2 @47	1716
			1828	6398	117	15.6	39	19 @94, 1 @47	1762
			1875	6563	120	15.6	40	20 @ 94	1807
			1922	6727	123	15.6	41	9 @141, 7 @94	1852
			1969	6891	126	15.6	42	10 @141, 6 @94	1897
			2016	7055	129	15.6	43	11 @141, 5 @94	1943
			2063	7219	132	15.6	44	12 @141, 4 @94	1988
			2109	7383	135	15.6	45	13 @141, 3 @94	2032
			2156	7547	138	15.6	46	14 @141, 2 @94	2078
			2203	7711	141	15.6	47	15 @141, 1 @94	2123
			2250	7875	144	15.6	48	16 @ 141	2168
HSB-424	385	260	2297	8039	147	15.6	49	13 @141, 5 @94	2213
			2344	8203	150	15.6	50	14 @141, 4 @94	2259
			2391	8367	153	15.6	51	15 @141, 3 @94	2304
			2438	8531	156	15.6	52	16 @141, 2 @94	2349
			2484	8695	159	15.6	53	17 @141, 1 @94	2394
			2531	8859	162	15.6	54	18 @ 141	2439
			2578	9023	165	15.6	55	15 @141, 5 @94	2484
			2625	9188	168	15.6	56	16 @141, 4 @94	2529
			2672	9352	171	15.6	57	17 @141, 3 @94	2575
			2719	9516	174	15.6	58	18 @141, 2 @94	2620
			2766	9680	177	15.6	59	19 @141, 1 @94	2665
			2813	9844	180	15.6	60	20 @ 141	2710
HSB-425	470	320	2859	10008	183	15.6	61	17 @141, 5 @94	2755
			2906	10172	186	15.6	62	18 @141, 4 @94	2800
			2953	10336	189	15.6	63	19 @141, 3 @94	2845
			3000	10500	192	15.6	64	20 @141, 2 @94	2891
			3047	10664	195	15.6	65	21 @141, 1 @94	2936
			3094	10828	198	15.6	66	22 @ 141	2981
			3141	10992	201	15.6	67	19 @141, 5 @94	3027
			3188	11156	204	15.6	68	20 @141, 4 @94	3072
			3234	11320	207	15.6	69	21 @141, 3 @94	3116
			3281	11484	210	15.6	70	22 @141, 2 @94	3161
			3328	11648	213	15.6	71	23 @141, 1 @94	3207
			3375	11813	216	15.6	72	24 @ 141	3252

Table B4-12. Model IWH Ratings 208V, 240V Supplies

Model	Maximum Flow (GPM) *	MBTU/Hr	Rated kW	ELEMENTS		# of CONTACTORS	NUMBER and kW of STEPS	3-PHASE AMPERES	
				Qty.	kW			208 V	240 V
IWH-611	135	51	15	3	5	1	1 @ 15	42	37
		102	30	6	5	2	1 @ 30	84	73
IWH-811	240	154	45	9	5	3	1 @ 45	125	109
		205	60	12	5	4	2 @ 30	167	145
		256	75	15	5	5	1 @ 30, 1 @ 45	209	181
IWH-812	240	307	90	18	5	6	2 @ 45	251	217
		358	105	21	5	7	1 @ 15, 3 @ 30	292	253
		409	120	24	5	8	4 @ 30	334	290

* Maximum flow rate based on a maximum velocity of 1.5 fps (feet per second) through the heater. Minimum flow rate should not be less than 10% of the maximum flow rate listed.

Table B4-13. Model IWH Ratings 380V, 415V Supplies

Model	Maximum Flow (GPM) *	MBTU/Hr	Rating kW	Elements		# of CONTACTORS	No. of Steps @ kW	3-PHASE AMPERES	
				Qty	kW			380 V	415 V
IWH-611	135	51	15	3	5	1	1@15	23	21
		102	30	6	5	1	1@30	46	42
IWH-811	240	154	45	9	5	2	1@45	68	63
		205	60	12	5	2	2@30	91	83
IWH-812	240	256	75	15	5	3	1@30, 1@45	114	104
		307	90	18	5	3	3@30	137	125
		358	105	21	5	4	2@30, 1@45	160	146
		409	120	24	5	4	4 @ 30	182	167
IWH-822	240	512	150	15	10	5	3@30, 1@60	228	209
		614	180	18	10	6	2@30, 2@60	273	250
		717	210	21	10	7	1@30, 3@60	319	292
		819	240	24	10	8	4@60	365	334
IWH-022	360	921	270	27	10	9	3@30, 3@60	410	376
		1024	300	30	10	10	2@30, 4@60	456	417
		1126	330	33	10	11	1@30, 5@60	501	459
		1228	360	36	10	12	6@60	547	501

* Maximum flow rate based on a maximum velocity of 1.5 fps (feet per second) through the heater. Minimum flow rate should not be less than 10% of the maximum flow rate listed.

Table B4-14. Model IWH Ratings 480V, 600V Supplies

Model #	Maximum Flow (GPM) *	MBTU/Hr	Rated kW	ELEMENTS		# of CONTACTORS 480/600 V	NUMBER and kW of STEPS 480/600 V	3-PHASE AMPERES	
				Qty.	kW			480 V	600 V
IWH-611	135	51	15	3	5	1	1 @ 15	19	15
		102	30	6	5	1	1 @ 30	37	29
IWH-811	240	154	45	9	5	2	1 @ 45	55	44
		205	60	12	5	2	2 @ 30	73	58
IWH-812	240	256	75	15	5	3	1 @ 30, 1 @ 45	91	73
		307	90	18	5	3	3 @ 30	109	87
		358	105	21	5	4	2 @ 30, 1 @ 45	127	102
		409	120	24	5	4	4 @ 30	145	116
IWH-822	240	512	150	15	10	5	3 @ 30, 1 @ 60	181	145
		614	180	18	10	6	2 @ 30, 2 @ 60	217	174
IWH-022	360	717	210	21	10	7	1 @ 30, 3 @ 60	253	203
		819	240	24	10	8	4 @ 60	290	232
		921	270	27	10	9	3 @ 30, 3 @ 60	325	261
		1024	300	30	10	10	2 @ 30, 4 @ 60	362	290
		1126	330	33	10	11	1 @ 30, 5 @ 60	398	318
		1228	360	36	10	12	6 @ 60	434	347

* Maximum flow rate based on a maximum velocity of 1.5 fps (feet per second) through the heater. Minimum flow rate should not be less than 10% of the maximum flow rate listed.

PERFORMANCE DATA

Efficiency

Electric boilers are void of losses normally associated with fuel fired equipment such as stack loss, combustion loss, excess air loss, etc. Therefore electric boilers are nearly 100% efficient at all operating points. For hot water boilers, the only loss from 100% is the radiation loss from the vessel which is ½%. For steam units, in addition to the radiation loss, blowdown losses should be factored in.

Emissions

Since electric boilers are void of fuel combustion, no emissions occur. Therefore, electric boilers are well suited for installations that must meet stringent emissions requirements.

Noise Level

With no moving parts, the electric boiler is nearly noiseless and thus, is well suited for installations sensitive to noise emissions from mechanical equipment. Installations such as hospitals, nursing homes, schools, research laboratories, and the like are ideal for an electric boiler application.

Regardless of output from minimum to maximum, noise emissions are almost undetectable.

ENGINEERING DATA

Boiler Information – Hot Water

Cleaver-Brooks electric hot water boilers are designed for service in any closed hydronic system and can be used to augment any hot water system. They can be put into operation as a single stand-alone unit with high turndown or in multiple units for larger turndown and capacity.

C-B electric hot water boilers may be utilized in water heating systems with temperatures from 400°F (4.4°C) to 245°F (118.3°C); ideal for ground water source heat pump applications, etc. Because the WB is an electric boiler, low water temperature (below the dewpoint) restrictions do not apply.

Variable temperature differentials can be designed to make use of changing outdoor conditions and thus, the WB is not restrictive to a nominal 200°F (10°C) differential. The boiler is designed to withstand thermal stresses with supply and return temperature differences of 100°F (55°C) and greater. However, when the elements are on, water flow through the boiler must be ensured and a flow switch to prove water flow is established is recommended.

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 B4-15 can be used to determine the full boiler output relative to system temperature drop and the maximum recommended system pump flow.

The pressure drop through the boiler is < 1 psig.

Table B4-15. Model WB Max Flow Ratings Sheet 1 of 2

Model #	Rated kW	System Temperature Drop °F							
		10	20	30	40	50	60	70	80
		Maximum Flow Rate in GPM							
WB-120	12	8.2	4.5	3	2	1.75	1.5	1.25	1
	18	12.4	6.5	4.5	3.2	2.6	2	1.75	1.6
	24	16.5	8	5.5	4.1	3.2	2.75	2.3	2.1
	30	20.5	10.3	6.75	5.1	4.1	3.4	3	2.6
	36	24.5	12.25	8.2	6.2	4.9	4.1	3.5	3.1
	45	30.9	15.7	10.3	7.7	6.3	5.1	4.4	3.9
	54	37	18.4	12.3	9.2	7.4	6.1	5.3	4.6
	60	41	20.5	13.5	10.3	8.2	6.8	5.8	5.1
	72	49.5	24.2	16.5	12.3	9.8	8.2	7	6.1
WB-121	90	61.5	30.5	20.5	15.4	12.3	10.3	8.8	7.7
	108	73.6	37	24.7	18.5	14.8	12.3	10.6	9.2
	126	86	43	28.7	21.6	17.3	14.4	12.3	10.8
	144	98	49.2	32.9	24.6	19.7	16.5	14.1	12.3
WB-122	162	110.5	55.5	37	27.7	22.2	18.5	15.9	13.7
	180	122.6	61.5	41	30.8	24.6	20.5	17.6	15.4
	198	135.5	67.5	45	33.9	27.1	22.6	19.4	16.9
	216	148	74	49.3	37	29.6	24.6	21.1	18.5
	234	160	80	53.4	40	32	26.7	22.9	20
	252	172	86	57.5	43.1	34.5	28.8	24.6	21.6
	270	184.3	92.4	61.6	46.2	37	30.8	26.4	23.2
	288	196	98.5	65.7	49.3	39.5	32.9	28.2	24.6
WB-201	324	222	111	74	55.5	44.4	37	31.7	27.7
	360	246.5	123	82.2	61.6	49.3	41.1	35.2	30.8
	396	271	135.5	90.4	67.8	54.2	45.2	38.7	33.9
	432	296	148	98.6	74	59.2	49.3	42.3	37
WB-202	468	320	160.3	106.8	80.1	64.1	53.4	45.8	40
	504	345	172.5	115	86.3	69	57.5	49.3	43.2
	540	370	185	123.3	92.5	74	61.6	52.8	46.2
	576	394	197	131.5	98.6	79	65.7	56.4	49.3
WB-241	600	411	205.5	137	102.7	82.2	68.5	58.7	51.4
	630	431	215.5	143.8	107.9	86.3	71.9	61.6	53.9
	660	452	226	150.7	113	90.4	75.3	64.6	56.5
	690	472	236	157.5	118.2	94.5	78.8	67.5	59.1
	720	493	246.4	164.4	123.3	98.6	82.2	70.5	61.6
B-242	750	514	257	171.2	128.4	102.7	85.6	73.4	64.2
	780	534	267	178.1	133.6	106.8	89	76.3	66.8
	810	555	277.5	185	138.7	110.9	92.5	79.2	69.3
	840	575	287.5	191.8	143.8	115.1	95.9	82.2	71.9
	870	596	298	198.6	150	119.2	99.3	85.1	74.5
	900	615	308	205.5	154.1	123.3	102.7	88.1	77
	930	637	318.5	212.3	159.2	127.4	106.2	91	79.6
	960	657	328.5	219.2	164.4	131.5	109.6	93.9	82.2

Table B4-15. Model WB Max Flow Ratings Sheet 2 of 2

Model #	Rated kW	System Temperature Drop °F							
		10	20	30	40	50	60	70	80
		Maximum Flow Rate in GPM							
WB-243	990	678	339	226	169.5	135.6	113	96.9	84.8
	1020	698	349	232.9	174.6	139.7	116.4	99.8	87.3
	1050	719	359.5	239.7	179.8	143.8	119.9	102.7	89.9
	1080	740	370	246.6	184.9	150	123.3	105.7	92.5
	1110	760	380	253.4	190	152.1	126.7	108.6	95
	1140	781	390.5	260.3	195.2	156.2	130.1	111.5	97.6
	1170	801	400.5	267.1	200.3	160.3	133.6	114.5	100.2
	1200	822	411	274	205.5	164.4	137	117.4	102.7
WB-361	1224	838	419	279.5	209.6	167.7	139.7	119.8	104.8
	1260	863	431.5	287.7	215.7	172.6	143.8	123.3	107.9
	1296	888	444	296	221.9	177.5	147.9	126.8	110.9
WB-362	1332	912	456	304.1	228.1	182.5	150.9	130.3	114
	1368	937	468.5	312.3	234.2	187.4	156.2	133.8	117.1
	1404	962	481	320.5	240.4	192.3	160.3	137.4	120.2
	1440	986	493	328.8	246.6	197.3	164.4	140.9	123.3
	1476	1011	505.5	337	252.7	202.2	168.5	144.4	126.4
	1512	1035	517.5	322.4	258.9	207.1	172.6	147.9	129.5
	1548	1060	530	353.4	265.1	212.1	176.7	151.5	132.5
	1584	1085	542.5	361.6	271.2	217	180.8	155	135.6
	1620	1109	554.5	370	277.4	221.9	184.9	158.5	138.7
	1656	1134	567	378	283.6	226.8	189	162	141.8
	1692	1159	579.5	386.3	289.7	231.8	193.1	165.5	144.9
	1728	1183	591.5	394.5	295.9	236.7	197.3	169.1	147.9
WB-363	1764	1208	604	402.7	302.2	241.6	201.4	172.6	151
	1800	1233	616.5	411	308.2	246.6	205.5	176.1	154.1
	1836	1257	628.5	419.2	314.4	251.5	209.6	179.6	157.2
	1872	1282	641	427.4	320.5	256.4	213.7	183.2	160.3
	1908	1307	653.5	435.6	326.7	261.4	217.8	186.7	163.4
	1944	1332	665.5	443.8	332.9	266.3	221.9	190.2	166.4
	1980	1356	678	452	339	271.2	226	193.7	169.5
	2016	1381	690.5	460.3	345.2	276.2	230.1	197.3	172.6
	2052	1405	702.5	468.5	351.4	281.1	234.2	200.8	175.7
	2088	1430	715	476.7	357.5	286	238.4	204.3	178.8
	2160	1480	740	493.2	369.9	295.9	246.6	211.3	184.9
	2240	1534	767	511.4	383.6	306.8	255.7	219.2	191.8
WB-421	2320	1589	794.5	529.7	397.3	317.8	264.8	227	198.6
	2400	1644	822	548	411	328.8	274	234.8	205.5
	2480	1699	849.5	566.2	424.6	339.7	283.1	242.7	212.3
	2560	1754	877	584.5	438.3	350.7	292.2	250.5	219.2
	2640	1808	904	602.7	452.1	361.6	301.4	258.3	226
	2720	1863	931.5	621	465.7	372.6	310.5	266.1	232.9
WB-422	2800	1918	959	639.3	479.5	383.6	319.6	274	239.7
	2880	1973	98.5	657.5	493.1	394.5	328.8	281.8	246.6
	3000	2055	1027.5	685	513.7	411	342.5	293.5	256.8
	3040	2082	1041	694	520.5	416.4	347	297.5	260.3
	3120	2137	1068.5	712.3	534.2	427.4	356.2	305.2	267.1
	3200	2192	1096	730.5	547.9	438.4	365.3	313.1	274
	3280	2247	1123	748.8	561.6	449.3	374.4	320.9	280.8
	3360	2302	1151	767.1	575.3	460.3	383.6	328.8	287.7

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 B4 – 16.

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.

Table B4-16. Model WB Minimum Over Pressure Requirements

Outlet Water Temperature °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)

Rule of Thumb Calculations

The following formula can be used to size a hot water boiler:

$kW = \text{gph (gallons per hour)} \times \text{delta T (as expressed in } ^\circ\text{F)} \text{ divided by } 410$

Or

$kW = 1 \text{ lph (liter per hour)} \times \text{delta T (as expressed in } ^\circ\text{C)} \text{ divided by } 862$. Where:

- kW is the boiler output rating.
- lph (liters per hour) or gph (gallons per hour) is the hot water flow rate.
- "delta T" is the temperature rise of water.

As an example:

$$kW = \text{gph} \times \text{delta T} / 410$$

$$kW = 5000 \times 20 / 410$$

$$kW = 100000 / 410$$

$$kW = 244$$

Boiler Information – Steam

Models CR, S, and HSB are designed for steam service and are built in accordance with the ASME Code for either low pressure steam applications (less than 15 psig operation) or for high pressure steam applications (above 15 psig).

For approximate conversion of pounds of steam to kW, the following can be used:

10 kW = 34 lbs. steam/hr = 1.02 boiler horsepower from and at 212° F.

It is important to know what the operating pressure will be and the feedwater makeup temperature, to properly size the steam boiler. From Table B4-17, one can obtain the pound of steam value for the operating pressure and corresponding feedwater makeup temperature. Based on this, the proper assumption can be made as to the required kW size of the electric boiler.

For example: Steam load required of 2000 pounds per hour of steam at an operating pressure of 100 psig and feedwater temperature of 170 degrees F. Referring to Table B4-17, we find the value of 0.3077 kW per pound of steam. We multiply the required pounds of steam by this value (2000 x 0.3077) and obtain 615. The required boiler would be 615 kW or the Model S-301-620, 150# design.

Table B4-17. kW per pound of steam

Feedwater Temperature (°F)	Boiler Operating Pressure (PSIG)				
	0	15	50	100	150
50	0.3318	0.3359	0.3401	0.3429	0.3441
70	0.3259	0.3300	0.3343	0.3370	0.3382
100	0.3171	0.3212	0.3255	0.3283	0.3294
120	0.3112	0.3154	0.3196	0.3224	0.3236
150	0.3025	0.3066	0.3108	0.3136	0.3148
170	0.2966	0.3001	0.3050	0.3077	0.3089
200	0.2878	0.2919	0.2962	0.2978	0.3001
212	0.2857	0.2898	0.2941	0.2957	0.2980
227	0.2836	0.2877	0.2920	0.2936	0.2967

Water Treatment

Even though hot water systems are “closed”, some amount of make-up water (up to 10%) will be introduced, usually due to pump seal leaks 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.

For steam boilers, proper blowdown (surface and bottom) is a required maintenance procedure. This water loss and associated steam use or loss must be made up. Any make-up water should be properly treated prior to introduction into the boiler via water softener, chemical feed, etc. Proper water chemistry in a steam boiler is mandatory for effective operation and longevity.

See **Table B4-18** for water quality requirements.

Table B4-18. Electric Boilers Required Water Quality Parameters

Parameter	Hot Water Boilers Water Limit	Steam Boilers Water Limit
pH	8.3 - 9.5	8.3 - 10.5
Iron	0.1 ppm	0.1 ppm
Alkalinity	< 300 ppm	< 600 ppm
Chlorides	30 mg/liter	30 mg/liter
Oxygen	0.1 mg/liter	0.1 mg/liter
Specific Conductivity	3500 umho/cm	4500 umho/cm
Total Hardness	< 3 ppm	< 3 ppm

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 when 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.

Clearances

The boiler must be installed so that all components remain accessible, especially be free of side mounted piping so the element flanges may be opened. Refer to Dimension Sheets **Figure B4 – 1 through B4 - 5**.

Hot Water Piping

Primary/Secondary Pumps are not necessary with the electric hot water boilers, although they can be used. As its design is such that thermal shock is not a concern, some flow is required whenever the boiler elements are on. Therefore, whether primary/secondary or system pump, an interlock such as a flow switch should be employed to ensure that water flow is established before the boiler elements are allowed on.

Electrical

Voltage requirements for the electric boilers are as noted in the ratings sheets including the relative ampacity. Switchgear above 600 amps will not be furnished by Cleaver-Brooks due to the overall size of the equipment and NEC Code requirement for switchgear wiring. The larger switchgear wiring requirements exceed the UL certification of the package boiler.

NOTES

ELECTRIC BOILER SPECIFICATIONS

CAPACITIES B37-40

STORAGE TANK HEATER CAPACITY B37-40

BOILER.....B37-40

HEATING ELEMENTS B37-40

TRIM AND CONTROLS B37-41

WARRANTY B37-41

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in meeting your customer's specific needs and application.



PART 1 GENERAL**1.1 CAPACITIES****A. Boiler Capacity - Hot Water**

1. The _____ gallon _____ capacity hot water boiler shall be Cleaver-Brooks Model _____ rated _____ kW at _____ V, _____ ph, 60 Hz, _____ MBtu/hr. Unit shall be suitable to operate under the following conditions: system flow rate _____ gpm; outlet water temperature _____ °F; return water temperature _____ °F; system operating pressure _____ psig.

B. Boiler Capacity - Steam

1. The _____ gallon _____ capacity steam boiler shall be Cleaver-Brooks Model _____ rated _____ kW at _____ V, _____ ph, 60 Hz. Unit shall produce _____ lbs steam/hr (from and at 212 °F) at a nominal pressure of _____ psig.

C. Water Heater Capacity - Instantaneous

- D. The horizontal circulation water heater shall be Cleaver-Brooks Model IWH _____ rated _____ kW at _____ V, _____ ph, 60 Hz.

1.2 STORAGE TANK HEATER CAPACITY

The _____ gallon capacity (horizontal or vertical) shall be Cleaver-Brooks Model _____ rated kW at _____ V, _____ ph, 60 Hz, and shall recover _____ gpm at 100 °F rise.

PART 2 PRODUCTS**2.1 BOILER**

- A. The vessel shall be constructed in accordance with ASME Boiler Code.
- B. The vessel shall be designed for _____ psig.
- C. The relief valve shall be per ASME Code, set at _____ psig.
- D. The vessel shall be insulated with a double wrap of 2-inch fiber blanket insulation having 1-1/2 PCF density.
- E. The boiler shall be UL listed, and bear the Underwriters Laboratories' label.
- F. The boiler shall be of the packaged type, factory assembled, wired, and tested.
- G. The boiler shall be mounted on a full size structural steel base.
- H. The boiler enclosure shall be 16-gauge steel.
- I. The entire enclosure shall be finished in light blue enamel paint.
- J. The overall dimensions of the boiler shall be _____ inches long, _____ inches wide, and _____ inches high.
- K. For CR Models, the boiler shall include built-in condensate receiver and feed pump, with make-up valve mounted on common base with boiler, factory wired and piped, and enclosed in boiler casing.

2.2 HEATING ELEMENTS

- A. The heating elements shall be individually mounted, rod type, and field replaceable with standard tools.
- B. The heating watt density shall not exceed _____ (50 or 75) W/sq-in.
- C. The heating elements shall be (copper or Incoloy) sheathed.

2.3 TRIM AND CONTROLS

- A. The units shall be complete with the following:
 - 1. Main lugs for supply circuits.
 - 2. Supplemental internal branch circuit fuses, current limiting, rated at 200,000 amps interrupting capacity.
 - 3. Fused 120 V control circuit transformer.
 - 4. Magnetic contactors rated at 500,000 cycles.
 - 5. Integral high temperature limit (hot water boilers).
 - 6. High pressure limit (steam boilers).
 - 7. Low water cutoff (float-type with gauge glass for steam) on all models except IWH which is supplied with a flow switch.
 - 8. Pressure-temperature gauge (hot water boilers).
 - 9. Pressure gauge (steam boilers).
 - 10. Pilot switch.
 - 11. Pilot lights for power on, low water, high temperature or pressure.
 - 12. Relief valve.
 - 13. Drain valve (hot water boilers).
 - 14. Bottom and water column blowdown valves (steam boilers).
 - 15. Feedwater stop and check valves (steam boilers).
 - 16. All models except IWH shall be supplied with modulating step controls to gradually apply the load in _____ steps.
 - 17. All models except IWH shall be supplied with proportioning temperature (hot water units) or pressure (steam units) control to balance power input to match system demand.
 - 18. Temperature control on IWH is one of the following methods (select a. or b. or c. below).
 - a. Thermostats - The heating elements shall be staged by control thermostats. (Standard for one and two step heaters).
 - b. Sequencer - The heating elements shall be staged by a time delay sequencer, to energize heating elements in _____ stages with an adjustable 1 to 15 second time delay between stages. (Standard for 3 or 4 step heaters.)
 - c. Modulating Step Control - (Standard for heaters above 4 steps).

PART 3 EXECUTION

3.1 WARRANTY

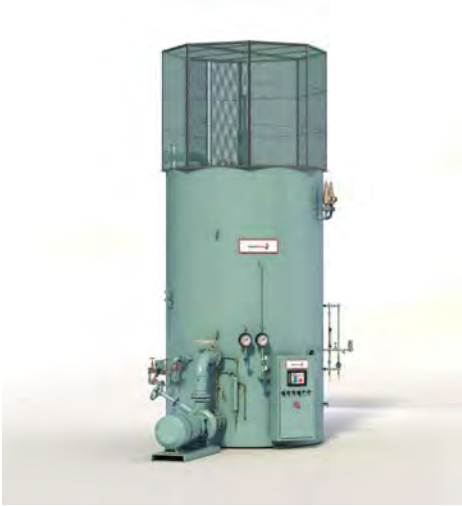
- A. The Cleaver-Brooks unit shall be warranted against defective workmanship and materials for a period of one year from the date of start-up or 18 months from shipment.



NOTES

ELECTRODE BOILERS

MODEL CEJS STEAM



CONTENTS

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Table B8-2. Electrode Boilers Required Water Quality Parameters	6
Table B8-3. CEJS Minimum Clearances.....	6

This section contains information on the complete line of Cleaver-Brooks electrode boilers with megawatt output ratings from 2 to 65 MW.

FEATURES AND BENEFITS

In applications where electric power is more economically available than fossil fuels, or where fossil fuel combustion and the handling of combustion by-products are unacceptable, electric boilers offer a viable alternative.

Economical Installation	Fuel lines, storage and handling equipment, economizers, stacks, and emission control equipment are not required, saving on capital expenditures.
Lower Operating Cost	Simple to operate and maintain - automatic controls reduce personnel requirements. No complex pollution or combustion control equipment to operate or maintain. No heating surfaces.
Emissions	Because there is no combustion, electrode boilers are 100% emission free. This is beneficial in meeting total emissions of the project site or in areas where fuel combustion emissions are not tolerated.
Quiet Operation	Elimination of combustion noise and minimal moving parts result in extremely quiet operation - very beneficial in applications such as hospitals, nursing homes, and schools.
High Efficiency	With minimum radiation losses and without the losses associated with combustion equipment the electric boiler will provide nearly 100% efficiency at all operating points.
Ease of Maintenance	The absence of high maintenance combustion equipment and the use of solid state control devices reduce the complexity and number of moving parts. The absence of fuel residue greatly simplifies boiler cleaning. Pressure vessel components are not subjected to thermal stresses induced by high temperature differentials or cycling encountered with fossil fuel combustion.
Quality Construction	All CEJS boilers are designed to ASME Boiler and Pressure Vessel Code and are certified and registered pressure vessels.
Design Features	The CEJS electrodes are vertically mounted around the inside of the pressure vessel, enabling the boiler to produce maximum amounts of steam in a minimum amount of floor space. The CEJS operates at voltages from 4.16 to 25 kV with up to 99.9% efficiency. Models are available to produce steam in capacities to 270,000 pounds per hour. Pressure ratings range from 100 psig to 500 psig.

PRODUCT OFFERING

Cleaver-Brooks electrode boilers are available in sizes ranging from 2 to 65 MW with operating pressures from 100 psig to 500 psig. Input power is by direct connection to a 4.16 to 25 kV supply.

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

Refer to Table B8-1 as a quick reference guide to the boiler models and sizes provided.



Table B8-1. Model CEJS Product Offering

Model No.		6.9 kV	11 kV	13.2 kV	20 kV	25 kV
CEJS 400	<i>lbs/hr @125 PSI</i>	6,700	11,100	13,500	16,800	17,800
	<i>lbs/hr @250 PSI</i>	6,400	10,500	12,800	16,000	16,900
	Max Megawatts	2.0	3.3	4.0	5.0	5.3
	Vessel OD (in.)	72"	72"	72"	96"	108"
	# of Electrodes	3	3	3	3	3
CEJS 600	<i>lbs/hr @125 PSI</i>	10,100	16,800	20,200	25,200	26,900
	<i>lbs/hr @250 PSI</i>	9,600	16,000	19,200	23,900	25,600
	Max Megawatts	3.0	5.0	6.0	7.5	8.0
	Vessel OD (in.)	72"	72"	72"	96"	108"
	# of Electrodes	3	3	3	3	3
CEJS 900	<i>lbs/hr @125 PSI</i>	15,100	25,200	30,300	37,800	40,300
	<i>lbs/hr @250 PSI</i>	14,300	23,900	28,800	35,900	38,300
	Max Megawatts	4.5	7.5	9.0	11.3	12.0
	Vessel OD (in.)	72"	72"	72"	96"	108"
	# of Electrodes	3	3	3	3	3
CEJS 1200	<i>lbs/hr @125 PSI</i>	20,200	33,600	40,400	50,400	53,800
	<i>lbs/hr @250 PSI</i>	19,200	31,900	38,400	47,900	51,100
	Max Megawatts	6.0	10.0	12.0	15.0	16.0
	Vessel OD (in.)	84"	72"	72"	96"	108"
	# of Electrodes	6	3	3	3	3
CEJS 1800	<i>lbs/hr @125 PSI</i>	30,200	50,400	60,600	75,600	80,600
	<i>lbs/hr @250 PSI</i>	28,700	47,900	57,600	71,800	76,600
	Max Megawatts	9.0	15.0	18.0	22.5	24.0
	Vessel OD (in.)	84"	84"	84"	108"	120"
	# of Electrodes	6	6	6	6	6
CEJS 2400	<i>lbs/hr @125 PSI</i>	40,300	67,200	80,800	100,800	107,500
	<i>lbs/hr @250 PSI</i>	38,300	63,800	76,800	95,800	102,100
	Max Megawatts	12.0	20.0	24.0	30.0	32.0
	Vessel OD (in.)	96"	84"	96"	108"	120"
	# of Electrodes	6	6	9	6	6
CEJS 3000	<i>lbs/hr @125 PSI</i>	50,400	84,000	101,000	126,000	134,400
	<i>lbs/hr @250 PSI</i>	47,900	79,800	96,000	119,700	127,700
	Max Megawatts	15.0	25.0	30.0	37.5	40.0
	Vessel OD (in.)	96"	96"	96"	120"	120"
	# of Electrodes	6	9	9	9	9
CEJS 3600	<i>lbs/hr @125 PSI</i>	60,500	100,800	121,200	151,200	161,300
	<i>lbs/hr @250 PSI</i>	57,500	95,800	115,100	143,600	153,200
	Max Megawatts	18.0	30.0	36.0	45.0	48.0
	Vessel OD (in.)	108"	96"	108"	120"	120"
	# of Electrodes	9	9	9	9	9
CEJS 4200	<i>lbs/hr @125 PSI</i>	70,600	117,600	141,400	176,400	188,200
	<i>lbs/hr @250 PSI</i>	67,100	111,700	134,300	167,600	178,800
	Max Megawatts	21.0	35.0	42.0	52.5	56.0
	Vessel OD (in.)	108"	108"	108"	120"	120"
	# of Electrodes	9	9	9	9	9
CEJS 5000	<i>lbs/hr @125 PSI</i>		140,100	168,300		
	<i>lbs/hr @250 PSI</i>		133,100	159,900		
	Max Megawatts	N/A	41.7	50.0	N/A	N/A
	Vessel OD (in.)		108"	120"		
	# of Electrodes		9	9		

Standard Equipment Equipment described below is for the standard steam electrode boilers offering:

A. Model CEJS Boiler

1. Each boiler is designed and constructed in accordance with the ASME Code and is mounted on an integral steel frame.
2. Trim and Controls:
 - a. Water column with 4-20mA transmitter and gauge glass; transmitter signal opens and closes the feedwater valve according to boiler water level.
 - b. High Water and High High Water limit probes.
 - c. Air vent.
 - d. Bottom and water column blowdown valves.
 - e. Surface blowdown.
 - f. Feedwater piping with regulating valve, check valve, and gate valve.
 - g. ASME pressure relief valves.
 - h. Boiler steam pressure gauge & transmitter.
 - i. System steam pressure gauge & transmitter.
 - j. Conductivity control system with sample cooler.
3. Pre-assembled centrifugal circulation pump with water-cooled mechanical seal.
4. Electric Equipment
 - a. High voltage supply - customer connected three-phase, four-wire, 'Y' connected configuration.
 - b. Medium voltage supply - powers the control panel, circulating pump, hydraulic pump, and (optional) chemical feed pump.
 - c. PLC with 10" color touch screen oversees automatic functioning of the following:
 - High pressure limit circuit
 - High and low water limit circuits
 - Alarm circuits
 - High voltage feedback
 - Conductivity controller
 - Load and pressure control
 - Standby control
 - Circulating pump
 - Hydraulic system
 - d. Electrodes (three, six, or nine depending on boiler size) - comprising upper and lower electrode assemblies installed through vessel and connected to electrode box and target plates; used to establish a current path to nozzle stock and to counter electrodes.
 - e. Attached pre-wired control panel on most models.
5. Hydraulics:
 - a. Positioning of the control sleeve is accomplished by a hydraulic system consisting of hydraulic pump, lift tower, and hydraulic cylinder.
6. Boiler Control System

- a. PLC-based control system with touchscreen HMI.
- b. Main control panel with panel door key lock.
- c. PID controls for steam pressure and water level.
- d. Real-time trending and bar graph display of process variable, setpoint, and control output.
- e. Automatic or manual operation.
- f. On-screen fault annunciation with diagnostics and alarm history

Optional Equipment For option details, contact the local authorized Cleaver-Brooks representative. Below are some options that can be provided with the boiler:

- Chemical feed pump.
- Standby heater.
- Three-valve bypass for feed system.

PERFORMANCE DATA

Efficiency	Whereas fuel-fired equipment is susceptible to efficiency losses such as stack loss, combustion loss, excess air loss, etc., electrode boilers by contrast are nearly 100% efficient at all operating levels.
Emissions	Electrode boilers do not use fuel combustion, and so produce no emissions. Therefore, electrode boilers are well suited for installations that must meet stringent emissions requirements.
Noise Level	The electrode boiler is nearly noiseless and thus is well suited for installations sensitive to noise emissions from mechanical equipment. Installations such as hospitals, nursing homes, schools, research laboratories, and the like are ideal for an electrode boiler application.

ENGINEERING DATA

Water Treatment	Proper blowdown is a required maintenance procedure. Any water lost in the procedure must be made up. Make-up water should be properly treated prior to introduction into the boiler via water softener, chemical feed, etc. Proper water chemistry in a steam boiler is mandatory for effective operation and longevity.

See **Table B8-2** for Model CEJS water quality requirements.

Table B8-2. Electrode Boilers Required Water Quality Parameters

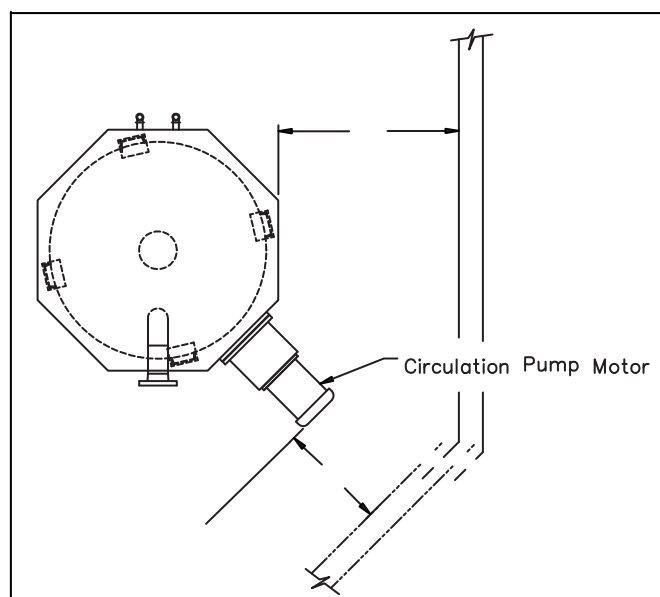
Parameter	Boiler Water Limit
pH	8.5 - 9.5
Iron	Ω2.0 ppm
Alkalinity	0 - 750 ppm
Oxygen	0.005 ppm
Conductivity	3500 μmho/cm
Hardness	Makeup water 0 - 0.5 ppm (preferably 0); Boiler water 0 ppm

Clearances

See below for Model CEJS minimum clearances.

Table B8-3. CEJS Minimum Clearances

Model Number	Minimum Clearances	
	A	B
CEJS-200	60"	30"
CEJS-400	60"	36"
CEJS-600	60"	36"
CEJS-900	60"	48"
CEJS-1200	60"	48"
CEJS-1800	60"	48"
CEJS-2400	60"	48"
CEJS-3000	60"	55"
CEJS-3600	60"	55"
CEJS-4200	60"	70"
CEJS-5000	60"	70"



SAMPLE SPECIFICATIONS

ELECTRODE STEAM BOILER MODEL CEJS SPECIFICATION

Provide High Voltage Electrode Steam Boiler for operation on _____ KV PH, 4 wire, _____ HZ. Boiler rating shall be _____ PSI and shall be designed for operation at _____ PSI steam pressure, MW capacity.

1.0 Design

The boiler design shall consist of a pressure vessel having a central column from which water, under pressure, is forced through nozzles toward the several electrodes which surround the column. Steam is generated from the surface of the several streams of water by heat generated as the electrical current flows from the electrode to the central column and through the stream of excess water as it falls from the electrode to a grounded "counter electrode" on its way back to the bottom of the boiler.

All streams of water originating in the central column shall be identical in shape based on pressure maintained in the central column therefore avoiding steam and interference droop causing splashing and potential electrical short leading to shutdown.

There shall be upper an level man-way(s) allowing a visual initial adjustment of stream shape by varying the speed of the boiler pump (see 2.1.4) to establish suitable pressure in the central column for internal distance based on voltage spacing.

Regulation of the boiler output shall be accomplished by a movable load regulating shield which prevents part or all of the nozzle streams from coming into contact with the boiler electrodes. The position of the load regulating shield will be regulated by the boiler controls to maintain the desired steam pressure or to prevent the boiler from drawing more than the desired kilowatts when the steam requirements exceed the boiler capacity. The boiler electrodes shall be located entirely in the boiler steam space so that stopping of the boiler pump will cause the boiler to shut down. Regulation of the boiler capacity shall be from 100% to 0% without the necessity of interrupting the high voltage supply.

2.0 The Boiler Component Parts

2.0.1 Boiler Shell

The boiler shall be a single shell, vertical type. The shell shall be constructed and stamped in accordance with the ASME Boiler & Pressure Vessel Code, and shall carry a National Board Pressure Vessel Registration Nameplate.

The shell design (and stamped) pressure rating shall be _____ PSI for operation at _____ PSI.

A man-way 355mm x 457mm (14" x 18") shall be provided for access to the boiler interior for internal inspection and repair/replacement of internal parts. A second man-way 305mm x 380mm (12" x 16") shall be provided at the upper level for inspection of the jets. No other access is required for inspection or service. All boiler connections over 50mm (2") pipe size shall be flanged.

2.0.2 The Central Column and Nozzle Stock Plates

The central column and nozzle stock, through which water is conducted to the stream nozzles, is fabricated from mild steel and supported from the top of the boiler.

For optimum water stream shape, each nozzle has a conical collector cone leading to a round pipe with a cross insertion forming straightening vanes. This design produces a sharply defined water stream from each nozzle.

The stream nozzles are inserted into bolted, removable plates to allow replacement or cleaning without removal of the nozzle stock from the boiler. Nozzle rows shall be horizontally slanted for smooth progressive interception and capacity control.

The pump shall deliver its full output to the nozzle stock at all times and maintain a constant static head inside the nozzle stock to assure that at no time during boiler operation will any stream nozzle have less than 15' of liquid static head supply pressure.

2.0.3 Electrode Boxes and Target Plates

Electrode boxes have 3 closed sides terminating in rounded edges.

Target Plates are removable and reversible with round bars facing the jet streams for smooth contact and no splashing. Water then flows smoothly in the formed grooves to a collection at the bottom of the box.

The bottom of the box is solid steel with machined holes with cross insertion to form the streams of water toward the counter electrode.

2.0.4 Counter Electrodes

Counter electrodes shall be made of solid steel plate with machined holes matching the holes in the bottom of the electrode box for smooth flow in order to avoid splashing. Solid welded bracket for attaching to boiler shell.

2.0.5 Insulators and Power Rods

Each electrode box is supported by the high voltage power rod. Power rods insulating tubes shall be quartz – 25KV class.

Insulators shall be 25KV class high grade aluminum, 9 skirts for long tracking path, coated, for maximum protection and reliability.

The internal insulator shall be protected by stainless steel steam throttling shield and rated for 750PPM alkalinity.

The external insulator shall be identical 25KV class coated insulator in order to offer maximum protection against deposits on skirts due to air contaminants in boiler room atmosphere.

2.0.6 The Load Regulating Shield 0-100%

The load regulating shield shall be concentric with the central column and will be supported by a yoke and rod extending through the top of the boiler to the load regulating mechanisms. The upper rim of the load regulating shield shall incorporate a stainless steel "knife" edge to intercept the flow from the water nozzles in a manner which will minimize the disturbance to the nozzle streams which are above the shield. This sharp edge shall be able to split the capacity of a stream for maximum accuracy in capacity control and without loss of quality or excessive splashing. A shield position Indicator shall be included in the control system. Boiler will be furnished with a hydraulic cylinder, pump and control system to control shield position according to demand between 0% and 100%.

2.0.7 Boiler Circulating Pump(s) on separate skid

The boiler circulating pump(s) shall be a centrifugal type rated for continuous duty at the boiler operating pressure and temperature and shall be selected for low NPSH and to deliver the flow and head required for proper operation of the boiler. The pump shall be coupled to the boiler with suitable piping spools, flanges and a manually set butterfly valve.

The pump shall incorporate a single mechanical seal with water cooling. Pump motors shall be sized for maximum pump horsepower requirements and to be standard shaft, T.E.F.C., foot mounted, and readily available. The pump will be belt-driven or VSD driven, allowing for a simple initial adjustment to maintain a steady pressure in the central column and therefore of the shape of the parallel water jets.

2.0.8 Standby Heater

The boiler will be supplied with an immersion type flanged heating element assembly rated at _____ V, _____ Ph, _____ Hz for use in maintaining the boiler at desired pressure when the boiler is not being used to generate steam. The standby heater shall be controlled by two pressure set points and by the "Standby-Run".

2.0.9 Steam Water Preheater

A steam injection preheater has been provided for quicker heating of the "cold" boiler water after a shut-down. It will bring the boiler to "stand-by" condition by using an outside source of steam to heat the water and generate steam in the isolated boiler. This procedure is manually controlled by a hand valve.

2.1 Boiler Control System

2.1.1 Pressure and Load Controls and associated Control Panel

The boiler control system shall incorporate processor pressure control and ampere load control in the primary control system in a manner which will permit the boiler to maintain the desired steam pressure so long as the steam demand does not exceed the desired maximum KW limit and at such times as the demand exceeds the rating, to regulate the boiler output to the desired maximum. The maximum allowable KW rating will be adjustable by the operator to ratings of 100% maximum to 5% minimum. The boiler will regulate the output from 0% to 100% as required by the pressure control. Boiler will utilize "split" streams to attain step-less control that is linear over entire output range of the boiler. Stable regulation shall be possible from 100% output down to zero load.

Controls shall be provided so electrodes are energized before water is supplied to electrodes. Boiler shall always start at zero load.

2.1.2 Standby-Run Control

The boiler shall incorporate a Standby-Run control which, when in "Standby", will manually override the Pressure and Load controls to cause the Load Regulating Shield to go to the "no output" position and simultaneously energize the Standby Heater control circuit and de-energize the conductivity control and surface blow-down. When the Standby-Run Control is returned to "Run", the boiler will resume normal operation starting at "0" load. This operation can also be remotely controlled.

2.1.3 Limit Controls

The boiler shall be equipped with limit controls to shut down the boiler in event of occurrence of any of the following conditions: (1) excess pressure; (2) low water; (3) high water; (4) sudden pressure drop in system supply line. Limit controls (optional or supplied by others) such as supervisory relays for over-current, ground fault, or phase imbalance (supplied by others) may be connected into the limit control circuit.

2.1.4 Water Level Controls

The boiler water level control will be a proportional type regulator which will adjust the position of a valve in the feed-water supply line to maintain the flow of feed-water to match the rate of steam generation. If a single dedicated suitable feed-water pump is used, the control valve could be replaced by a variable speed control on the pump motor.

2.1.5 Conductivity Control and Sample Cooler Assembly

Conductivity of the water being circulated to the boiler electrodes will be controlled by an indicating type conductivity controller which will have separately adjustable high and low set points. On actuation of the "high" set point, automatic boiler bleed (surface blow-down) will begin and a light will indicate that bleed is in process.

"Low conductivity" closes a PLC contact and may be used to signal a chemical feed pump to start. Chemical feed pump is optional or supplied by others. It is not furnished as part of this boiler.

A Sample Cooler assembly shall be supplied, including the sample cooler, connections for the boiler water, connections for the cooling water, valves, conductivity measuring cell, and manual sampling valve.

2.2 Boiler Trim

The boiler will be supplied with the following trim items:

2.2.1 Pressure Control Piping

Pressure gauges will indicate steam pressure in the boiler shell and in the user's steam header. Gauge ranges shall be approximately 2 times the operating pressure. The Gauges and Pressure Controllers will be mounted on the boiler at eye level, pre-piped and pre-wired.

2.2.2 Water gauge glass

Water gauge glass complete with drain valve will be provided.

2.2.3 Water Column

A water column will be provided and will be suitable for mounting of the water gauge glass, gauge cocks, the water level controller and the high and low water cutoffs. A water column drain valve will be provided. A separate control is provided for the "Low-Low" water level protection.

2.2.4 Feed-water Valves

Boiler feed-water line will be equipped with shut off valve and check valve between the boiler and the feed-water regulating valve of 2.2.4. or pump

2.2.5 Blow-down Valves

Boiler blow-off line will be fitted with one quick and one slow opening valve. Valves shall be "Y" pattern rated for boiler blow-off service.

2.2.6 Steam Valve

Boiler steam outlet valve are optional such as a stop and check.

2.2.7 Back Pressure Regulating Valve

A pneumatic back pressure regulating valve will be provided and will be adjusted to throttle or close when the boiler steam pressure drops below the operating pressure range. Valve and controller will be pneumatic type. This Valve will protect the boiler against a sudden drop in system pressure. Timing shall be adjusted for quick closing and slow opening.

2.2.8 Safety Valves

The boiler will have a minimum of two safety valves which shall be ASME rated and stamped. Aggregate capacity of the safety valves at their set pressure will not be less than 110% of the boiler rating in kilograms of steam per hour. Boiler rated output will be taken as 3.5lbs of steam per KW. (1.59 kg of steam per KW).

2.2.9 Bleed Valves (for conductivity control)

The boiler bleed (surface blow-down) valve shall be a needle type valve with calibrated stem, optional adder for boiler. This valve shall be set to control the bleed rate. On-Off control of the bleed will be by means of a separate valve, air operated.

2.3 Insulation and Casing

The boiler will be insulated with 2" of glass fiber insulation secured to the boiler to prevent sagging. Insulation rings are provided on the boiler pressure vessel. Insulation is covered by 18GA Aluminum sheets.

2.4 Top Cage

The boiler high voltage terminals will be enclosed in a preferably full height heavy screen enclosure with Kirk key interlock on access opening to prevent entrance unless the boiler supply switch-gear is open. Kirk interlock shall be supplied by others.

2.5 Control Panel

Power required to Control Panel is _____ V, 3Ph, _____ Hz, incorporating a _____ A disconnect switch.

All electrical controls, relays, pump and shield drive starters and associated push buttons, lights, ammeters, and other components of the boiler control system will be attached to the boiler before shipment and pre-wired with a 2 door NEMA 12 dust proof panel. Power and Control sections are separate, each with front access.

The H.V. switch-gear (by others) should include CTs and PTs to be connected (by others) to the Control Panel (see 2.6). In addition to their use for the boiler control logic, the information on V, A, KW is available in the PLC. KW value can be sent to a building system if desired.

3.0 Boiler Assembly and installation

The boiler will be shipped in two containers or on a flat bed truck in main sections, and will require field erection and assembly and completion of electrical and piping connections. The boiler manufacturer's representative will supply labor for the assembly and start-up of the boiler. The representatives will reassemble under supervision the internal components of the boiler which were disassembled (Power Rods, Insulators and Boxes) before shipping in order to protect them in transit. Containers should be opened at the site. This is an opportunity to train local personnel. Boiler access is through the lower level manhole.

Insulated boiler is provided with lifting lugs for handling vertically or horizontally. Labor, material and equipment required for setting of the boiler and electrical and piping work is not included in this proposal.

4.0 Electrical Supply System

The boiler will require a 3 phase, 4 wire supply circuit derived from a distribution or a transformer with a wye connected secondary and having the transformer neutral grounded at the transformer and extended by means of a full size insulated conductor to the boiler neutral lug. The boiler shell and casing must also be grounded to the building ground system. The motors specified for the boiler circulating pump and shield control and stand-by heater will be _____ V, 3Ph, _____ Hz., unless otherwise specified. The boiler control circuits will be 120V, 1 phase, _____ Hz.

4.1 High Voltage Switchgear

High voltage switchgear for the boiler supply circuit is not included as a part of the boiler proposal. The boiler supply circuit switchgear shall be air or vacuum or SF6 circuit breaker rated for the boiler voltage and ampere load and should be equipped with protective relays as required to open the switchgear in event of phase unbalance or loss of a phase, over-current and under-voltage, and ground current.

The switchgear may also be such that it can be made to open by the boiler high pressure limit control for safety shutdown. Instrumentation should include an ammeter and an ammeter switch for monitoring of phase amperages. The breaker shall be equipped with a Kirk key interlock which shall be keyed to match the access door of the boiler high voltage terminal compartment described in par. 2.5.

It will be the Purchaser's responsibility to advise the supplier of the switchgear of the need to coordinate the keying system with A.E.P. Thermal Inc. Provide CT's and PT's for connection to boiler control circuit in boiler panel (2.6). The switchgear shall incorporate a disconnect switch or equivalent means to provide a visible break in the power supply circuit to the boiler.

5.0 Feedwater Treatment

No feed-water treatment equipment is included in this proposal. The necessary feed-water treatment is not detailed in this typical specification.

The water hardness, required conductivity in the boiler shell, water pH, and alkalinity play a key role in the proper functioning of the boiler. See ***Electrode Boilers Required Water Quality Parameters*** table.

Boiler will operate at up to 3500 µmho conductivity for reduced blow-down and 750PPM alkalinity with superior insulators.

CLEARFIRE - MODEL CFC

Full Condensing Boiler
500-2,500 MBTU
Hot Water 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

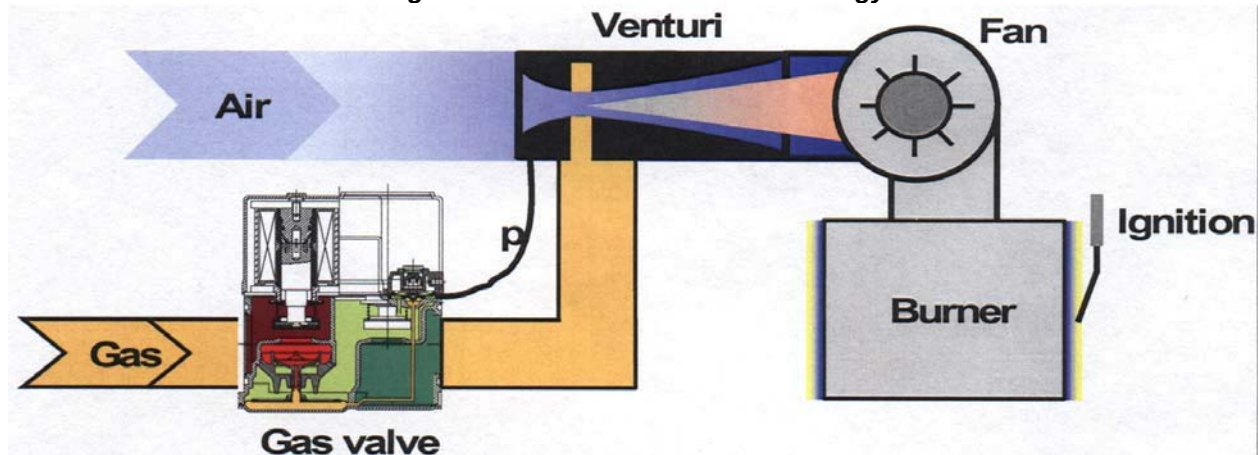
Quality Construction

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 the 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.

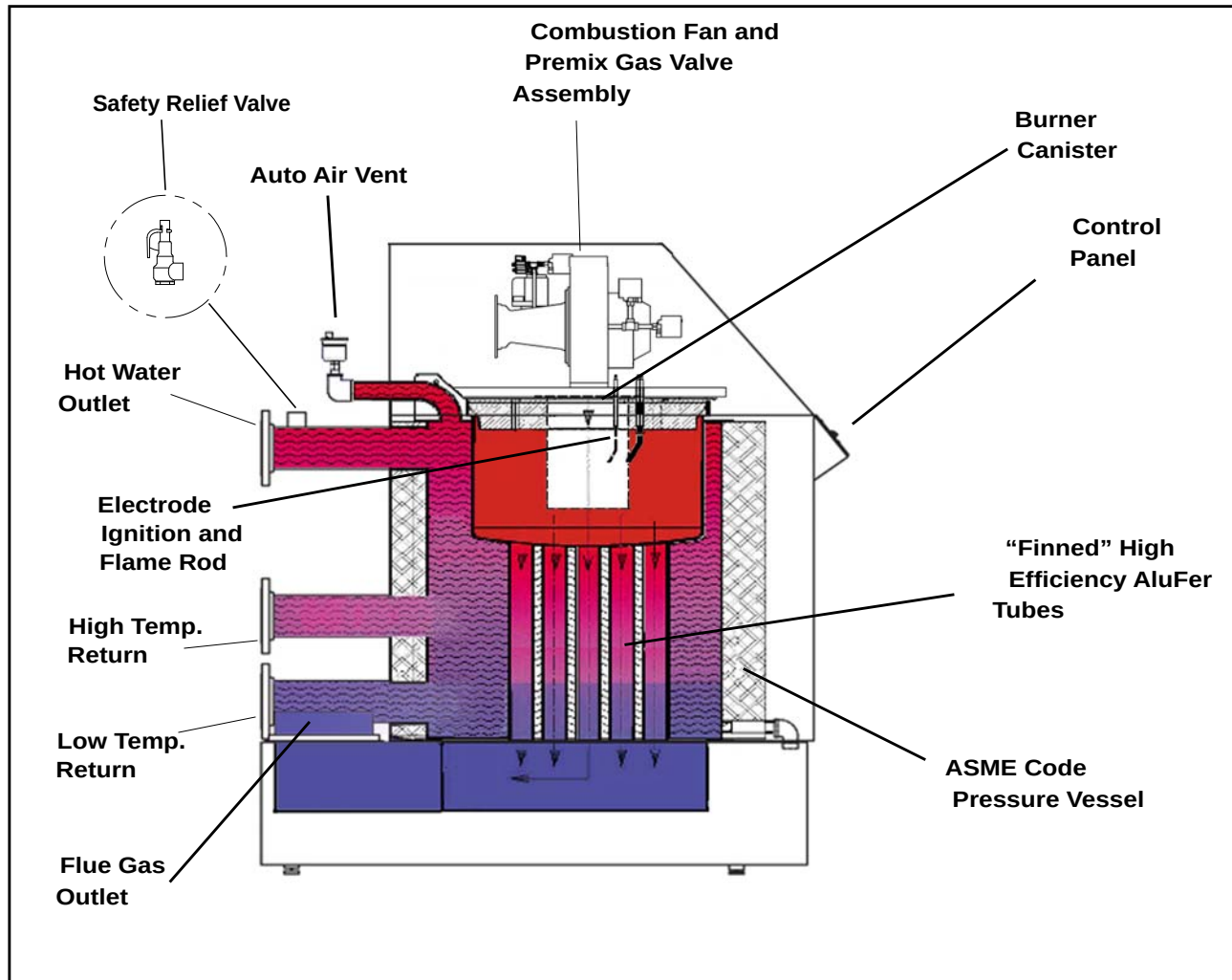


Figure B5-4. Model CFC Heat Flow and Component Orientation

MODEL CFC PRODUCT OFFERING

Information in this section applies to condensing hot water boiler sizes ranging from 500,000 Btu input through 2,500,000 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 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, 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.

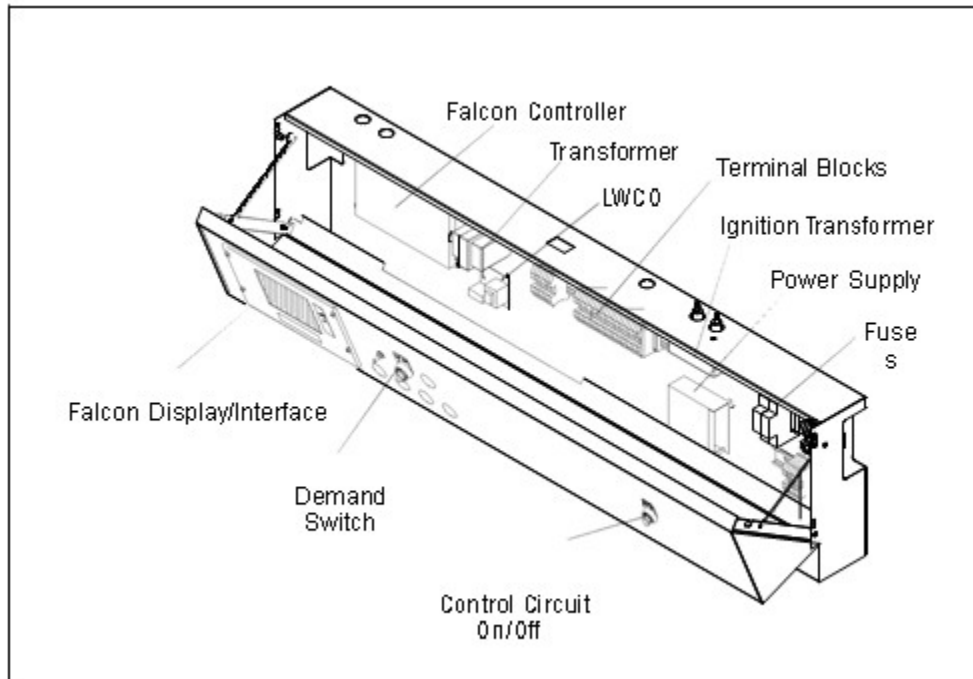


Figure B5-5. ClearFire Control Panel

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.
- 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:

- Dual gas train for quick and easy fuel switchover.
- Reusable air filter.
- Condensate neutralization tank assembly – consist of neutralizing media, filter, and PVC condensate holding tank with integral drain trap. This assembly is mounted beneath the boiler and is further described in Chapter 2.
- Outside air intake for direct vent combustion.
- Outdoor temperature sensor for indoor/outdoor control.
- Header temperature sensor for multiple boiler Lead/Lag operation.
- Auxiliary Low Water Control (shipped loose) for field piping by others into the system piping.
- Alarm Horn for safety shutdown.
- Relays for output signal for burner on, fuel valve open.
- Stack Thermometer.
- Stack temperature limit-sensor.
- Auto air vent.
- 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) and thus, with the ClearFire's lower stack temperature,

due to its more efficient heat transfer design, it captures the latent heat of condensation over a broader range.

Fuel-to-Water efficiency is relative to specific operating conditions. Operating efficiency will be greater when performance is in the "condensing" mode of operation as noted above, yet, with its inherently greater heat transfer surfaces and superior pre-mix burner, efficiency at "traditional" hot water conditions is 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 when in low fire or minimal firing rates and low temperature returns.

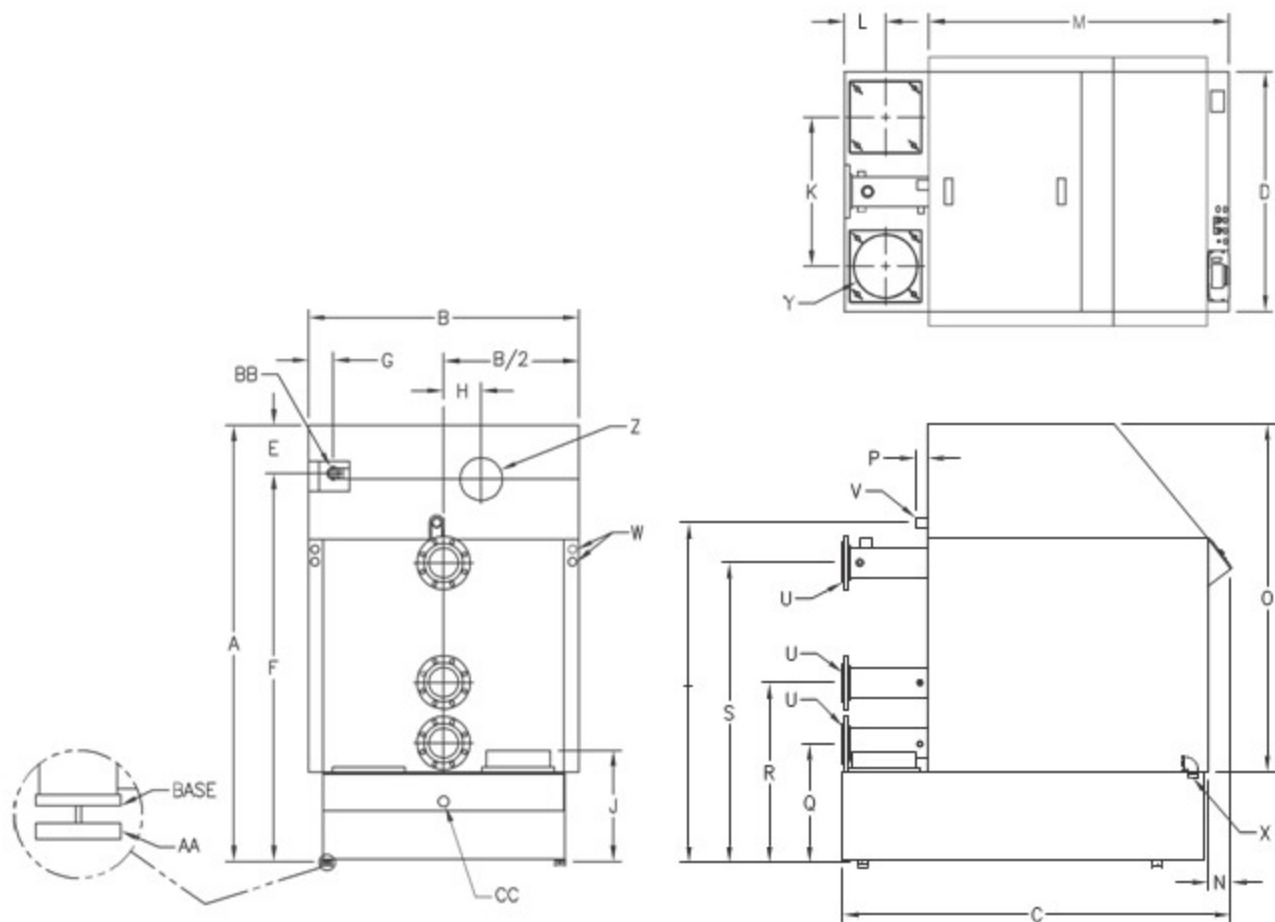


Figure B5-6. Model CFC Dimensional Views

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

ITEM	DIMENSIONS	Boiler Size					
		500	750	1000	1500	1800	2500
A	Overall Height	71.8"	71.8"	75.7"	81.6"	81.6"	82.2"
B	Overall Width	32.3"	32.3"	36.6"	43.7"	43.7"	50.8"
C	Overall Depth	48.8"	48.8"	62.6"	65.6"	65.6"	72.6"
D	Width less casing	26.8"	26.8"	31.1"	38.2"	38.2"	45.3"
E	Gas Connection to Top of Casing	8.1"	8.1"	9.5"	12.5"	10.2"	9.4"
F	Gas Connection to floor	63.7"	63.7"	66.2"	69.1"	71.4"	72.8"
G	Side of Casing to Gas Connection	2.3"	2.3"	4.3"	3.4"	5.2"	4.7"
H	Boiler Centerline to Air Inlet	4.0"	4.0"	4.0"	4.9"	7.1"	7.1"
J	Floor to Top of Stack Connection	18.6"	18.6"	18.1"	19.1"	19.1"	20.9"
K	Centerline to Centerline of Stack Stub	15.4"	15.4"	16.9"	21.0"	21.0"	28.1"
L	Rear of Boiler to Centerline of Stack Stub	5.4"	5.4"	7.5"	8.1"	8.1"	8.6"
M	Front of Boiler to Rear of Casing	38.8"	38.8"	49.4"	49.5"	49.5"	56.5"
N	Control Panel Projection	4.1"	4.1"	4.1"	4.1"	4.1"	4.1"
O	Casing Height	56.2"	56.2"	60.0"	65.4"	65.4"	65.4"
P	Air Vent Line Projection	2.2"	2.2"	2.2"	2.2"	2.2"	2.2"
Q	Floor to Centerline of Lower Return	19.5"	19.5"	19.6"	20.7"	21.3"	22.4"
R	Floor to Centerline of Upper Return	28.2"	28.7"	30.5"	20.3"	32.3"	33.8"
S	Floor to Centerline of Supply Connection	54.3"	54.3"	56.2"	57.1"	56.2"	56.2"
T	Floor to Centerline of Air Vent	59.9"	59.9"	62.3"	63.1"	63.1"	63.6"
AA	Boiler Adjustment Foot Height	2.5"	2.5"	2.5"	2.5"	2.5"	2.5"
	Height Above Boiler for Burner Service	14"	14"	14"	14"	14"	14"
CONNECTIONS							
U	Water Supply/Return, 150# RF Flg	2-1/2"	2-1/2"	2-1/2"	3"	4"	5"
V	Boiler Air Vent, NPT	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"
X	Boiler Drain, NPT	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"
Z	Combustion Air Option	4"	4" OR 6"	4" OR 6"	6"	6"	6" OR 8"
BB	Gas Connection, NPT	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"
CC	Condensate Drain, FPT	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
	Relief Valve @ 125 # Setting	3/4"	3/4"	3/4"	3/4"	1-1/4"	1-1/4"
	Voltage Fan Motor, single phase	115	115	115	115	115	115
	Voltage Control Circuit	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

ITEM	DIMENSIONS (mm)	BOILER SIZE					
		500	750	1000	1500	1800	2500
A	Overall Height	1845	1845	1935	2090	2090	2100
B	Overall Width	820	820	930	1110	1110	1290
C	Overall Depth	1243	1243	1590	1666	1666	1818
D	Width Less Casing	693	693	803	952	983	1163
E	Gas Connection to Top of Casing	206	206	234	316	256	230
F	Gas Connection to Base	1639	1639	1701	1774	1834	1870
G	Side Of Casing to Gas Connection	64	59	109	87	132	118
H	Boiler Centerline to Air Inlet Centerline	101	101	101	124	179	179
J	Base to Top of Stack Connection	405	405	405	430	430	450
K	Centerline to Centerline of Stack Stub	391	391	434	534	534	714
L	Rear of Boiler to Centerline of Stack Stub	136	137	188	207	197	218
M	Front of Boiler to Rear of Casing	982	982	1243	1256	1256	197
N	Control Panel Projection	106	106	106	106	106	106
O	Casing Height	1439	1439	1529	1659	1659	1649
P	Air Vent Line Projection from Rear of Casing	119	114	125	120	120	107
Q	Base to Centerline of Lower Return	496	501	507	536	559	584
R	Base to Centerline of Upper Return	721	721	737	786	839	874
S	Base To Centerline of Supply Connection	1383	1383	1437	1461	1446	1443
T	Base To Centerline of Air Vent	1524	1524	1586	1611	1611	1631
AA	Boiler Height Adjustment (Max.)	64	64	64	64	64	64
CONNECTIONS (INCHES)							
U	Water Supply/Return, 150# RF Flg	2-1/2"	2-1/2"	2-1/2"	3"	4"	5"
V	Boiler Air Vent, NPT	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"
X	Boiler Drain, NPT	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"
Z	Combustion Air Option	4"	4" OR 6"	4" OR 6"	6"	6"	6" OR 8"
BB	Gas Connection, NPT	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"
CC	Condensate Drain, FPT	3/4"	3/4"	3/4"	3/4"	3/4"	1"
	Relief Valve @ 125 # Setting	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"

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

Description	Units	Boiler					
		500	750	1000	1500	1800	2500
Input Max.	BTU/Hr.	500,000	750,000	1,000,000	1,500,000	1,800,000	2,500,000
	KCAL/Hr.	120,998	189,000	252,000	378,000	453,600	629,989
Natural Gas	FT ³ /Hr	500	750	1000	1500	1800	2500
Propane	FT ³ /Hr	200	300	400	600	720	880
Natural Gas	M ³ /Hr	14.16	21	28	42	51	70.7
Propane	M ³ /Hr	5.66	8.5	11	17	20	24.9
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
	KCAL/Hr.	120,958	181,440	241,920	362,880	435,456	604,790
	BHP	14.3	21.5	28.7	43	51.6	71.7
	KW	140	211	281	422	506	703
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
	KCAL/Hr.	109,618	164,430	219,240	328,860	394,632	548,091
	BHP	13	19.5	26	39	47	65
	KW	127	191	255	382	458	637
MAWP	PSI	125	125	125	125	125	125
	BAR	8.6	8.6	8.6	8.6	8.6	8.6
Operating Temp., Max.	°F	194	194	194	194	194	194
	°C	90	90	90	90	90	90
Water Content	Gallons	52	52	87	108	105	126
	Liters	196.8	196.8	329.3	408.8	397.5	477.0
Weight w/o Water	Pounds	1,010	1,010	1,554	1,940	2,061	3,500
	Kg	458	458	705	880	935	1588
Standby Heat Loss	BTU/Hr	1,206	1,810	1,912	2,390	2,459	3,415
	Watts	353	530	560	700	720	1,000
Fan Motor Size	Watts	335	335	335	750	1200	1200
Operating Voltage, Fan	Volts/Ph/Hz	120/1/60	120/1/60	120/1/60	120/1/60	120/1/60	120/1/60
Control Circuit	Volts/Ph/Hz	120/1/60	120/1/60	120/1/60	120/1/60	120/1/60	120/1/60
Current Draw, Fan	Amperes	4	4	4	8.5	12	12
Current Draw Cont. Ckt.	Amperes	1.5	1.5	1.5	1.5	2	2
Condensate Quantity Firing Nat. Gas & operating @ 104/86 F.	Gal/Hr.	4	4.7	5.8	7	8.1	12
	l/Hr.	15.14	17.8	22	26.5	30.9	45
Condensate Value	PH	5 - 5.5	5 - 5.5	5 - 5.5	5 - 5.5	5 - 5.5	5 - 5.5
Flue Gas Mass Flow @ 100% Firing	lb/hr	557	835	1,113	1,670	2,004	2,783
	kg/h	253	378	505	757	909	1262
Flue Gas Temp. Oper. 176/140 F [80/60 C]	°F	155	180	160	170	170	160
	°C	68	82	71	77	77	71
Flue Gas Temp. Oper. 104/86 F [40/30 C]	°F	105	125	106	108	108	110
	°C	41	52	41	42	42	43

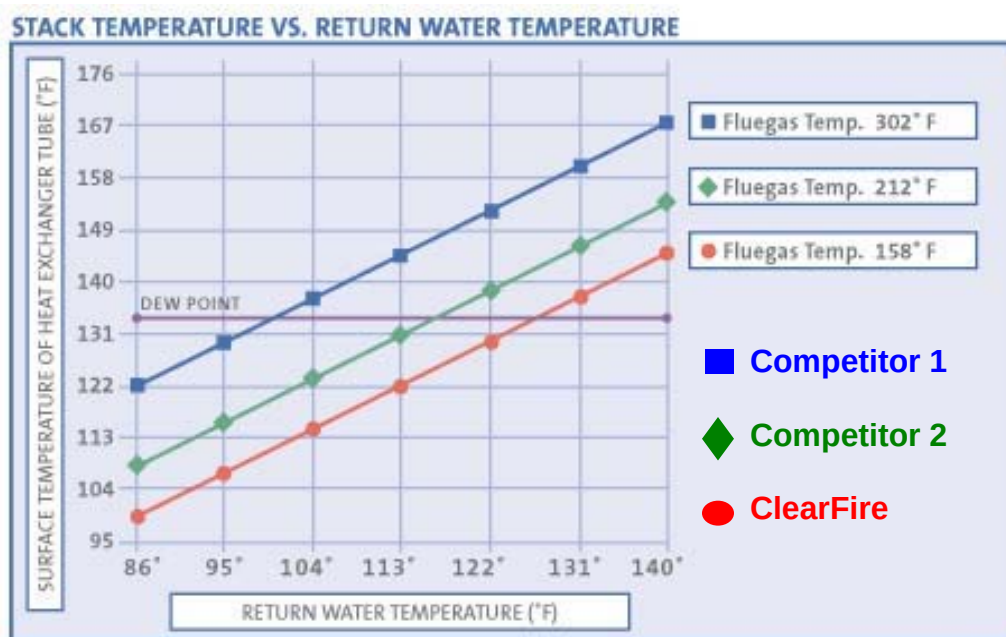
Table B5-4. Altitude Correction for Input Capacity at Various Altitude Levels (Natural Gas)

	700' ASL	2000'	4500'	6000'	8000'	10000'
CFC 2500	2500	2500	2250	2025	1925	1730
CFC 1800	1800	1779	1530	1472	1413	1356
CFC 1500	1500	1500	1350	1296	1244	1194
CFC 1000	1000	1000	900	864	829	783
CFC 750	750	750	700	675	645	620
CFC 500	500	500	450	425	425	400

** Ratings assume 35% excess air, 80F combustion air.

Blower speed adjustments should be made to match performance accordingly.

Gas pressure corrections for altitude should be made per Boiler Book Table B5-19.

**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 with in 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	98.4	97	96.5	95	93	87.5
50	98.25	98.1	96	92.5	93	89	87.5
75	98	97	94	87.5	88	87.5	86.5
100	97.2	96	90.5	87.25	87	87	86

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	99	98.4	97	96.5	95	93	87.5
50	98.25	98.1	96	92.5	93	89	87.5
75	98	97	94	87.5	88	87.5	86.5
100	97.2	96	90.5	87.25	87	87	86

Table B5-7. CFC 1000 ClearFire Efficiency

Firing Rate %	Return Water Temperature F ⁰ (C)						
	68 (20)	80 (27)	105 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	99	98.5	97	95.5	94.5	88.5
50	99	99	97.5	93.5	92	90.5	87.9
75	98	97	93	89	88	87.5	86.5
100	97.2	97	91.5	88.50	87.5	87	86.50

Table B5-8. CFC 1500 ClearFire Efficiency

Firing Rate %	Return Water Temperature F ⁰ (C)						
	68 (20)	80 (27)	105 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	99	98	97	96.5	94	88
50	98.25	99	97	93	91.5	89.5	87
75	98	97	93	89	88	87.5	86.5
100	97.2	97	91	88	87.5	87	86.25

Table B5-9. CFC 1800 ClearFire Efficiency

Firing Rate %	Return Water Temperature F ⁰ (C)						
	68 (20)	80 (27)	105 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	99	98	97	95.5	93.7	88
50	98.25	99	97	93	91.5	89.5	87.5
75	98	97	93	89	88	87.5	86.5
100	97.2	96.5	91	88.25	87.5	87	86.25

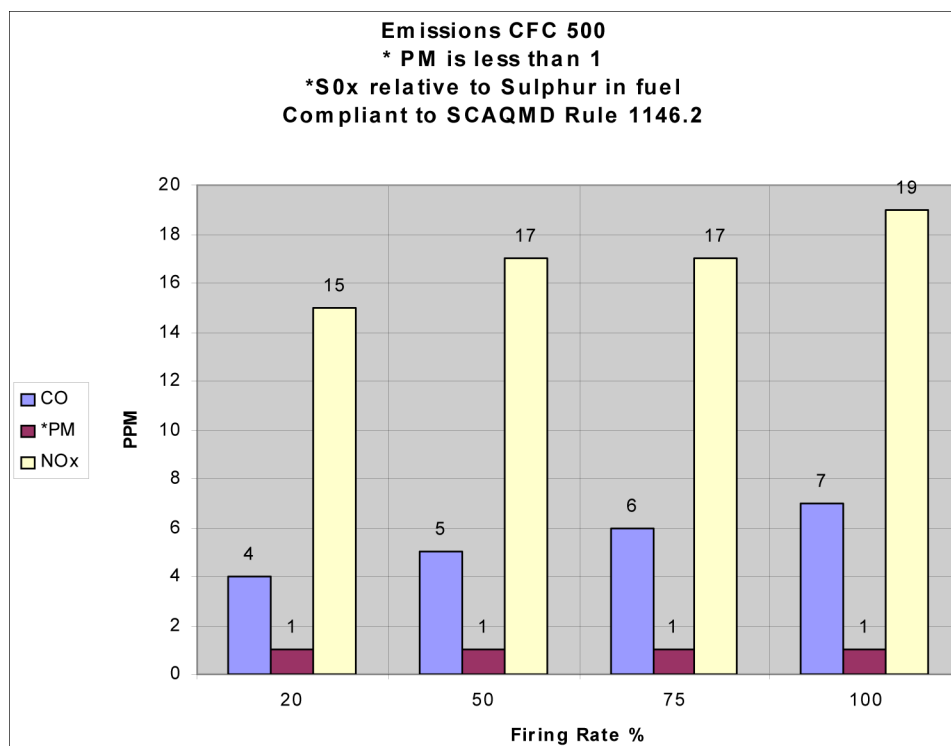
Table B5-10. CFC 2500 ClearFire Efficiency

Firing Rate %	Return Water Temperature F ⁰ (C)						
	68 (20)	80 (27)	105 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	99	98	97	95.5	93.7	88
50	98.25	99	97	93	91.5	89.5	87.5
75	98	97	93	89	88	87.5	86.5
100	97.2	96.5	91	88.25	87.5	87	86.25

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**

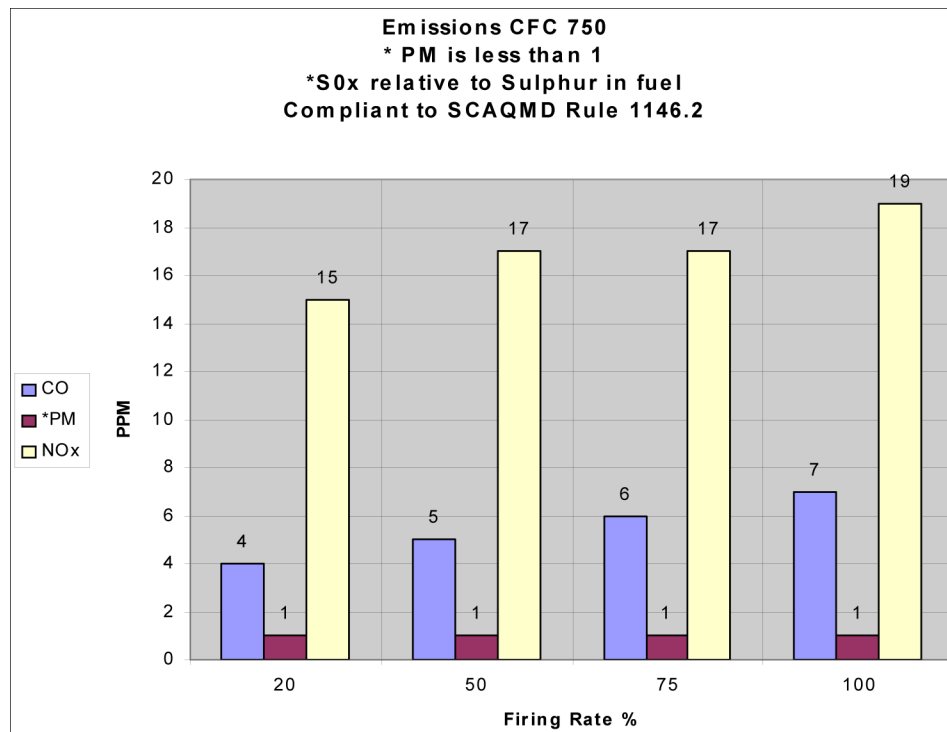


Figure B5-9. Emissions Data ClearFire Model CFC 750

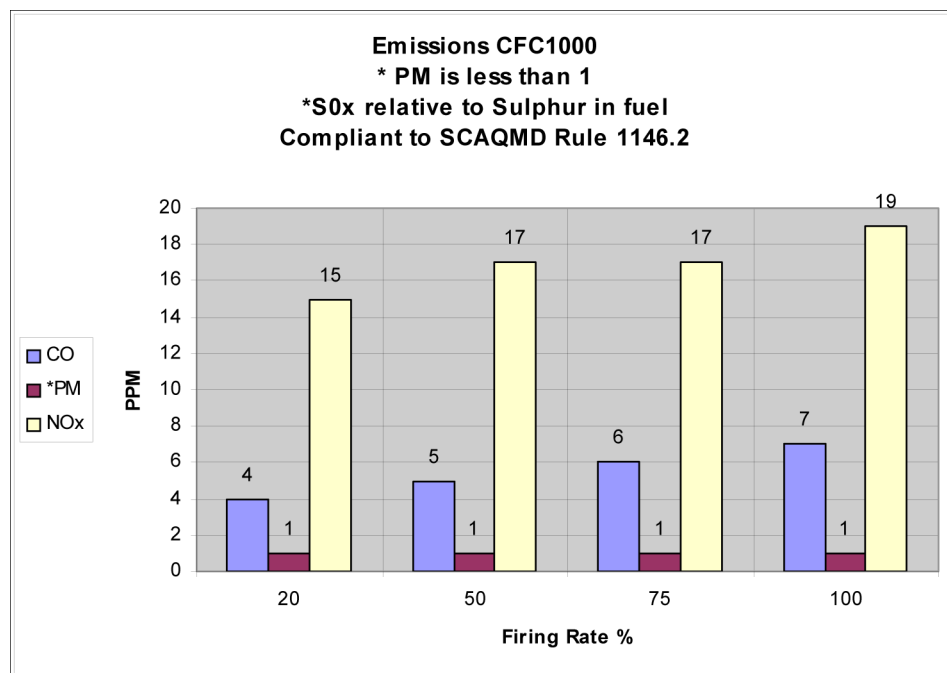


Figure B5-10. Emissions Data ClearFire Model CFC 1000

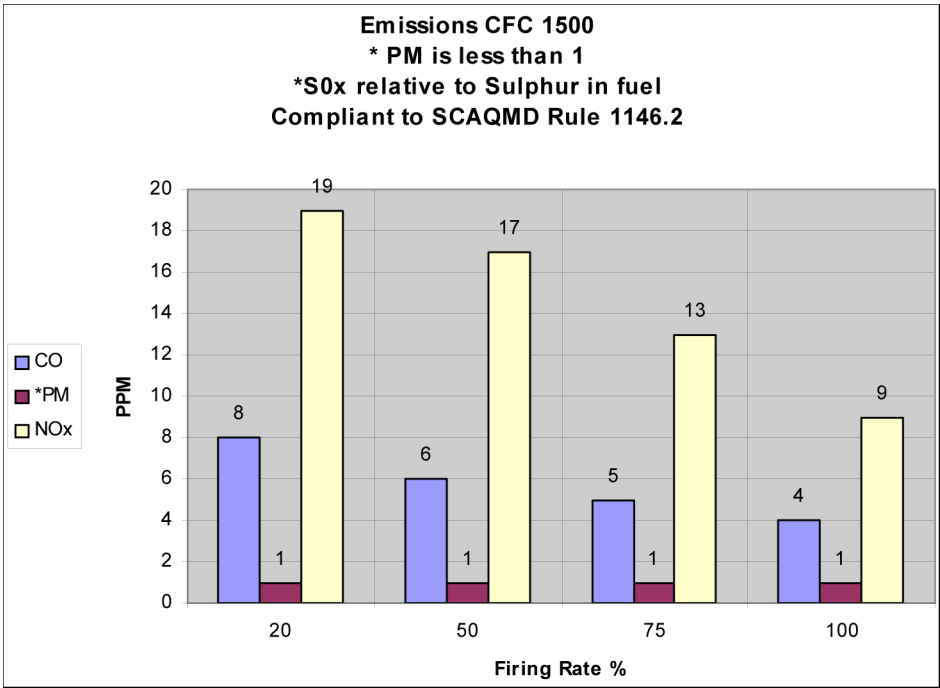


Figure B5-11. Emissions Data ClearFire Model CFC 1500

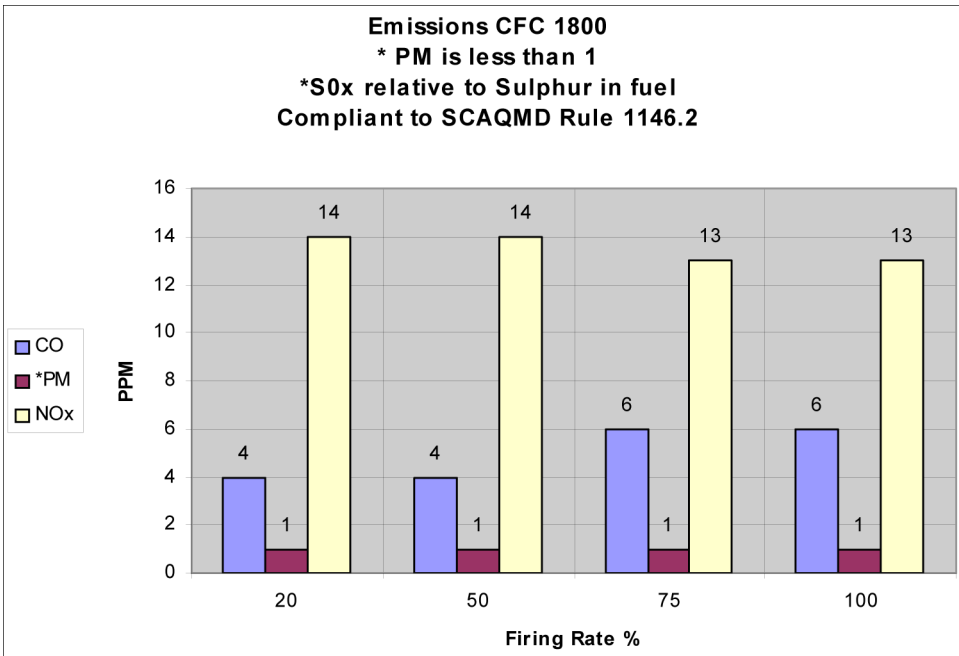


Figure B5-12. Emissions Data ClearFire Model CFC 1800

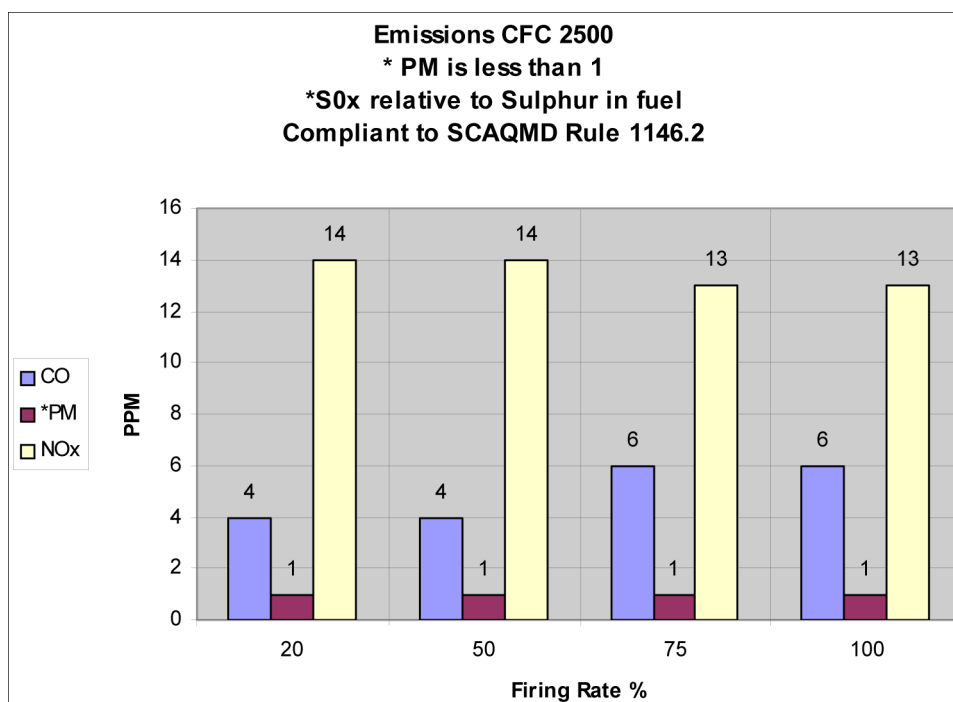


Figure B5-13. Emissions Data ClearFire Model CFC 2500

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

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 B5-24.

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 B5-15 and Table B5-16).

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 B5-12. Maximum Flow Rate Through ClearFire Boilers (US Flow Rates)

System Temperature Drop ° 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

Recommended flow rates relative to temperature drop so as not to exceed boiler output.

Table B5-13. Maximum Flow Rate Through ClearFire Boilers (Metric Flow Rates)

System Temperature Drop ° 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

Recommended flow rates relative to temperature drop so as not to exceed boiler output.

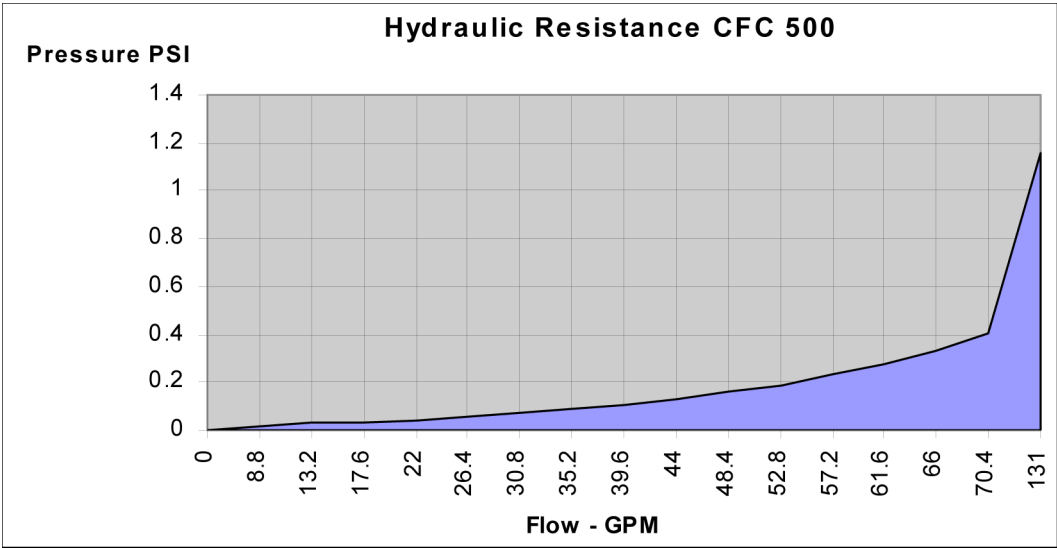


Figure B5-14. Pressure Drop Curve ClearFire Boiler Size 500, U.S. Flow Rates.

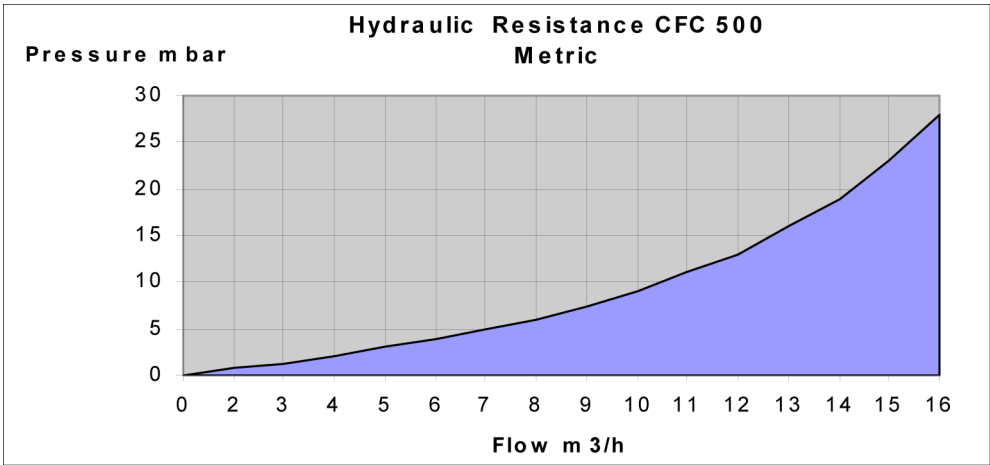


Figure B5-15. Pressure Drop Curve ClearFire Boiler Size 500, Metric Flow Rates.

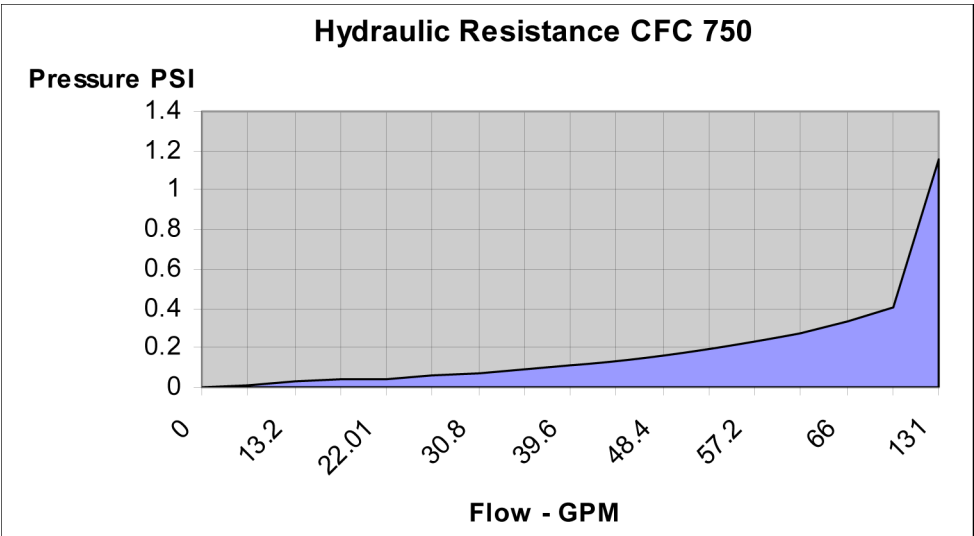


Figure B5-16. Pressure Drop Curve ClearFire Boiler Size 750, U.S. Flow Rates.

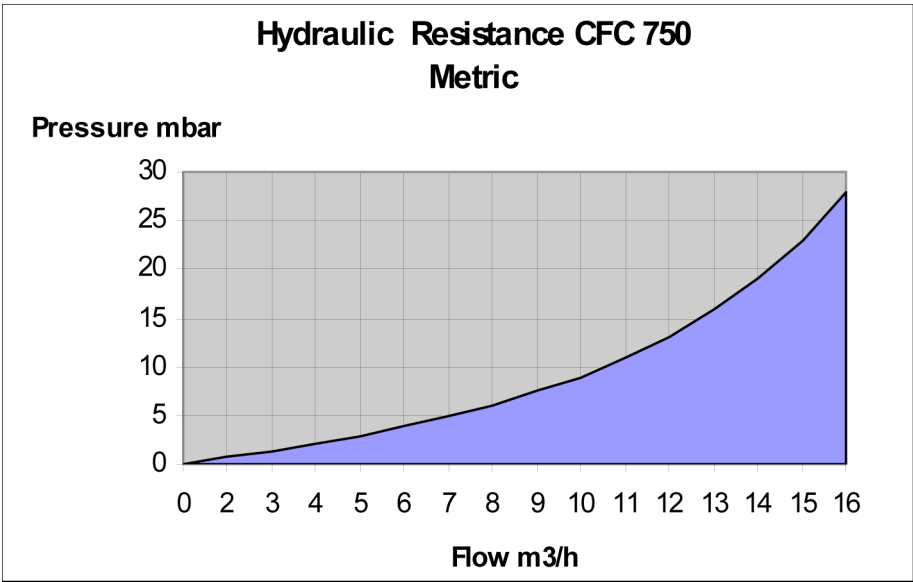


Figure B5-17. Pressure Drop Curve ClearFire Boiler Size 750, Metric Flow Rates.

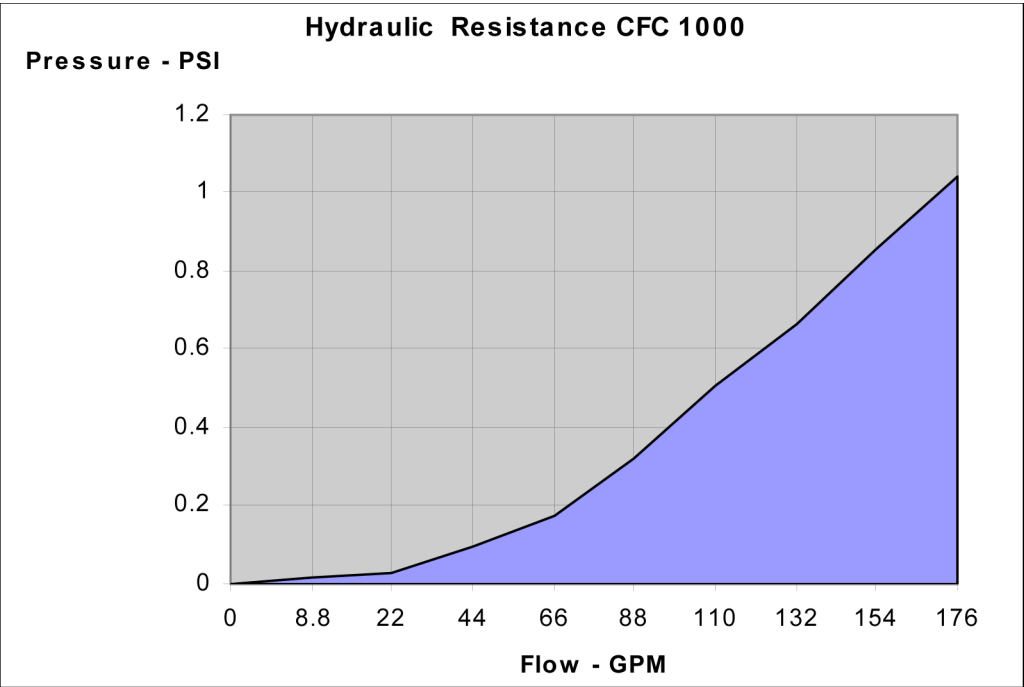


Figure B5-18. Pressure Drop Curve ClearFire Boiler Size 1000, U.S. Flow Rates.

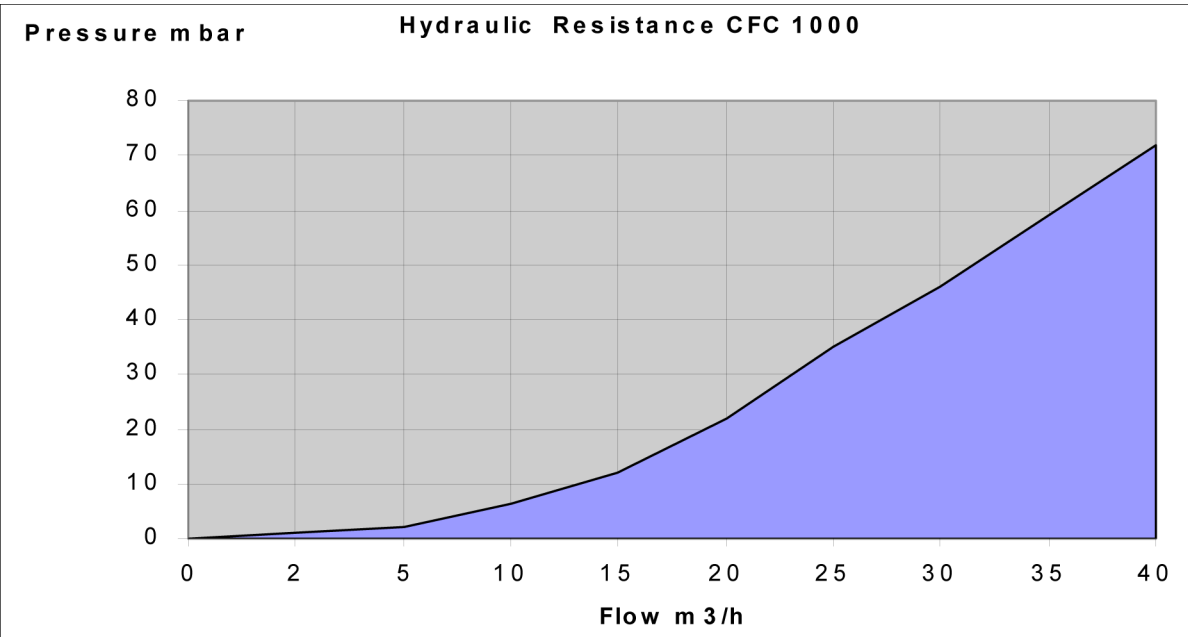


Figure B5-19. Pressure Drop Curve ClearFire Boiler Size 1000, Metric Flow Rates.

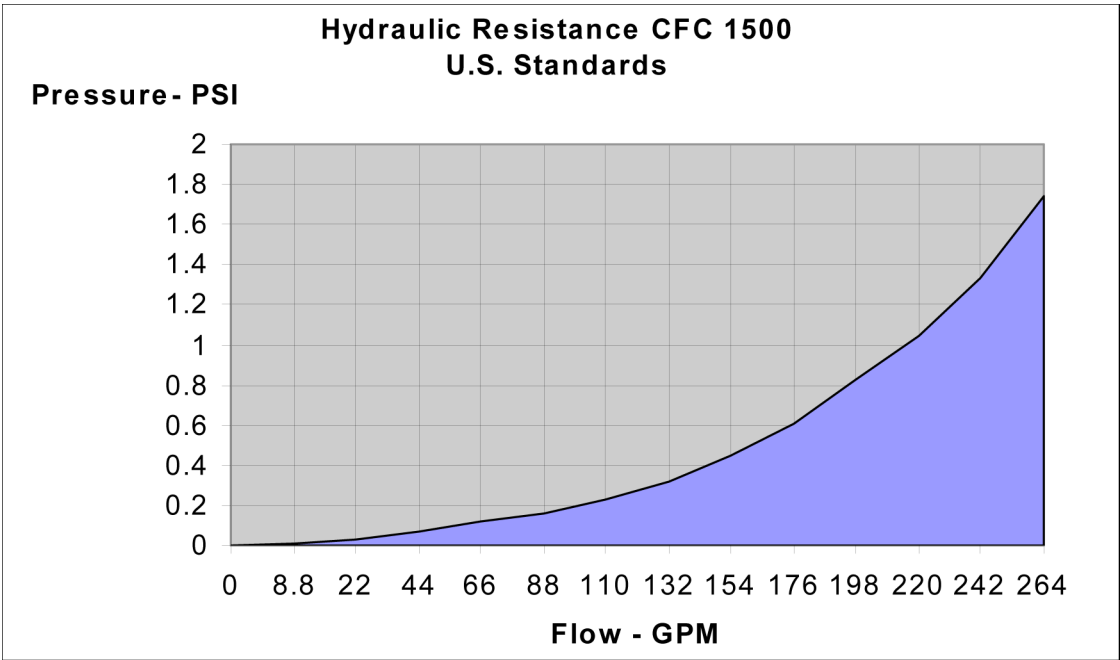


Figure B5-20. Pressure Drop Curve ClearFire Boiler Size 1500, U.S. Flow Rates.

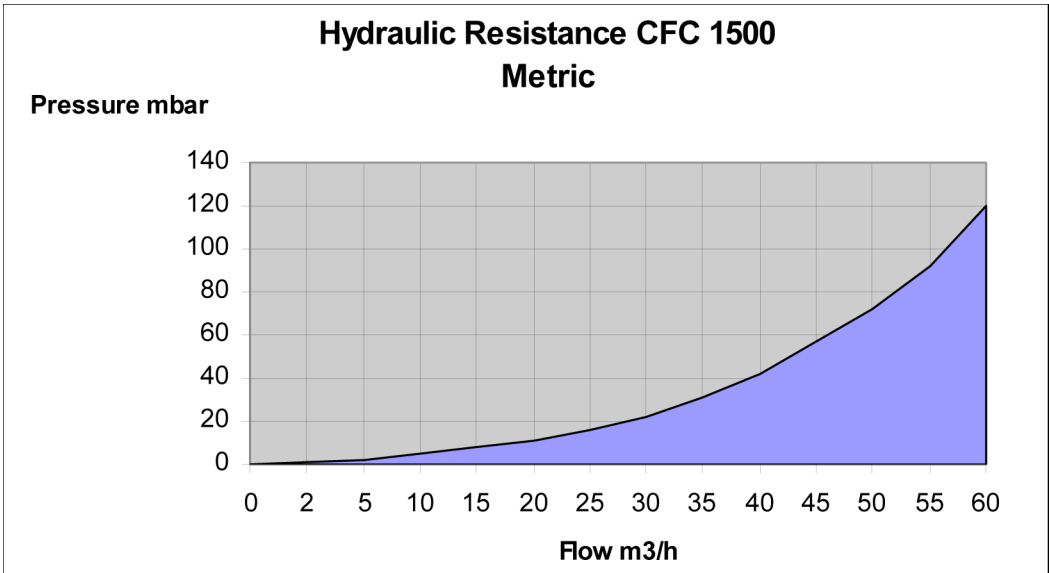


Figure B5-21. Pressure Drop Curve ClearFire Boiler Size 1500, Metric Flow Rate.

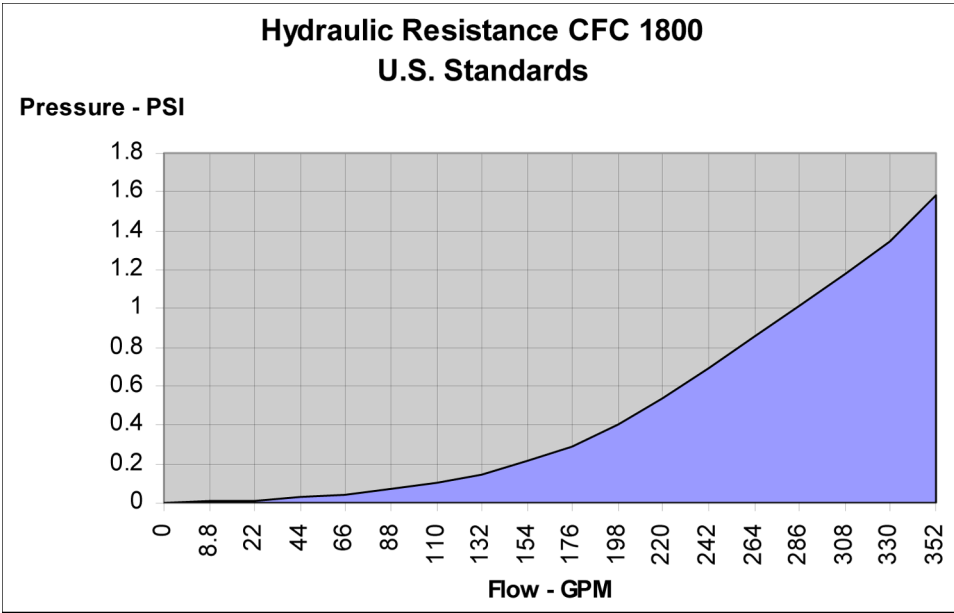


Figure B5-22. Pressure Drop Curve ClearFire Boiler Size 1800, U.S. Flow Rates.

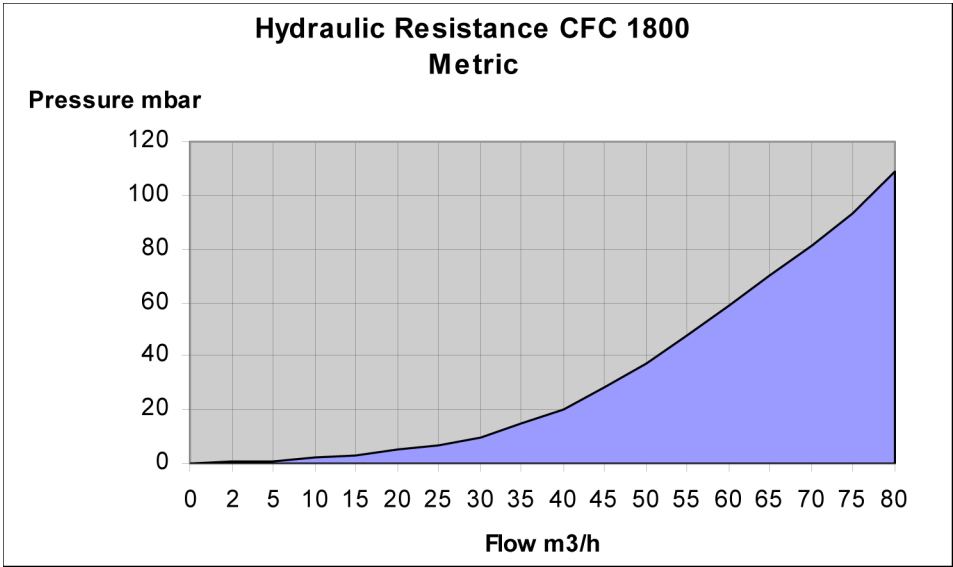


Figure B5-23. Pressure Drop Curve ClearFire Boiler Size 1800, Metric Flow Rates.

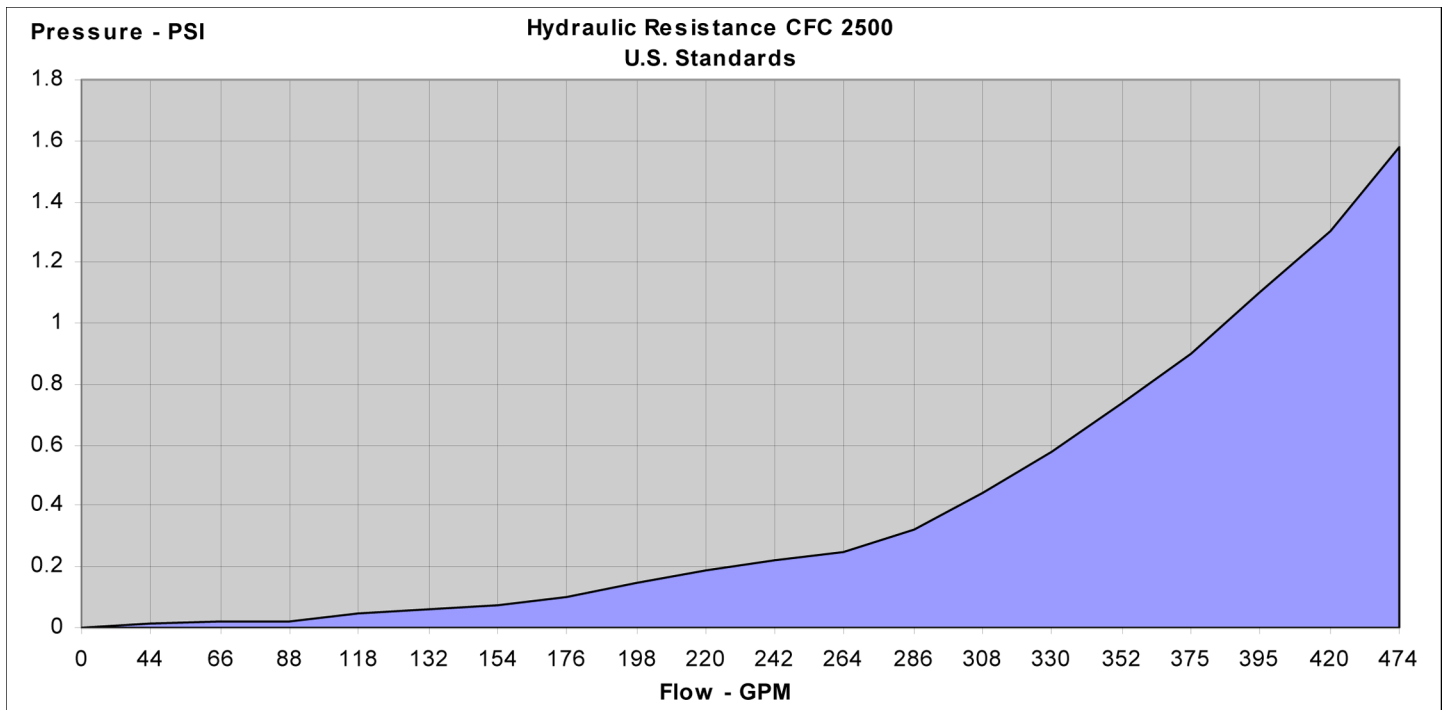


Figure B5-24. Pressure Drop Curve ClearFire Boiler Size 2500, U.S. Flow Rates.

Table B5-14. Model CFC Minimum Over Pressure Requirements

Outlet Water Temperature ° 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 @ 60 PSIG

Boiler Size	Valve Connection @ Boiler	Valve Setting 125 psig		Relief 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

Table B5-16. Model CFC Boiler Safety Valve Information @ 30 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

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 Guidelines - Model CFC

Minimum required boiler circulation rate (gpm) at maximum firing rate.				
ClearFire	System ΔT (°F)			
Model-Size	$\Delta T = 10^\circ$	$\Delta T = 20^\circ$	$\Delta T = 30^\circ$	$\Delta T = 40^\circ$
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

Notes/Limitations:

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

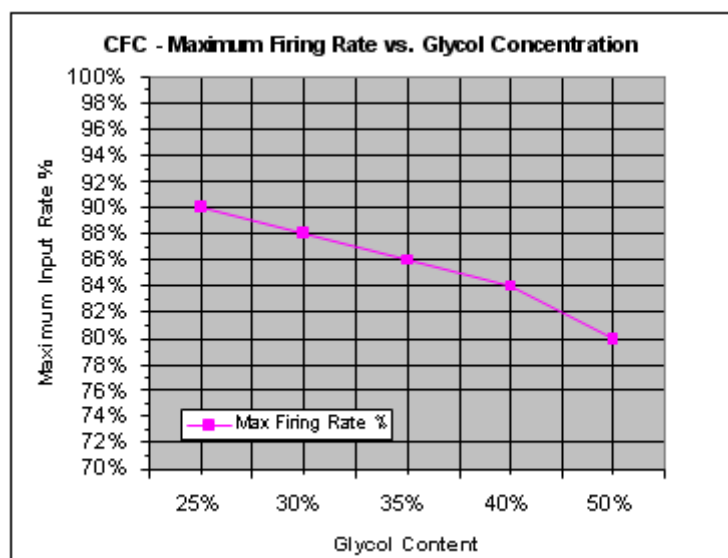
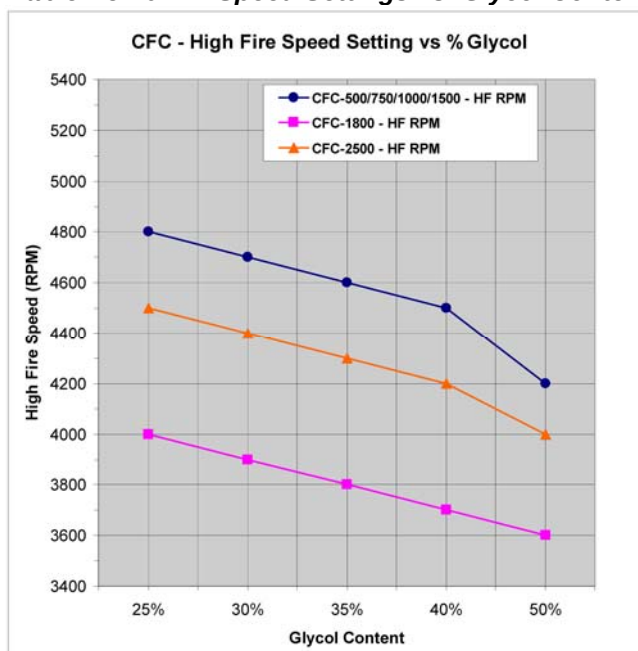
Table B5-19. Max Firing Rate vs. Glycol Concentration

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 this 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)

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 B5-25 depicts piping without the treatment assembly and Figure B5-26 shows the optional treatment assembly.

Note: One treatment kit may be used for up to four boilers as shown in Figure B5-27 and Figure B5-28.

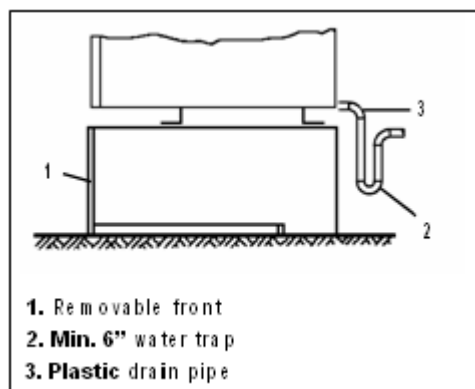


Figure B5-25. Condensate Piping Direct To Drain

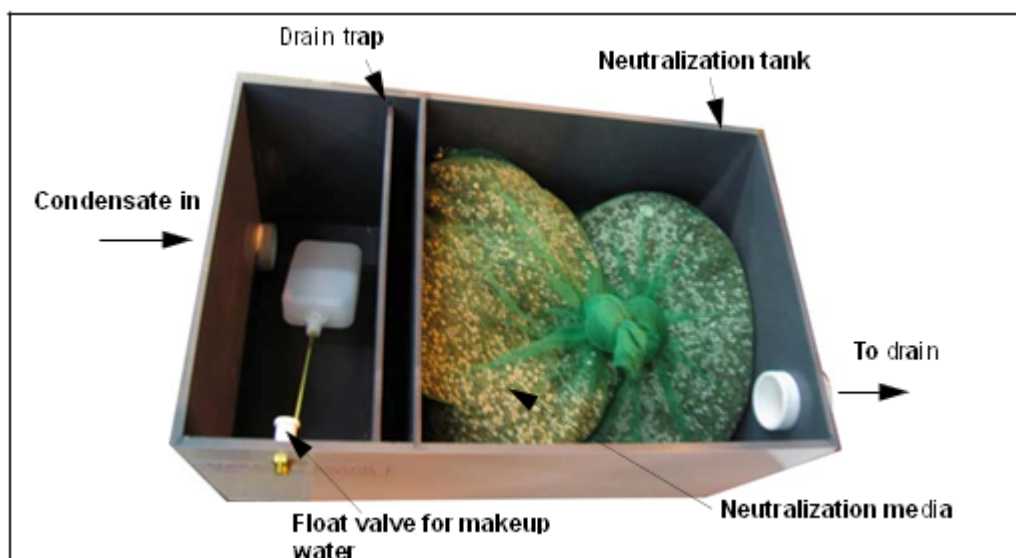


Figure B5-26. Optional Condensate Treatment Assembly

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.

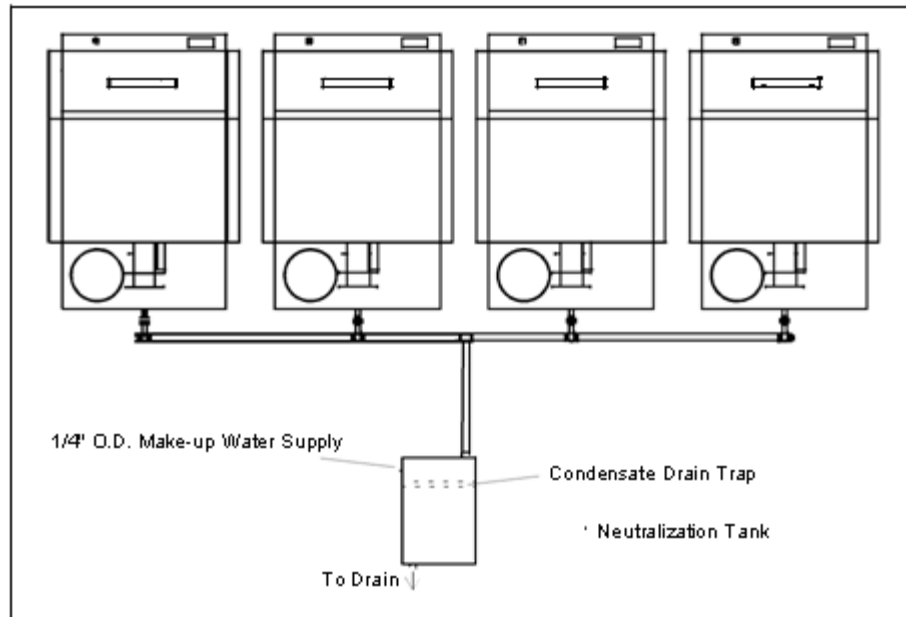


Figure B5-27. Condensate Piping for Multiple Boilers

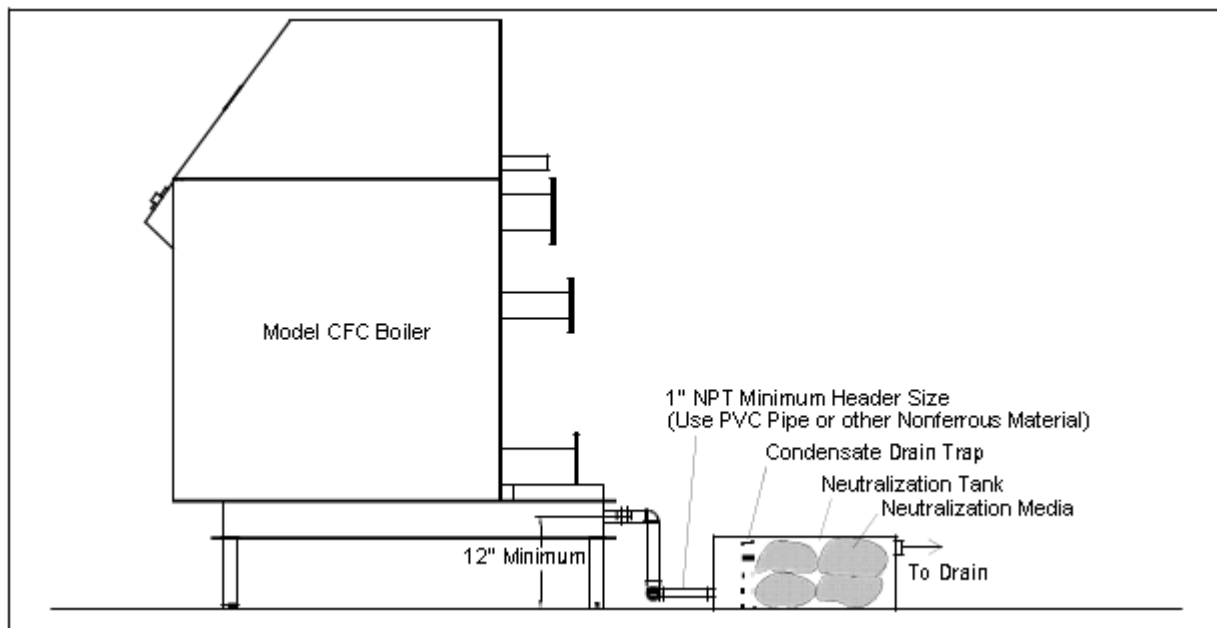


Figure B5-28. Condensate Treatment Tank for Multiple Boilers

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 B5-29, and Figure B5-30 for piping suggestions.

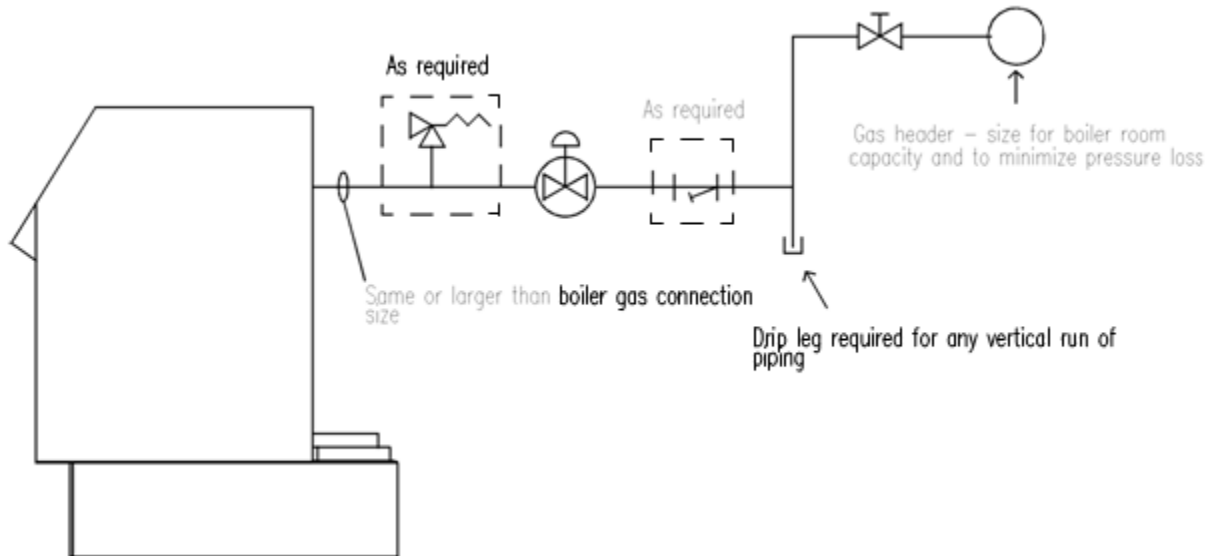
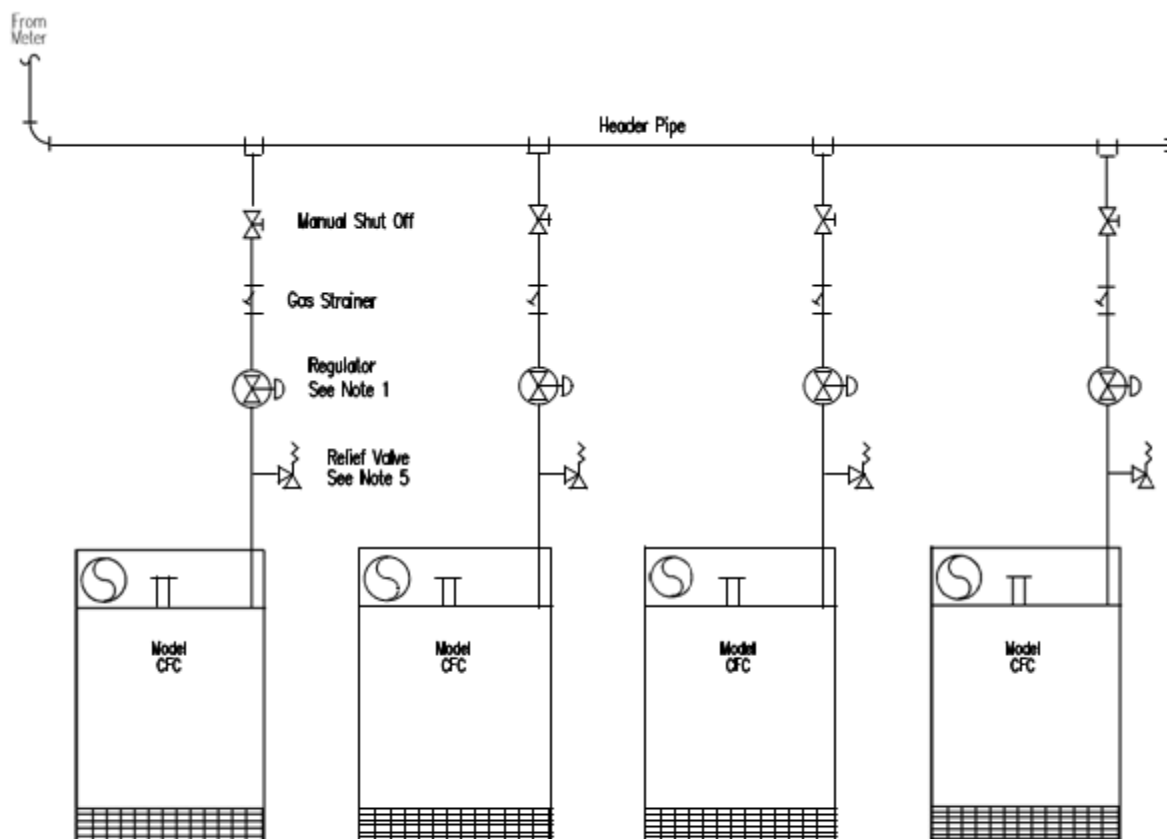


Figure B5-29. Gas Piping Schematic

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 B5-22 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 B5-23 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 B5-30. Gas Header Piping

Table B5-22. Model CFC Minimum and Maximum Gas Pressure

Boiler Model	Minimum pressure required at gas train		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.	

Table B5-23. 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 B5-23 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 B5-31.

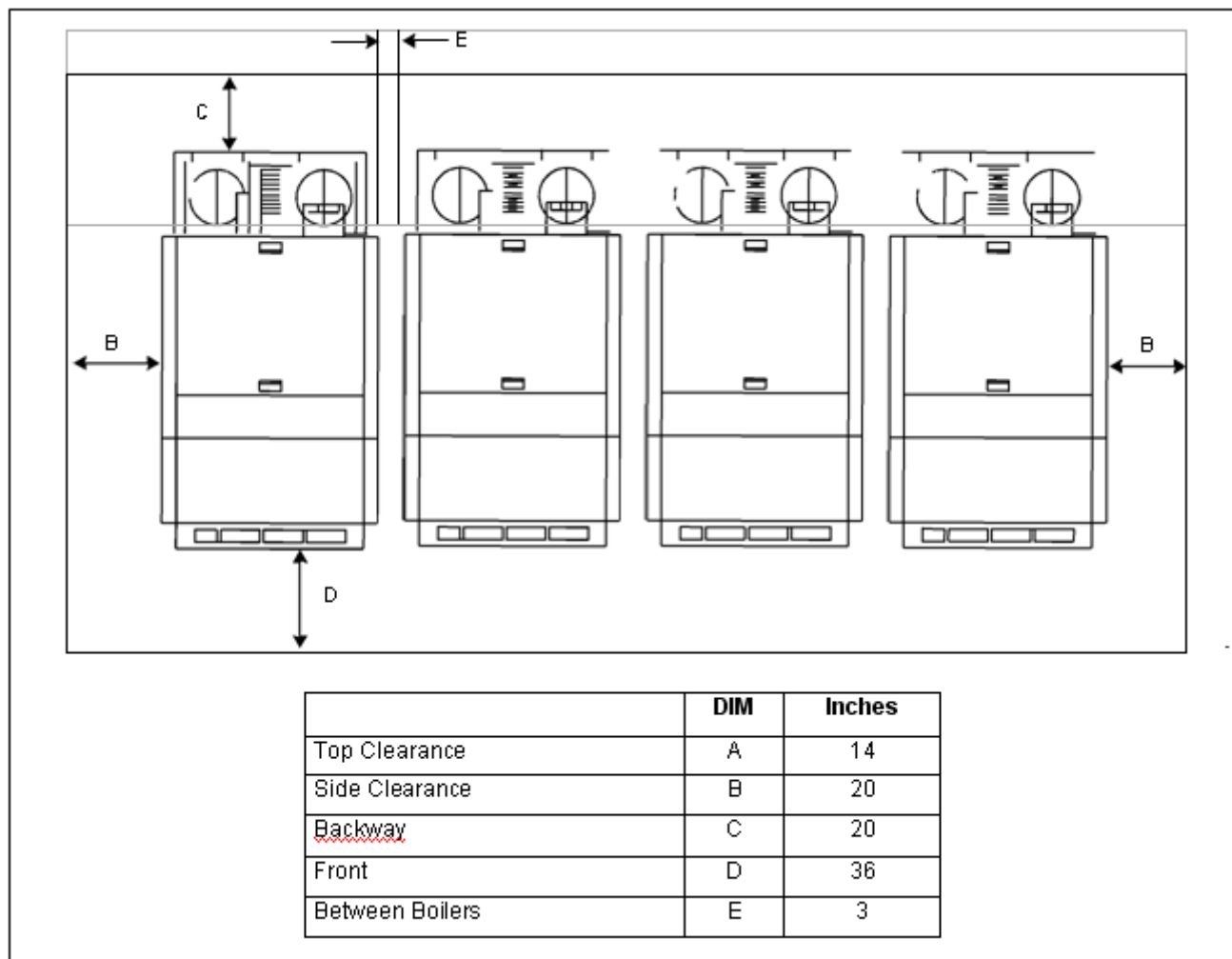


Figure B5-31. Model CFC Minimum Room Clearance Dimensions

Seismic Legs

Seismic mounting details shown below

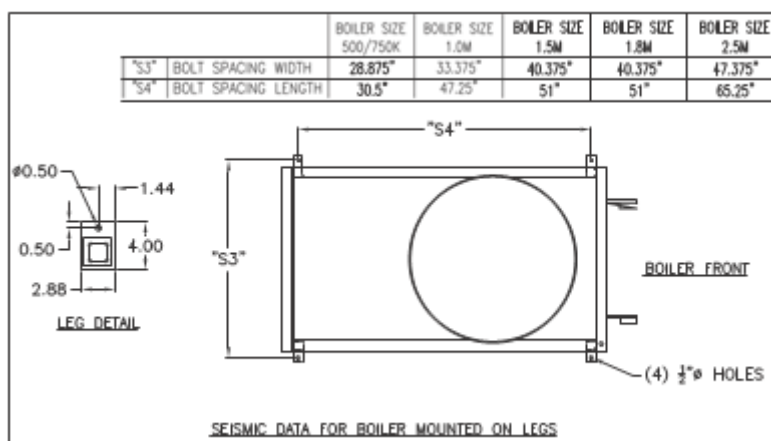


Figure B5-32. CFC Seismic Mounting

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.

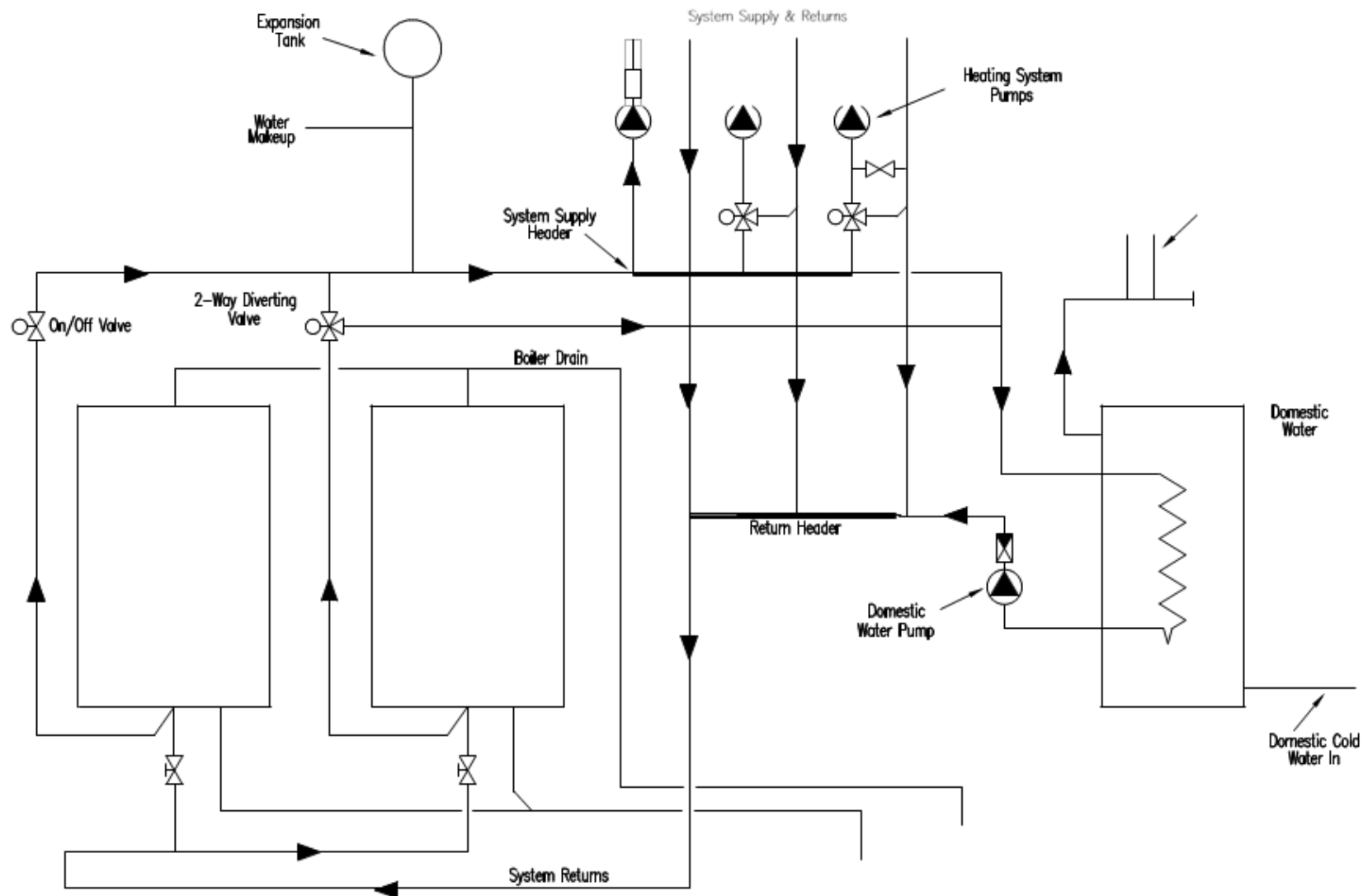


Figure B5-33. No primary Loop with Domestic Water and 2-Way Divert Valve

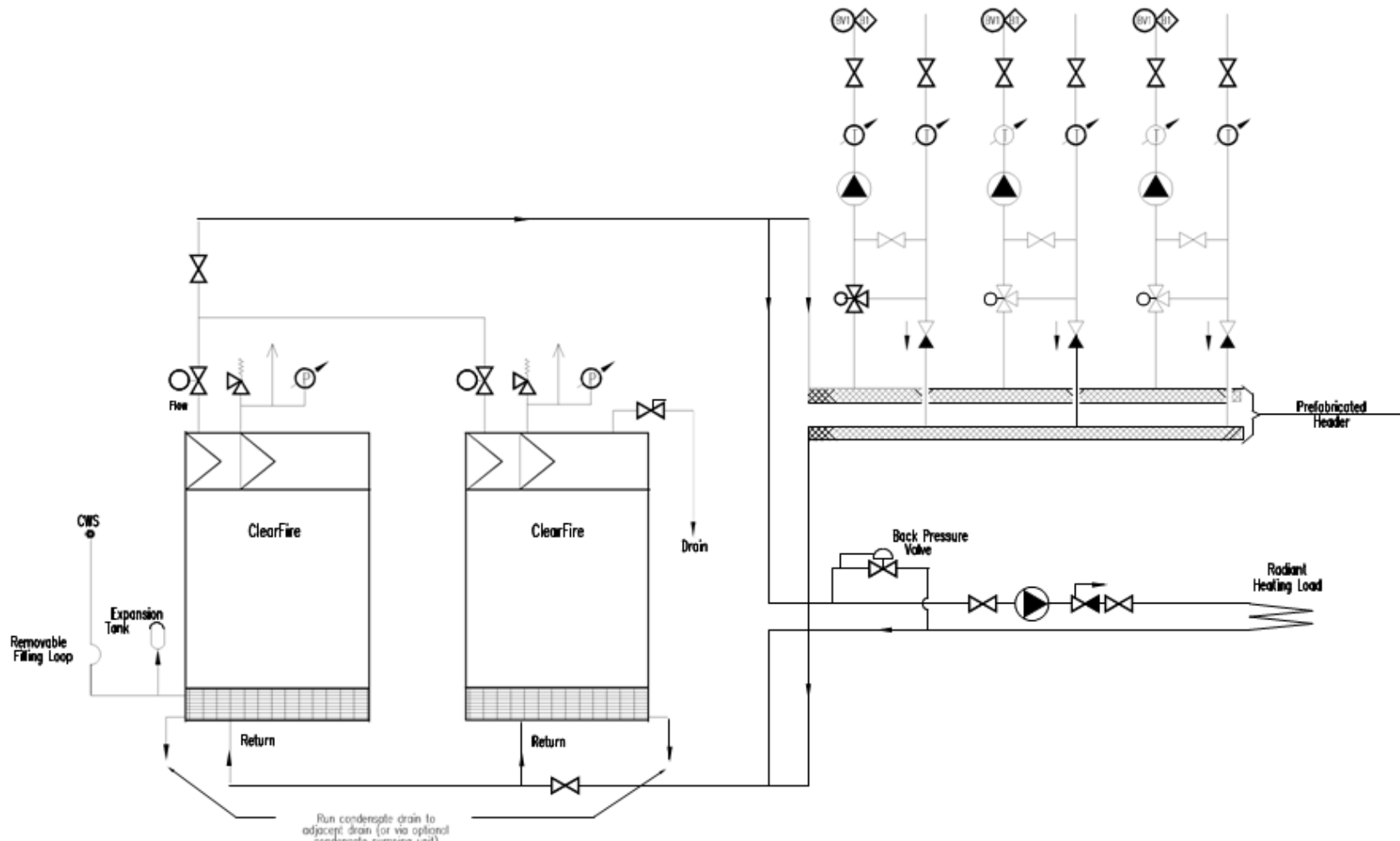


Figure B5-34. Two Boilers and Three Variable Temperature Zones (No Primary Loop)

- ① BOILER OUTLET (SUPPLY)
- ② BOILER INLET (RETURN)
- ③ SECONDARY CONNECTION
12" MAX APART AT ALL SECONDARY CONNECTIONS
TO PREVENT FORCED FLOW IN SECONDARY
CAUSED BY PRESSURE DROP THROUGH PIPING
BETWEEN CONNECTIONS
- 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
SECONDARY CIRCUITS)
- ⑫ DOMESTIC PUMP
- ⑬ DOMESTIC WATER TANK

- A TEMPERATURE CONTROL BY SECONDARY
CIRCULATION ONLY
- B TEMPERATURE CONTROL USING MIXING
VALVE
- C TEMPERATURE/HEAT INPUT CONTROL
USING INJECTION PUMPING

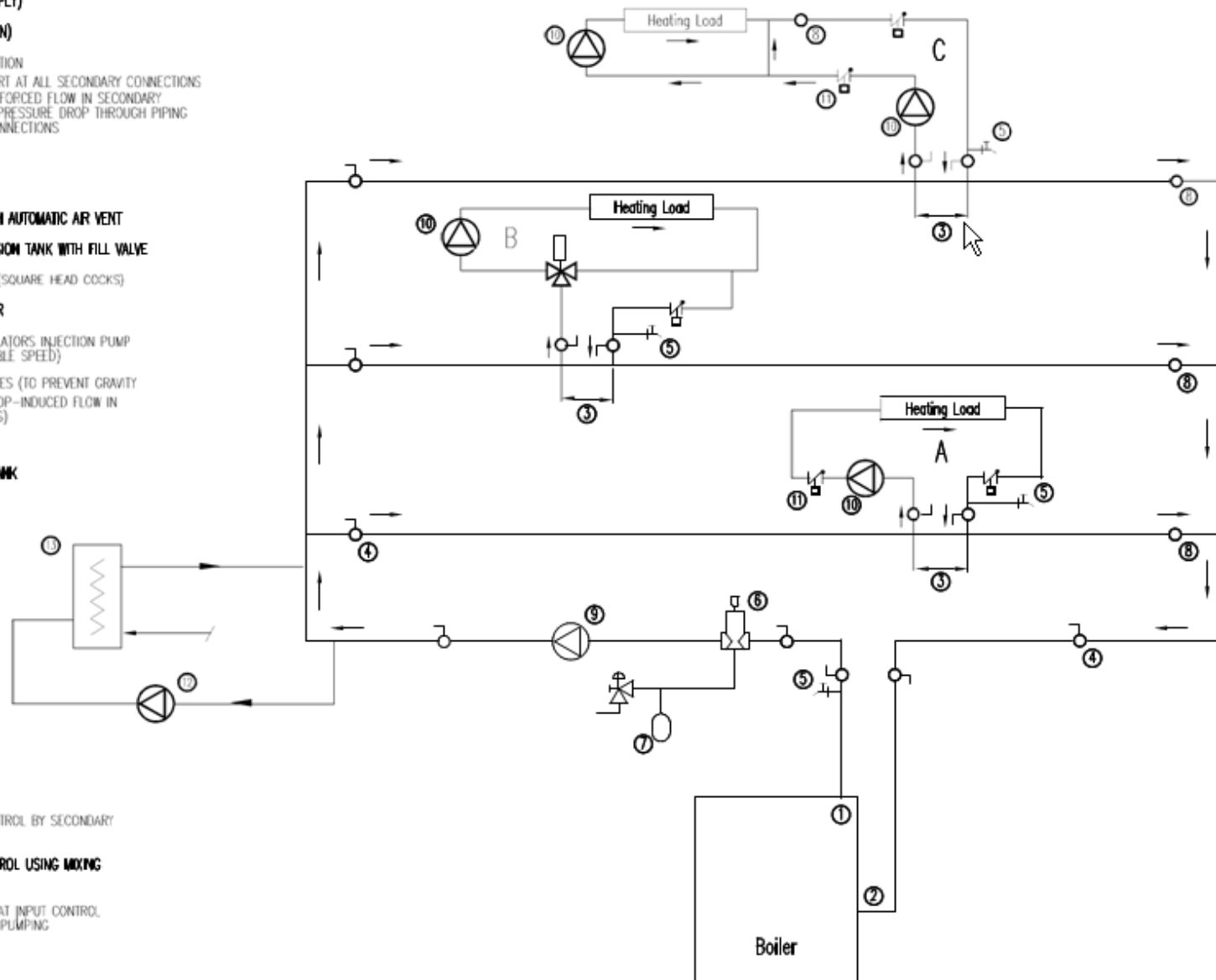


Figure B5-35. Two-Pipe Primary/Secondary Piping with Domestic Hot Water

- 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 SECONDARY CIRCUITS)
- ⑬ 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

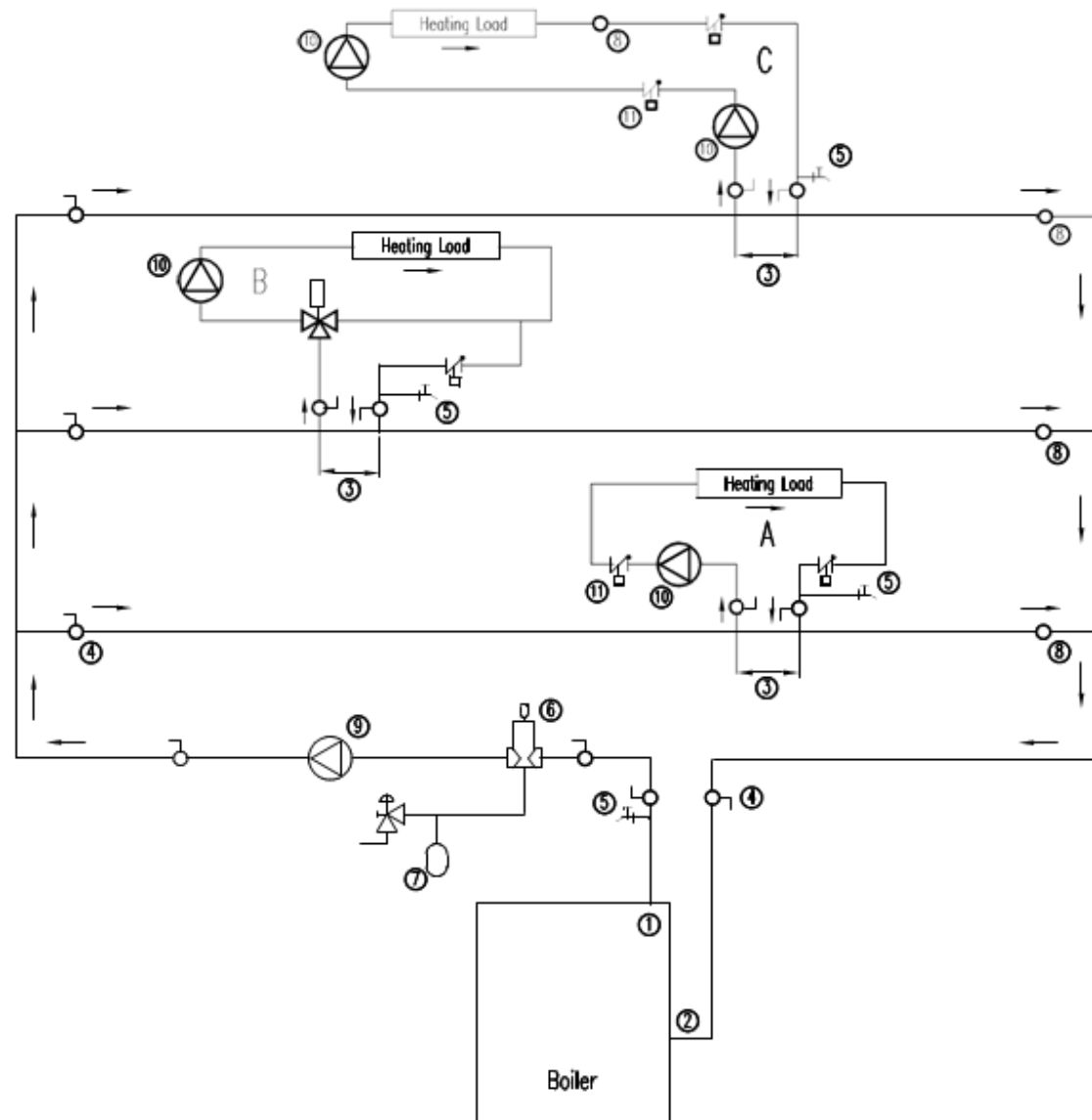


Figure B5-36. Two-Pipe Primary/Secondary Piping

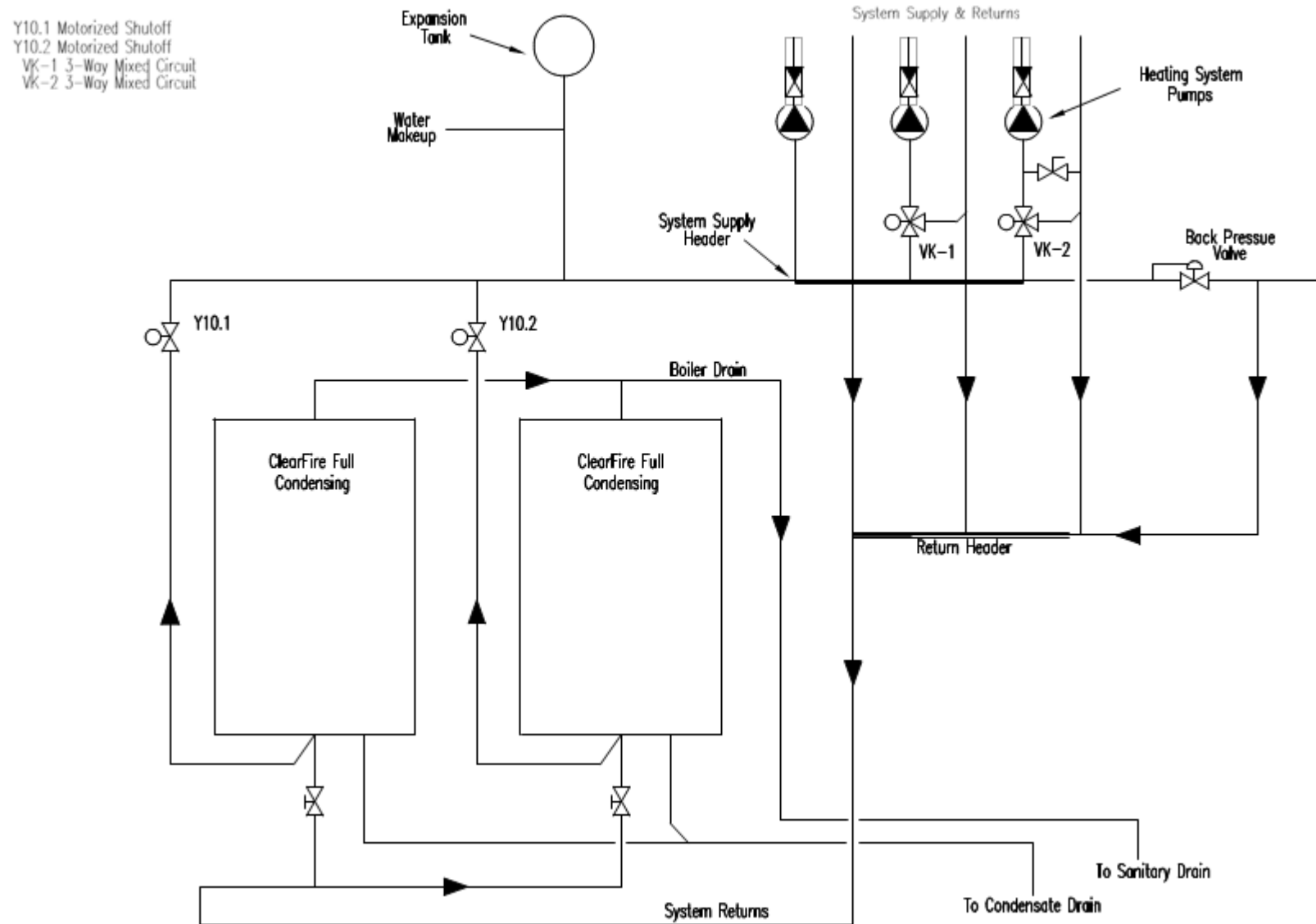


Figure B5-37. No Primary Loop

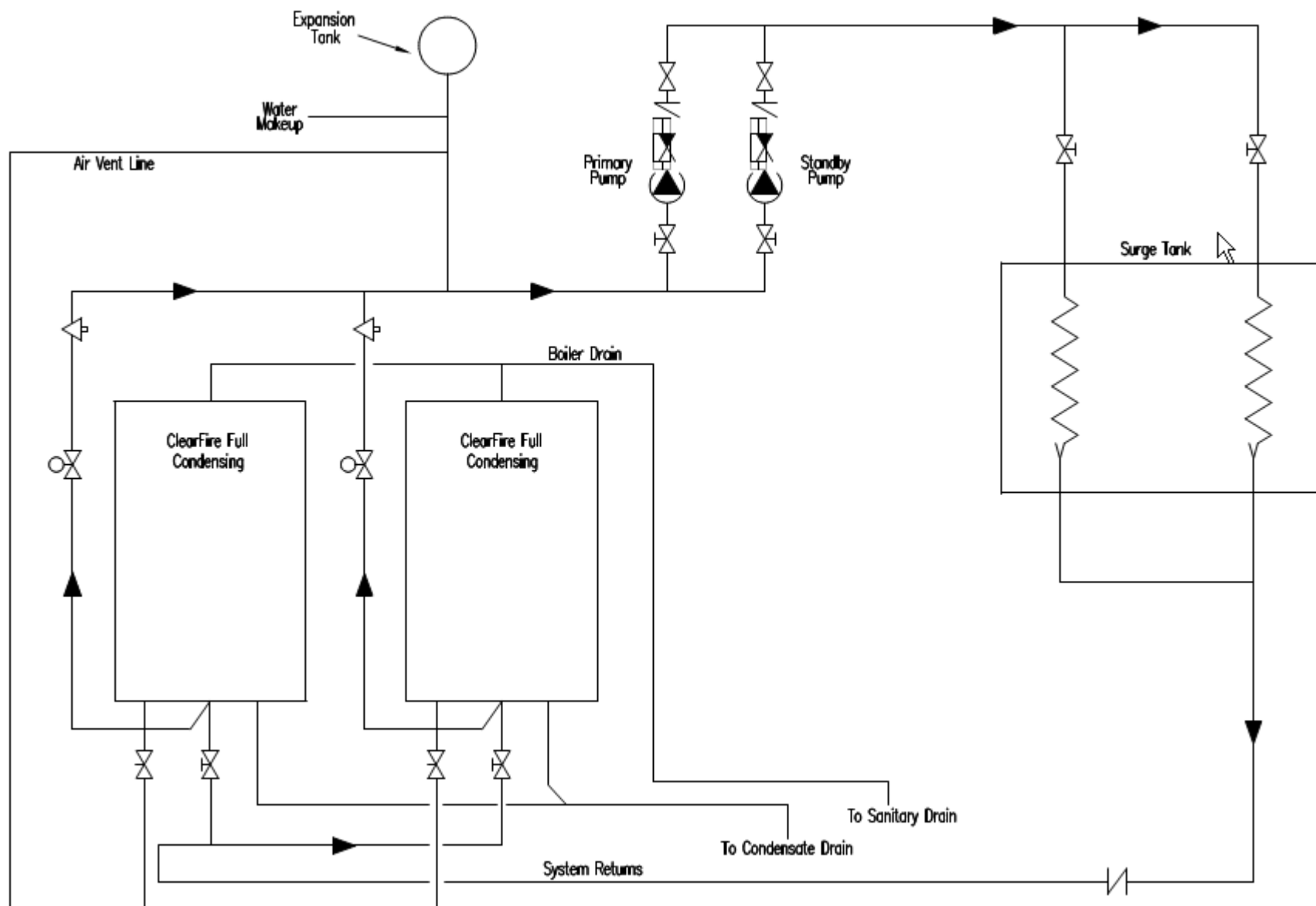


Figure B5-38. Domestic Water Heating, No Primary Loop

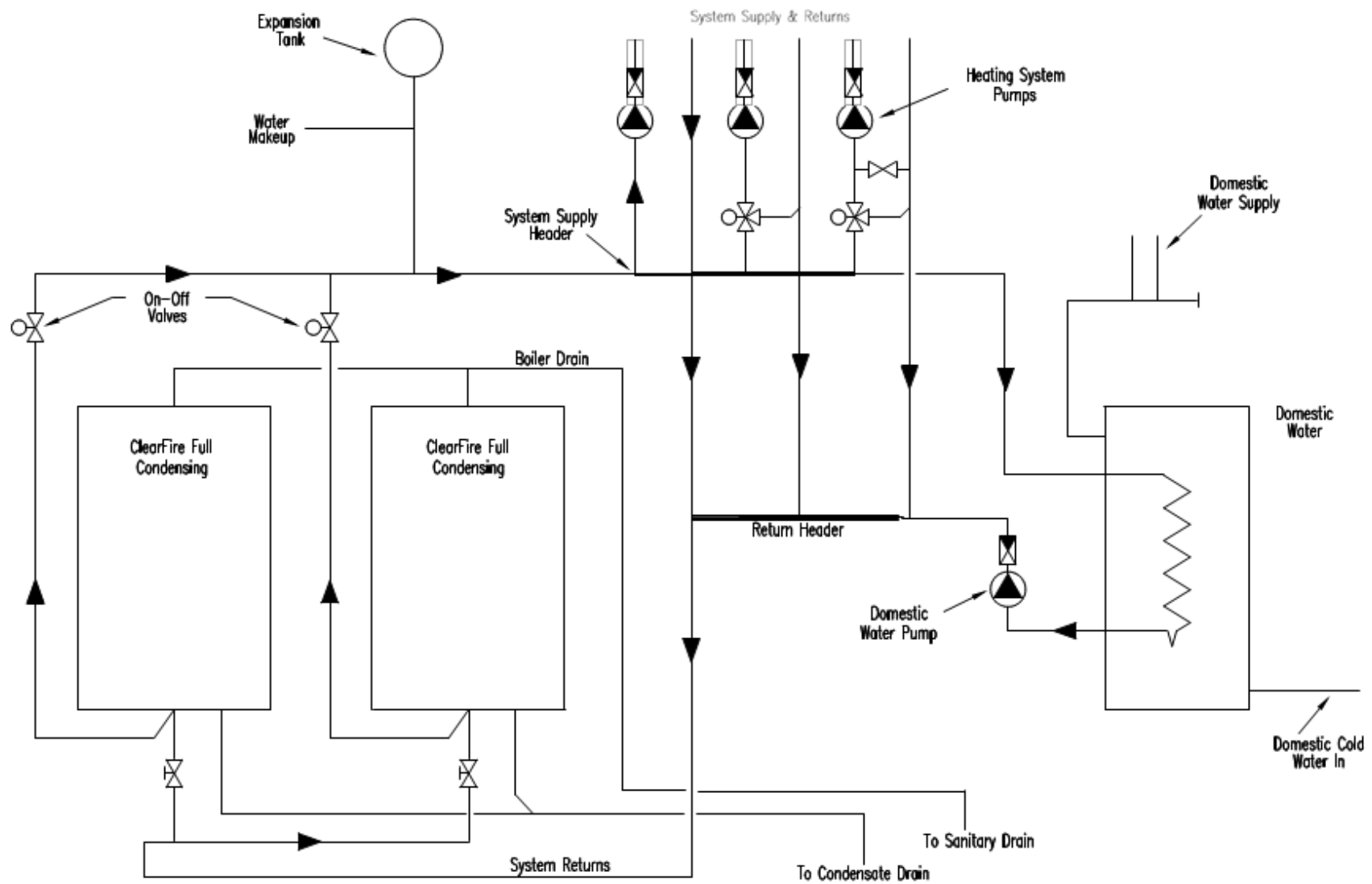


Figure B5-39. Domestic Water with On/Off and 3-Way Valves

- 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

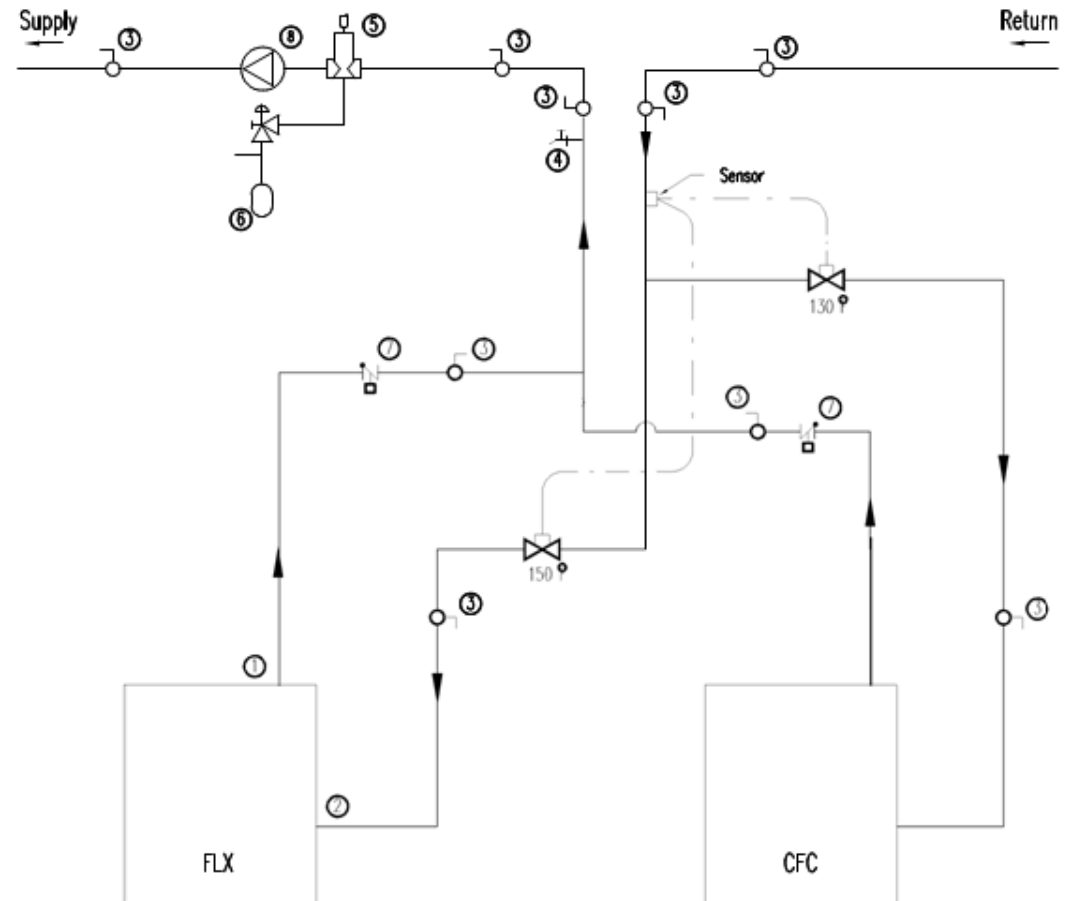


Figure B5-40. Piping 'Hybrid' Boilers

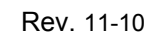


Figure B5-41. 'Hybrid' Boilers with Domestic Water

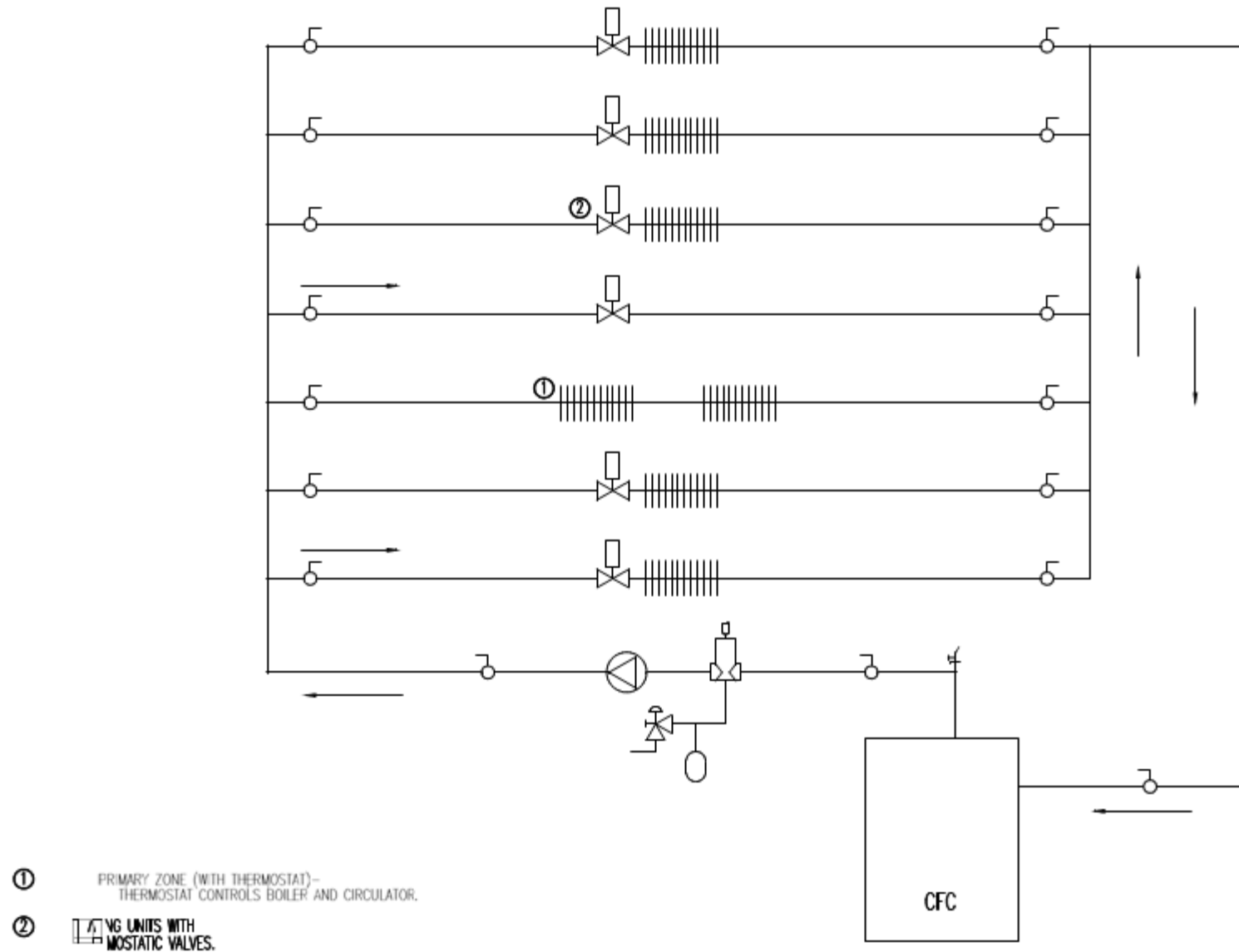


Figure B5-42. 2 Pipe System, Typical (reverse-return)

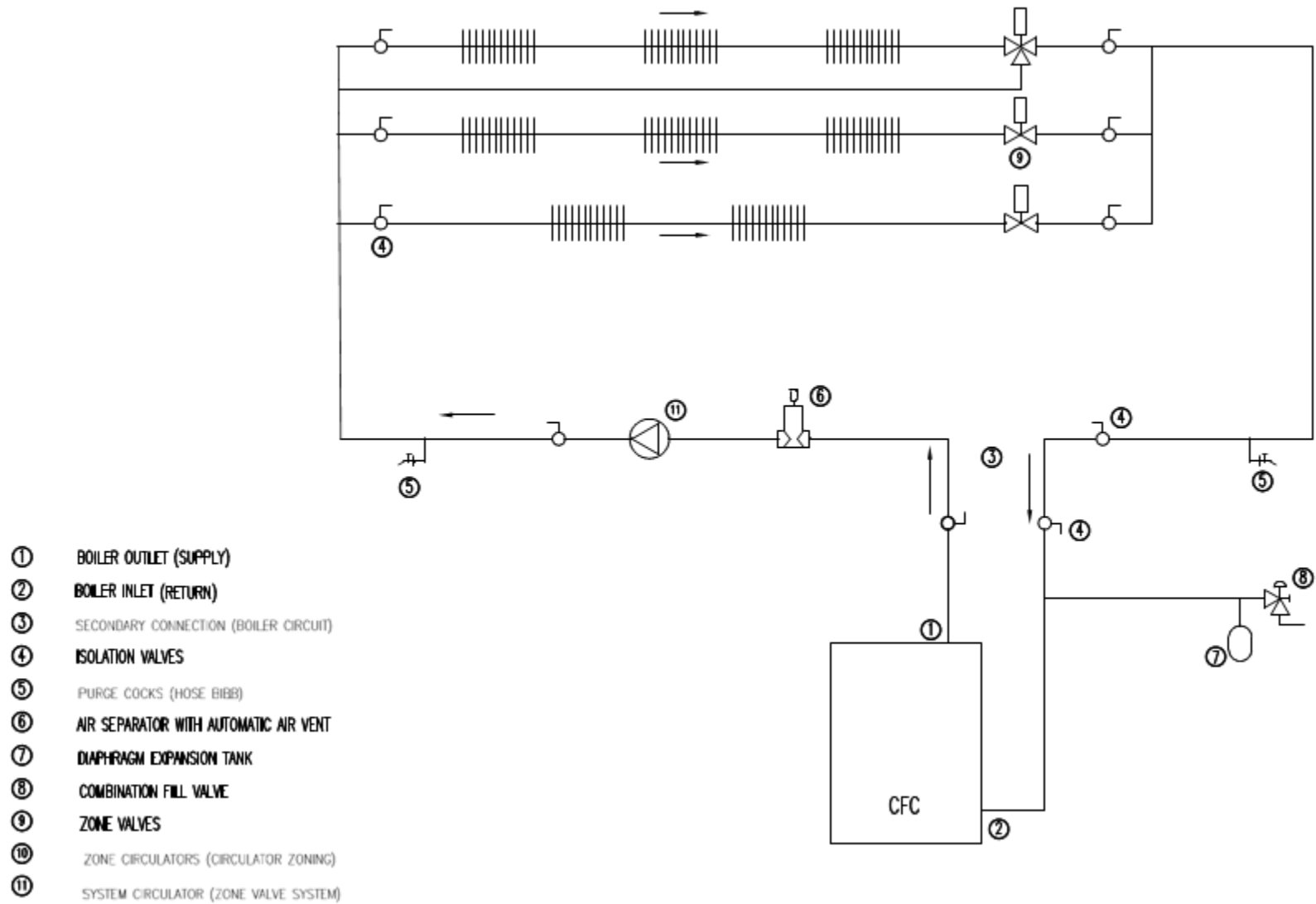
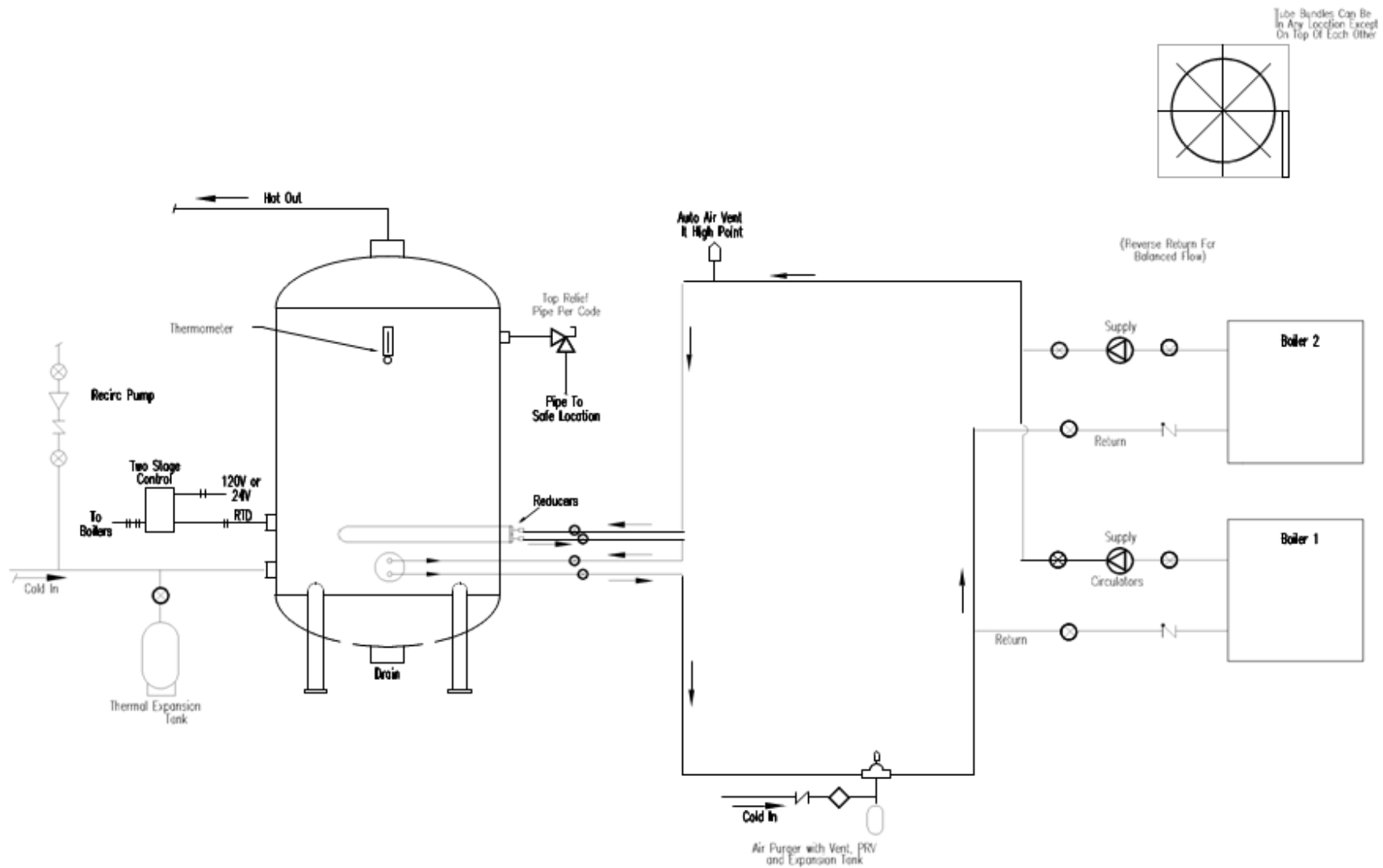


Figure B5-43. Zoning with Zone Valves



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 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 use. (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 an unconfined space, use the following guidelines:

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

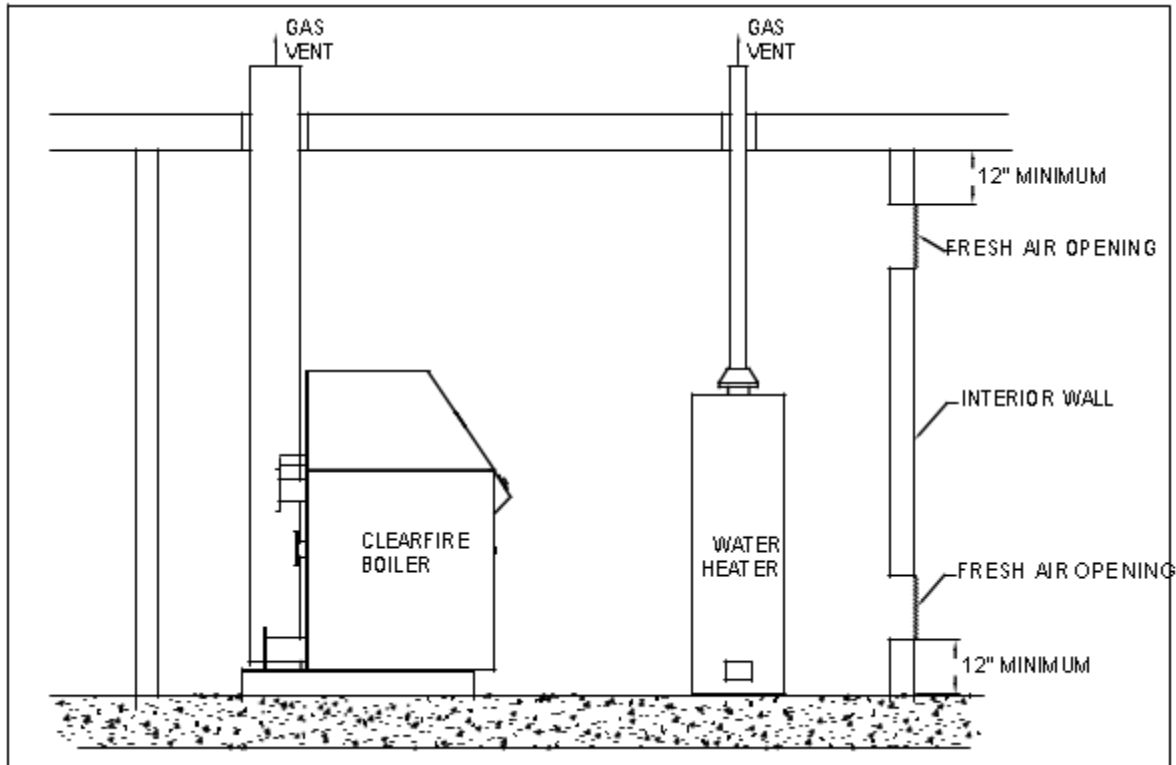


Figure B5-45. Two Opening Outside Wall Method

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.

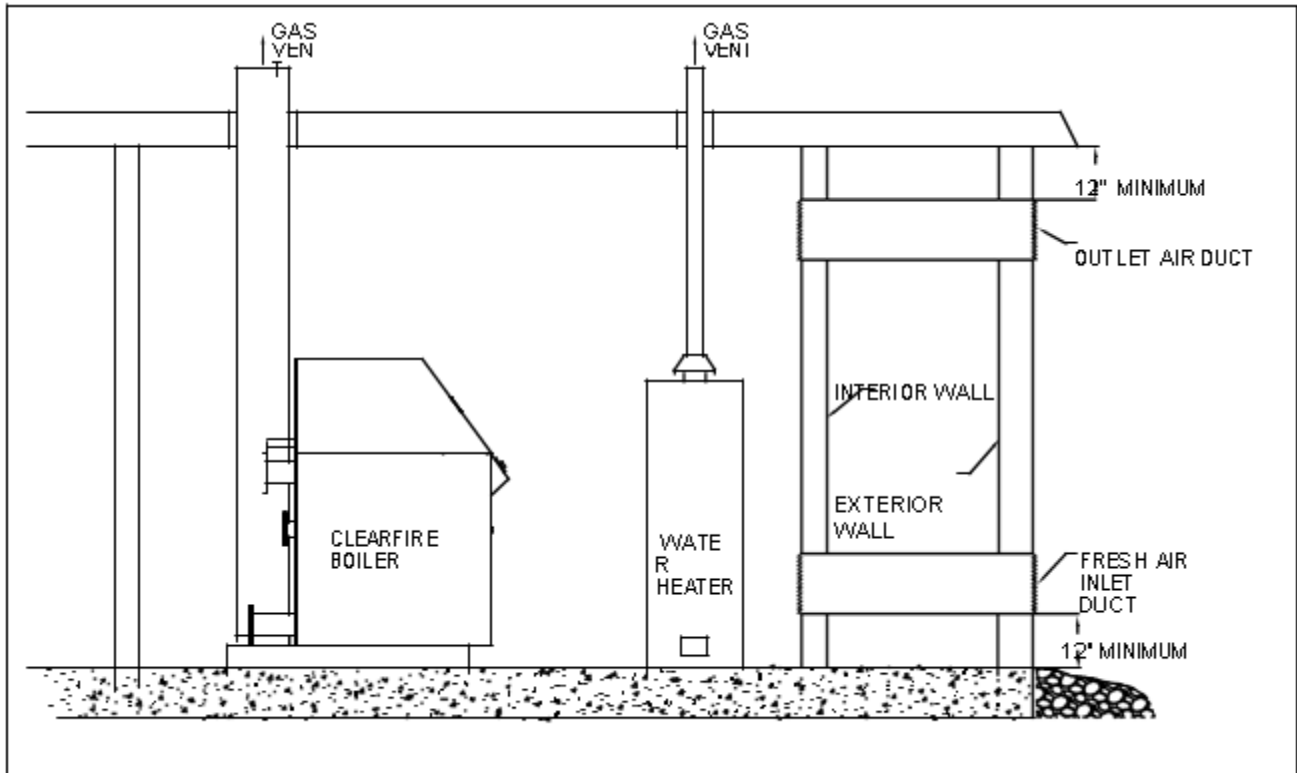


Figure B5-46. Two Opening Ducted Method

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.

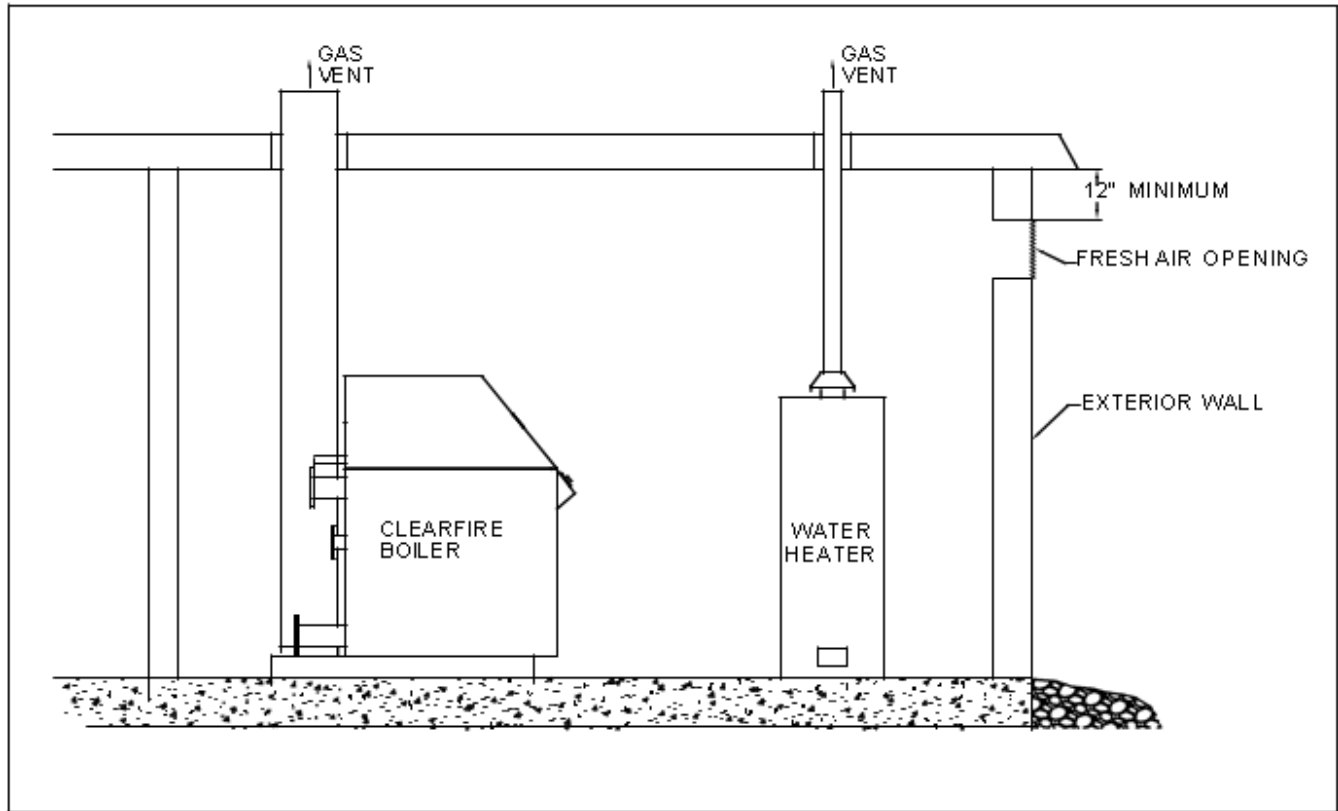


Figure B5-47. One Opening Method

**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:

A. Size (area) and location of air supply openings in the boiler room.

1. 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.
2. 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.
3. 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.
4. Under no condition should the total area of the air supply openings be less than one square foot.

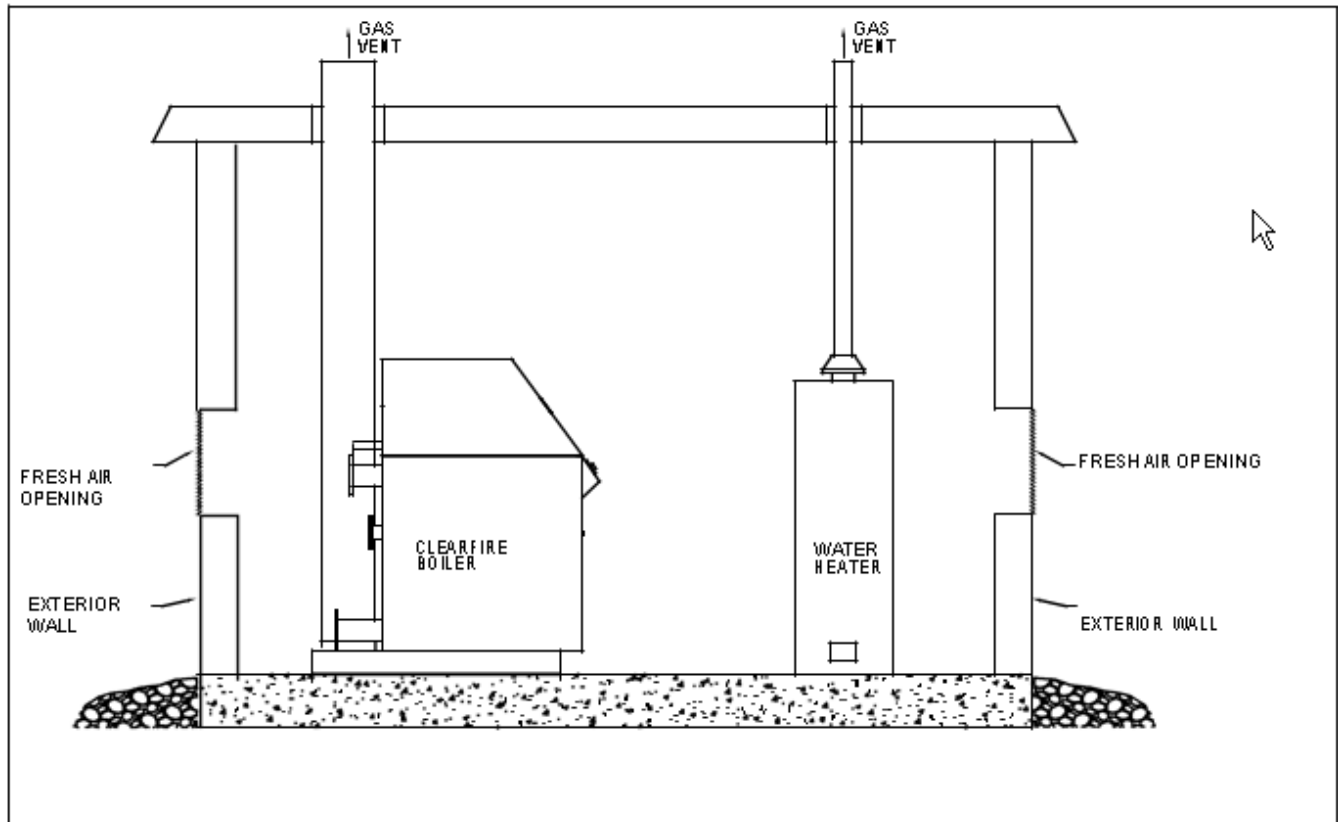


Figure B5-48. Two Opening Engineered Method

5. 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

B. Amount of Air Required (cfm).

1. Combustion Air = 0.25 cfm per kBtuh.

2. Ventilation Air = 0.05 cfm per kBtuh.

3. Total air = 0.3 cfm per kBtuh (up to 1000 feet elevation. Add 3% more per 1000 feet of added elevation.)

C. Acceptable air velocity in the Boiler Room (fpm).

1. From floor to 7 feet high = 250 fpm.

2. 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: $1800 \times 2 = 3600$ kBtuh. From 2C above, $3600 \times 0.3 = 1,080$ cfm.
- Air Velocity: Up to 7 feet = 250 fpm from 3 above.
- Area required: $\text{Area} = \text{cfm} / \text{fpm} = 1,080 / 250 = 4.32$ 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. Refer to Figure B5-49 for suggested piping of direct vent combustion installations. Figure B5-50 shows the optional direct vent combustion kit providing easy adaptation of the contractor supplied air duct to boiler connection. Refer to Table B5-22 for sizing the direct vent combustion air pipe.

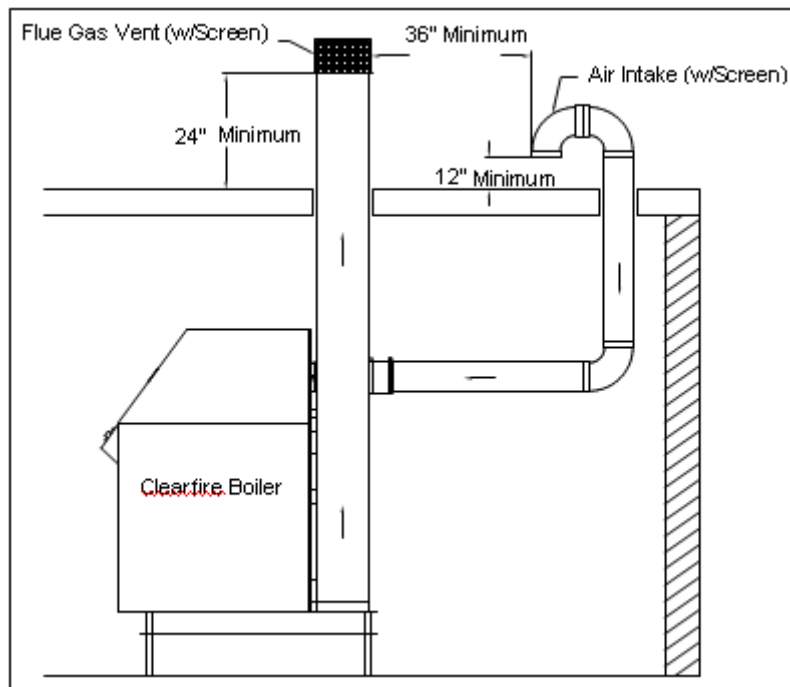


Figure B5-49. Direct Vent Combustion Piping Options

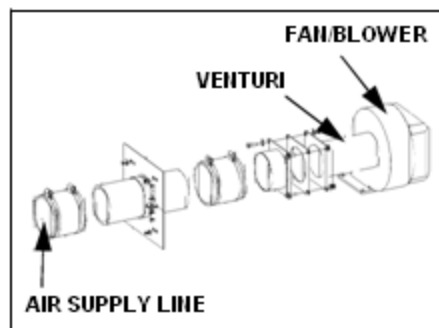


Figure B5-50. Optional Direct Vent Combustion Kit

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 B5-51)

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 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.

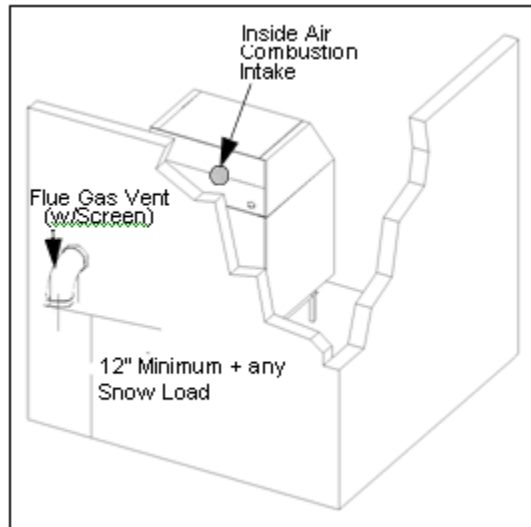


Figure B5-51. Horizontal Through the wall venting using inside air for combustion

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 B5-21 for the recommended sizes of horizontal vent pipe.

Horizontal Through The Wall Stack Venting Direct Vent Combustion. See Figure B5-52.

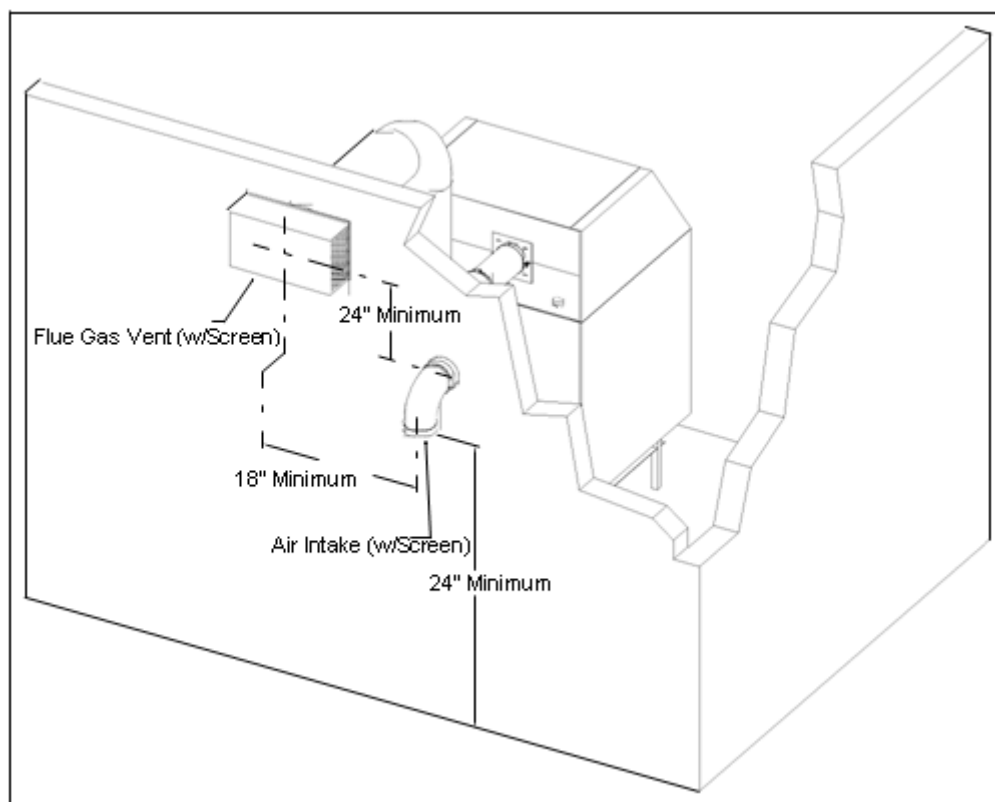


Figure B5-52. Horizontal Flue through-wall with direct vent combustion intake

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 B5-21. Stack Design Single Boiler Using Room Air

Boiler Size	Boiler Stack Connection	Maximum length of breeching or stack (feet)*
CFC 500	6" Standard	80
CFC 750	6" Standard	60
CFC 1000	8" Standard	140
	6" Option	80
	10" Option	200
CFC 1500	10" Standard	80
	8" Option	60
	12" Option	120
CFC 1800	12" Standard	100
	10" Option	60
CFC 2500	12" Standard	110

* Each additional 90 elbow equals 5 equivalent feet of ductwork. Subtract from the maximum or minimum length accordingly.

Maximum allowable pressure drop in flue vent ducting is 0.25" w.c.

Table B5-22. Stack Sizing Using Outside Air for Combustion

Boiler	Boiler Stack Connection	Boiler Air Intake Duct & Connection	Maximum length of Flue Gas Vent in Feet*	Maximum length of Air Intake Duct in Feet**
CFC 500	6" Standard	4"	75	75
		6"	80	80
CFC 750	6" Standard	4"	40	40
		6"	50	50
CFC1000	8" Standard	6"	60	60
	6" Option	6"	40	40
	10" Option	6"	80	80
CFC1500	10" Standard	6"	40	40
		8"	60	60
	8" Option	6"	30	30
		8"	40	40
	12" Option	6"	60	60
		8"	80	80
	12" Standard	6"	50	50
		8"	80	80
CFC1800	10" Option	6"	40	40
		8"	55	55
CFC 2500	12" Standard	8"	100	100

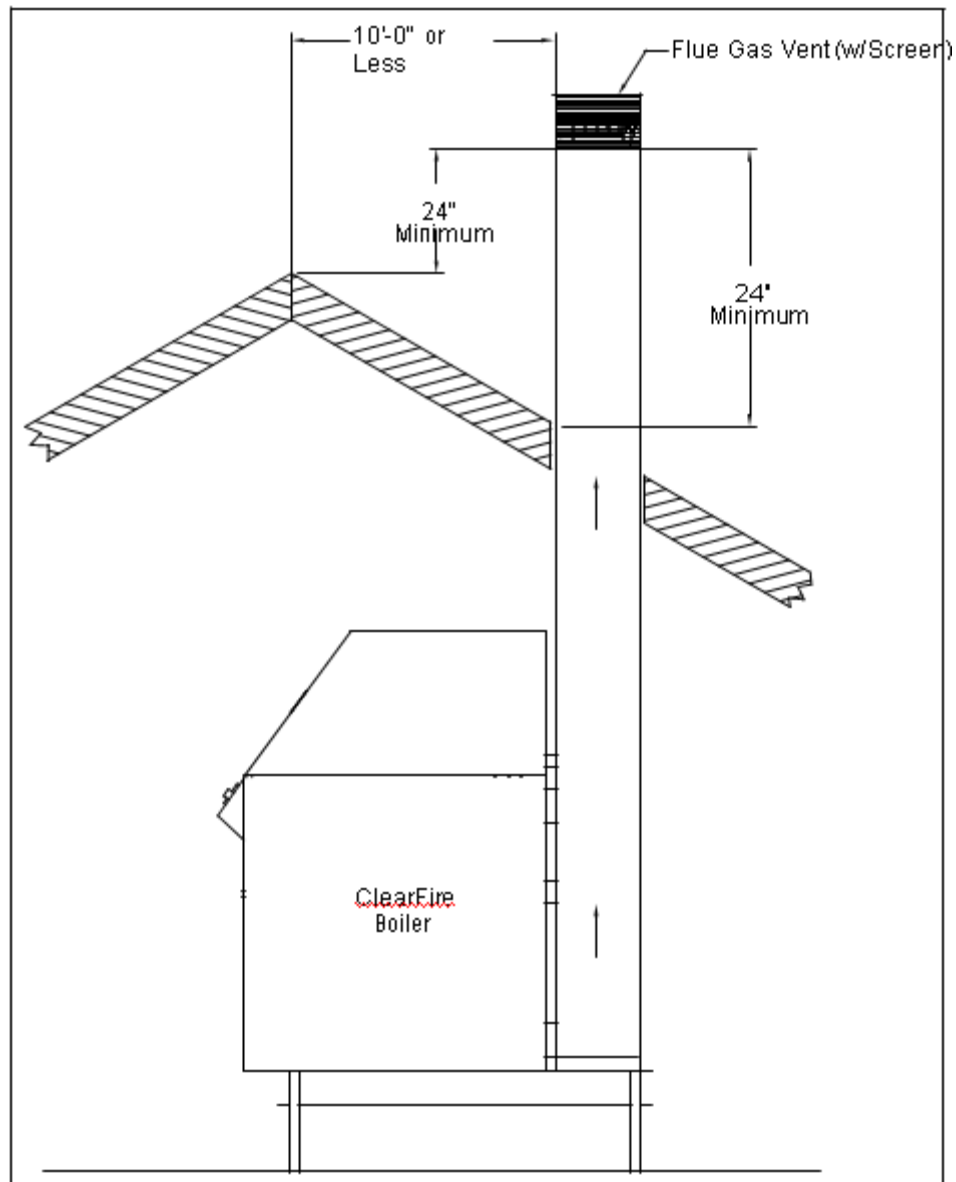
* Each additional 90 elbow equals 5 equivalent feet of ductwork. Subtract from the maximum or minimum length accordingly.

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

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

**Vertical Venting
Inside Combustion
Air**

See Figure B5-53.

**Figure B5-53. 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 B5-21.

**Vertical Venting
Inside Combustion
Air**

See Figure B5-54.

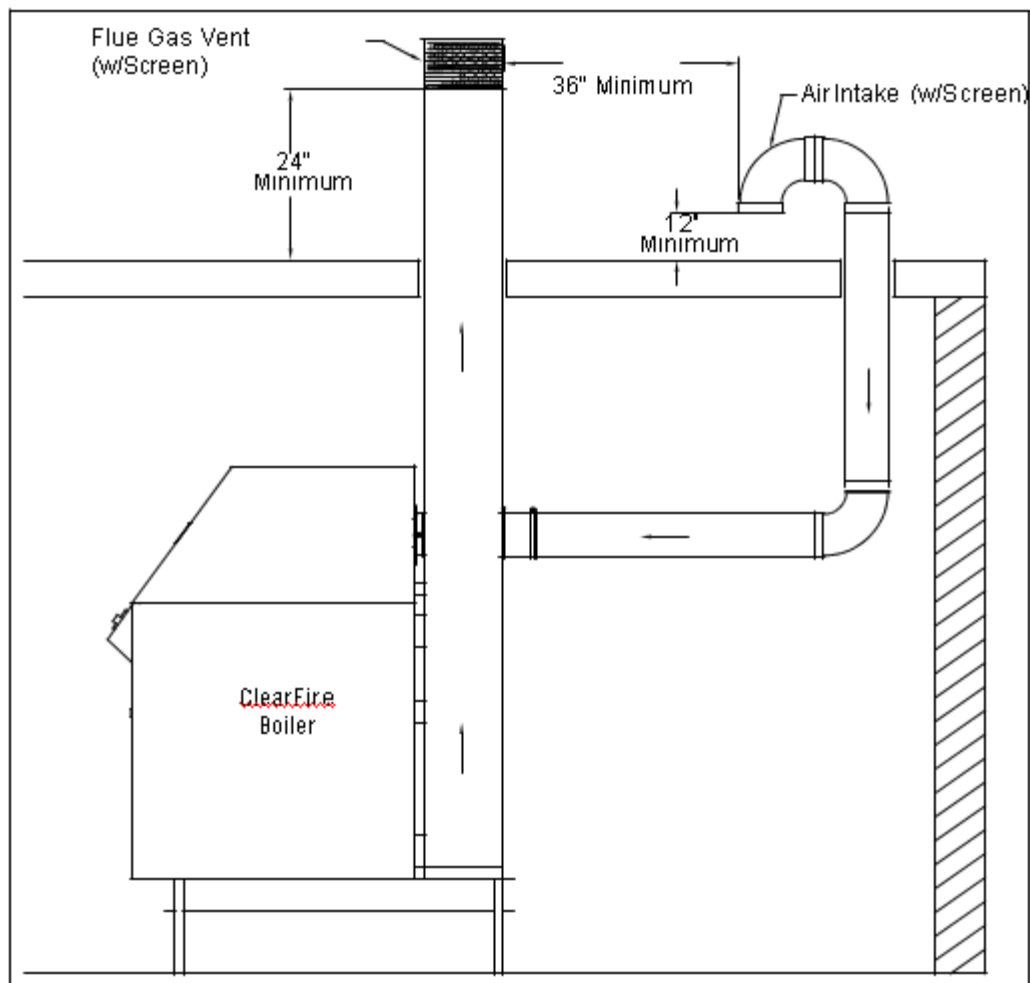


Figure B5-54. Vertical Stack with Direct Vent Combustion Air

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 B5-22.

Electrical

Voltage requirements for the Fan Motor are 115 - 120/1/60.

Control Circuit voltage is 120/1/60.

Refer to Table B5-3 "Ratings" for capacity requirements.

Refer to Figure B5-55 and Figure B5-56 for wiring connections and control locations.

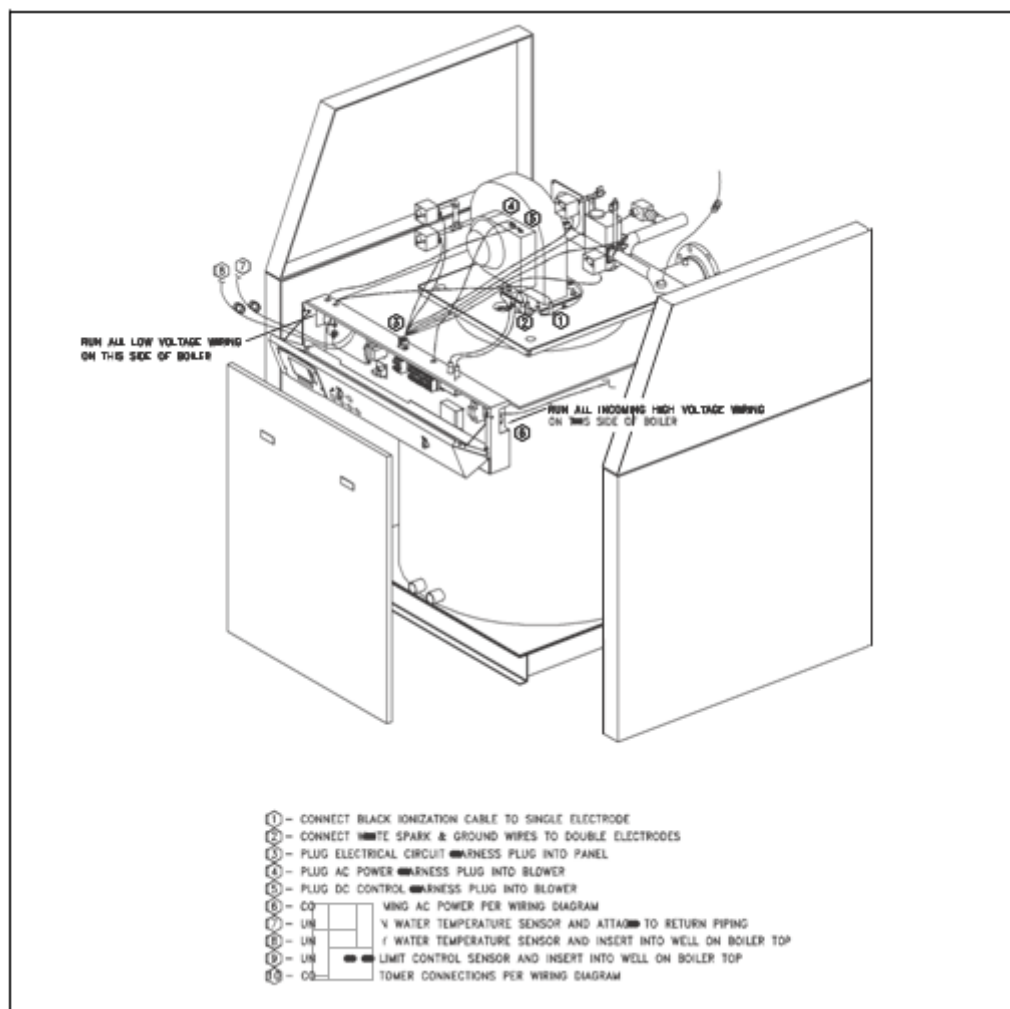


Figure B5-55. Electrical Connection Diagram

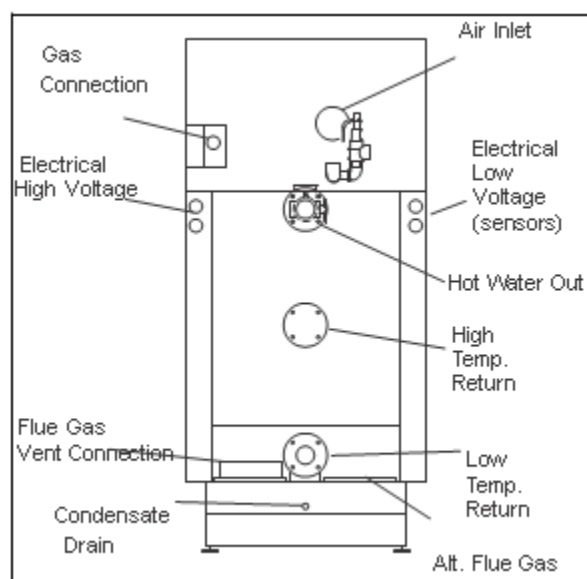


Figure B5-56. CFC Connections

FALCON CONTROLLER

1. Control Description - The 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:
 - o End-user
 - o Installer/Service Engineer (password protected)
 - o OEM Manufacturer (password protected)

Table B5-23. 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 B5-24. 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 B5-25. 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
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 (10k Ω @ 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 - Falcon configuration is grouped into the following functional groups:

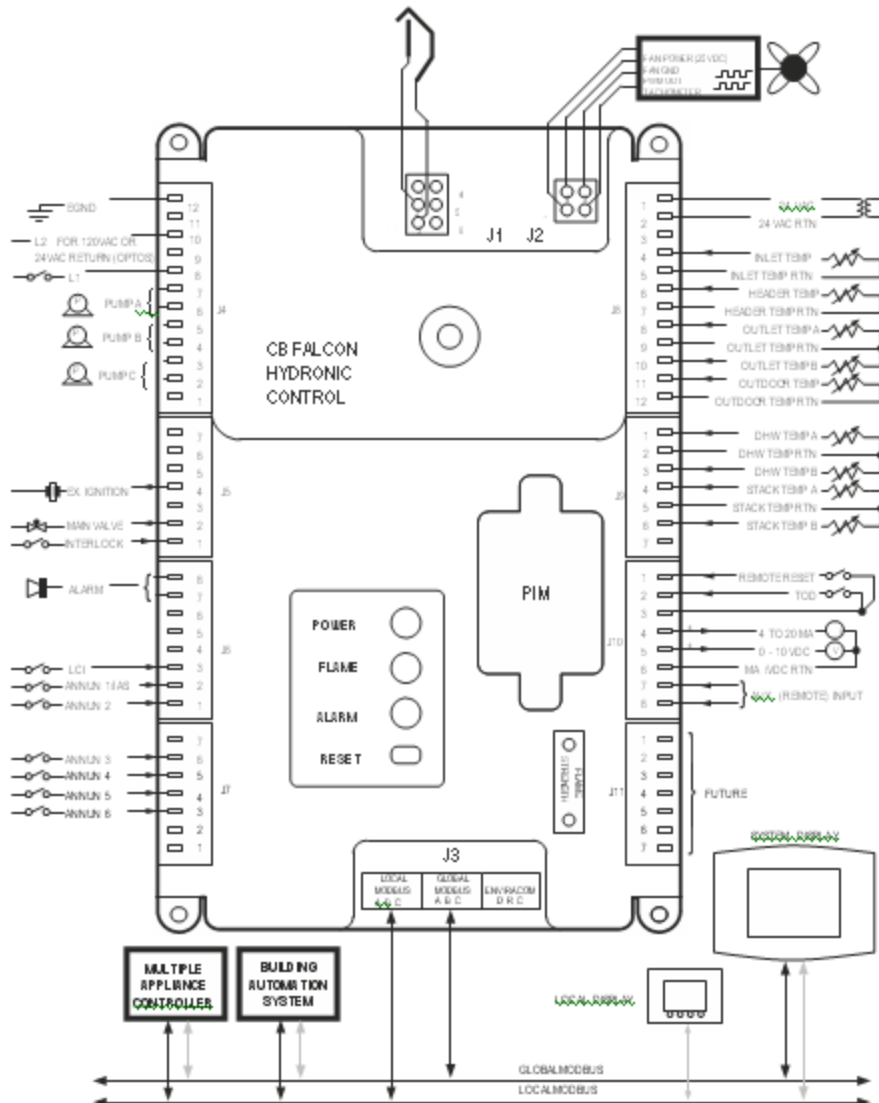
System Identification and Access	Statistics Configuration
CH - Central Heat	High Limit
Outdoor Reset	Stack Limit
DHW - Domestic Hot Water	Delta T Limits
DHW Storage	T-Rise Limit
DHW Plate	Heat Exchanger High Limit
Warm Weather Shutdown	Anti-condensation
Demand Priority	Frost Protection Configuration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

10. Falcon Access - There are three levels of access to the 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 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 C-B or factory authorized service personnel.

For additional information regarding service and setup of the burner controller, refer to CFC manual part no. 750-263 or to the Falcon manual 750-265.

Figure B5-57. Falcon pinout



Sample Specifications ClearFire Model CFC

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SAMPLE SPECIFICATIONS

PART 1 GENERAL Cleaver-Brooks Condensing Boiler Line

1.01 SCOPE

- A. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled, low- pressure full condensing hot water boilers as described in the specifications herein.
- B. Related Sections include the following:
 - 1. Division 15 Section "Chemical Water Treatment" for feedwater treatment.
 - 2. Division 15 Section, "Breechings, Chimneys, and Stacks" for connections to chimneys, and stacks.
 - 3. Division 15 Sections for control wiring for automatic temperature control.

1.02 REFERENCES

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field- installed wiring.
- D. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Maintenance Data: Include in the maintenance manuals specified in Division
 - 1. Include parts list, maintenance guide, and wiring diagrams for each boiler.
- G. Other:
 - 1. ASME Section IV - Heating Boilers
 - 2. ANSI Z21.13 - Gas Fired Low Pressure Boilers
 - 3. NFPA 54/ANSI Z221.3 - National Fuel Code
 - 4. FM - Factory Mutual
 - 5. ASME CSD-1 - Controls and Safety Devices
 - 6. XL-GAP (Formerly GE-GAP/IRI)
 - 7. UL or CSA Standards for Gas Fired Boilers
 - 8. UBC - Uniform Building Code
 - 9. UMC - Uniform Mechanical Code
 - 10. NEC - National Electrical Code

1.03 QUALITY ASSURANCE

- A. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment

features, details, accessories, appurtenances, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.

- B. The equipment shall be of the type, design, and size that the manufacturer currently offers for commercial sale and appears in the manufacturer's current catalogue. The equipment shall be new and fabricated from new materials and shall be free from defects in materials and workmanship
- C. The equipment must fit within the allocated space, leaving ample allowance for maintenance and cleaning, and must leave suitable space for easy removal of all equipment appurtenances.
- D. All units of the same classification shall be identical to the extent necessary to ensure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.
- E. To accept unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified. The boiler manufacturer shall be responsible for guarantying that the boiler provides the performance as specified herein.

1.04 SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval by the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. The engineer shall review and stamp submittals. Work may proceed and equipment released for fabrication after contractor receives returned submittals stamped with "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
- C. Shop Drawings - Shop drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
 - 2. Schematic flow diagram of gas valve trains.
 - 3. Schematic wiring diagram of boiler control system of the ladder-type showing all components, interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring by others.
 - 4. Manufacturer's Warranties: Manufacturer's printed warranties, as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
 - 5. Manufacturer's Field Service: Manufacturer's printed field service procedures and reports, as specified hereinafter, shall be submitted prior to final acceptance by the engineer. Report forms shall contain all information as required to do start-up and testing as specified in the product section.

1.05 SUBSTITUTIONS/MODIFICATIONS

- A. The bidder must submit in writing to the engineer any request for a proposed deviation, omission, modification, or substitution to this specification for evaluation no later than ten (10) days prior to the bid date.

- B. Technical data, drawings, product samples, and complete data substantiating compliance of proposed substitution with these specifications shall accompany a request for any substitution.
- C. No materials shall be deemed acceptable if not in strict and full compliance with these specifications.
- D. All bidders must bid solely on the specified materials unless acceptance by the engineer of a deviation, omission, modification, or substitution is granted in writing to all bidders prior to the bid date.

1.06 CERTIFICATIONS

- A. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner, and other associated mechanical and electrical equipment have been properly coordinated and integrated to provide a complete and operable boiler package.
 - 3. ASME Certification.
 - 4. ASME CSD-1 Certification.
 - 5. CSA or UL Certification.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.
- B. Contractor's Certification: The contractor shall certify the following:
 - 1. The products and systems installed are in strict compliance with the specifications.
 - 2. The specified field tests have been satisfactorily performed.
- C. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- D. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall be responsible for the timely delivery of the equipment to the jobsite. The contractor shall be responsible for unloading and rigging of the equipment. The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as jobsite conditions during construction.
- B. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.
- C. Responsibility of making freight claims to be performed by contractor or owner personnel.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Contractor shall furnish and install Cleaver-Brooks Model CFC 700-____ - 125 natural gas (LP Gas) fired hot water boiler(s) with input as scheduled on the drawings.
- B. Alternate manufacturers complying with plans and specifications must be submitted and approved by the engineer within 10 days prior to bid date (Approval of alternate manufacturer does not imply that performance, including warranties, efficiencies, etc. are waived, only that alternate manufacturers are acceptable).

2.02 GENERAL DESCRIPTION

- A. Each unit shall be a down-fired firetube type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be factory packaged. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG. The boiler shall be CSA (formerly AGA/ CGA) certified as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.

2.03 PERFORMANCE: BOILER SIZE AND RATINGS

- A. The capacity of each unit shall be indicated on the drawing schedule.
- B. Exit flue gas temperature of the boiler shall not exceed ____°F gross at maximum rated input and a hot water supply temperature of ____°F and return temperature of ____°F. The boiler net input shall not exceed ____ BTU/Hr and the output not less than ____ BTU/Hr with an overall fuel-to-water efficiency of ____% at high fire and ____% at low fire at above operating temperatures.
- C. Performance Criteria:

Manufacturer:	CLEAVER-BROOKS
Model:	CFC _____
Horsepower:	_____ HP
Output:	_____ MBTU
Gas Input:	_____ MBTU
Design Pressure:	_____ PSIG
Operating Pressure:	_____ PSIG
Heating Surface (minimum):	_____ Sq. Ft. Fireside
Burner Turndown Ratio	5:1
Overall Efficiency (With a hot water supply	_____ % at low fire
_____ % at low fir	_____ % at High Fire

Temperature of _____ °F and return	
Temperature of _____ °F.	
NOX Emission (maximum)	20 PPM (corrected to 3% O ₂)
CO Emissions (maximum)	10 PPM (corrected to 3% O ₂)
Electrical:	115-120V / 60H / 1P
Fan Motor:	_____ HP Max
Noise level	70 dBA Max
Available Gas Supply Pressure	_____ PSIG
Weight	
Dry:	Flooded: _____
Seismic Zone: _	Altitude: _____ ? ASL
Code Requirements:	ASME / NATIONAL BOARD CSD-1 CSA STATE OF _____ FACTORY MUTUAL (FM) XL-GAP - Formerly GE-GAP (IRI)

- A. Noise Sound Levels: Based on ABMA test code for packaged boilers measured @ 4 1/2 feet vertically above the bottom of the base and 3'0" horizontally in front of the end of the burner or front surface of control cabinet. Sound levels dBA on the scale in reference to 0.0002 microbars.

2.04 BOILER DESIGN

- A. Boiler shall be a compact, single-pass, vertical down-fired Firetube type, with stainless steel tubes and tube sheets. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with powder coated finish. To prevent installation damage, the casing shall be packaged separately and shall ship loose for field installation by the manufacturer's service representative.
- B. The tubes shall be UNS S32101 Duplex Stainless Steel and shall be fitted with AluFer internal heat transfer fins creating no less than 10 square feet of fireside heating surface per boiler horsepower.
- C. The Vessel shall be mounted on a structural steel stand with exhaust gasses collected in a polymer drain collection box complete with drain fitting for draining condensation from the products of combustion. As an option, a condensate neutralizing box complete with limestone granules shall be shipped loose for field installation by contractor.
- D. The top tubesheet shall be fully accessible by lifting the burner assembly which shall come complete with lifting hinges and pneumatic lifters. The boiler shall have a built in hinged platform allowing the operator to access the

tubesheet, burner, ignition assembly and flame rod without the use of a ladder.

- E. The vessel shall be fully insulated with a minimum of 2" of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.
- F. The condensing capability shall allow the boiler to be operated without the use of a 3-way valve for the boiler supply water temperature reset. No minimum boiler return water temperature or secondary pump or minimum flow rate shall be required.
- G. Boiler shall be built to seismic zone ____ requirements and manufacturer shall provide seismic calculations showing tie-down requirements for bolt diameters. Bolts and tie-down shall be by contractor.
- H. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.
- I. The boiler shall be designed for top rear water outlet and bottom rear water inlet; the water inlet [return] shall be equipped with internal baffling. Inlet connection size shall be ____ flanged. Outlet connection size shall be ____ flanged. The maximum pressure drop through the boiler shall not exceed 0.45 psi with a 20-degree differential and less than 0.05 psi with a 60-degree differential.
- J. A threaded air vent connection shall be furnished at the top rear of the boiler for field piping to an expansion tank or for the addition of an auto-vent valve when a bladder type expansion tank is utilized.
- K. To drain the boiler, a bottom-threaded connection shall be provided at the front of the boiler and field piped by the installing contractor with a manual full size shutoff valve to drain.

2.05 BURNER DESIGN

- A. General: Forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tubes are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on hydraulic piston arms, one on each side to provide open support of the burner assembly.
- B. A drop down hinged service platform shall be furnished to provide service personnel an easy means of accessing the burner and controls for service and maintenance. When out of use, this platform shall fold up beneath the front service boiler panel.
- C. The burner shall be of the Unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages, damper motor drives and single speed fans shall not be acceptable.
- D. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven fecralloy material creating a 360 degree low temperature radiant flame.

- E. Emissions: The boiler(s) burner shall be guaranteed to limit NOx emissions to 20 PPM or less, as certified by an independent testing lab. NOx emissions shall be at full operating conditions. Proof of such certification shall be made available to the engineer and purchaser. External flue gas recirculation shall not be accepted for emission control.
- F. Gas Train - As a minimum, the gas train shall meet the requirements of CSA and ASME CSD-1 and shall include:
 - 1. Low Gas Pressure Interlock, manual reset.
 - 2. High Gas Pressure Interlock, manual reset.
 - 3. Upstream and downstream manual test cocks.
 - 4. Ball Type manual shutoff valve upstream of the main gas valve.
 - 5. Unibody double safety gas valve assembly.
 - 6. Gas Pressure Regulator
 - 7. Union connection to permit burner servicing.
- G. Combustion Air Proving Switch shall be furnished to ensure sufficient combustion airflow is present for burner firing.
- H. To ensure that proper draft is not blocked in the stack, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack back draft.

2.06 BOILER TRIM

- A. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler water outlet. Size shall be in accordance with code requirements and set to open at 125 psig.
- B. Temperature and pressure gauge shall be mounted on the water outlet.
- C. Solid State Low water cut-off probe with manual reset and test switch.
- D. Outlet water supply sensing probe for operating water limit setpoint.
- E. Return water-sensing probe for operating water limit setpoint.

2.07 BOILER CONTROLS

- A. The Boiler shall include a Falcon Computerized Boiler Burner control which shall be an integrated, solid state digital micro- processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.
- B. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:
 - 1. Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition, and post purge. Flame rod to prove combustion.
 - 2. Flame Supervision - The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent 15 faults. The control shall be connected to a touchscreen display that will retrieve this information.
 - 3. Safety Shutdown with display of error.
 - 4. Modulating control of the variable speed fan for fuel/air input relative to load requirements.

5. Gas pressure supervision, high and low.
 6. Combustion Air Proving Supervision.
 7. The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
 8. Controller shall be equipped with a touch screen display for set up, trouble shooting, and operational display, and shall include ModBus communication capability of this information.
 9. Include the programming of system circulating pump and provide the programming of 2 heating loops.
- C. All parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.
 - D. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to UL requirements.
 - E. Electrical power supply shall be 120 volts, 60 cycle, single phase for the fan and 120 volts for control circuit requirements.
 - F. System shall be capable of staging up to up to 8 boilers in a lead/ lag configuration. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority, and a system display. The control shall force each boiler to a lower fire before allowing any boiler to operate at high fire. This allows for inverse efficiency (lower fire rate, higher efficiency). The control shall monitor supply and return water temperature and shall communicate between boilers via RS-485 wiring.

2.08 BOILER FLUE VENTING

- A. Venting shall be accomplished with a category II, III, or IV vent piping as appropriate to the installation. Venting to be installed in accordance with applicable national and local codes.
- B. For direct venting, the boiler shall have the combustion air intake supply ducted with PVC pipe from the outside. Vibration isolation components are not required.

2.09 MANUFACTURER'S FIELD SERVICES

- A. General: The boiler supplier's factory authorized service organization shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. A detailed written record of the start up performance, including burner setting data over the entire load range shall be furnished to the engineer before final acceptance. All labor, equipment, and test apparatus shall be furnished by the authorized service organization. All equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.
- B. Equipment inspection: Boiler representative to provide ____ hours of jobsite assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. All shipped loose components, such as casing, to be mounted on boiler by boiler provider after contractor has set boiler in building.

- C. Pre start-up walk through: Boiler representative shall spend ____ hours at jobsite reviewing installation with mechanical contractor to be conducted approximately 1 week prior to start-up.
- D. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization, and shall include:
 - 1. Demonstrate that boiler, burner, controls, and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 - 2. Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x, and overall boiler efficiency.
 - 3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non compliance with referenced standards or overloading as applicable.
 - 4. Commissioning Requirements:
 - a. Fireside inspection
 - b. Set up fuel train and combustion air system
 - c. Set up operating set points
 - d. Check all safeties, including Flame safeguard, LWCO, Airflow, Fuel pressures, High limits.
 - e. Set up and verify efficiencies at 20%, 50%, 75%, and 100%
 - f. Set up and verify burner turndown.
- E. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single ____ hour continuous session to accommodate operator's availability on site.

2.10 OPERATING & MAINTENANCE MANUALS

- A. Provide two (2) Operating and Maintenance manuals including cut- away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.
- B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

2.11 WARRANTY DATA

- A. The pressure vessel shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 170 °F or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.

- B. The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years. The condensate collection box shall be guaranteed for 20 years.
- C. All parts not covered by the above warranties shall carry a 1 year warranty from startup, or 18 months from shipment, whichever occurs first. This shall include all electrical components and burner components.

PART 3 EXECUTION

3.01 GENERAL

Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced personnel previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.02 INSTALLATION

- A. Install equipment in strict compliance with manufacturer's installation instructions.
- B. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
- C. Maintain manufacturer's recommended clearances around sides and over top of equipment.
- D. Install components that were removed from equipment for shipping purposes.
- E. Install components that were furnished loose with equipment for field installation.
- F. Provide all interconnecting electrical control and power wiring.
- G. Provide all fuel gas vent and service piping.
- H. Provide all piping for boiler pipe connections.

3.03 FIELD TESTING

- A. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced.
- B. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

3.04 START-UP, INSTRUCTION AND WARRANTY SERVICE

- A. The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

CLEARFIRE - MODEL CFW

400-2,400 MBTU
Hot Water Vertical Boiler



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FEATURES AND BENEFITS

General

The ClearFire Model CFW is a single pass, vertical down-fired durable firetube hydronic boiler. Extended heating surface tubes provide a very high level of performance in a compact package. An integral premix burner is provided for natural gas operation. As standard, the Model CFW burner provides low emissions of <20 PPM NO_x.

Advanced Technology

Heat is transferred through 3" OD carbon steel tubes with patented AluFer© extended heating surfaces. The AluFer© tube design provides for optimum heat transfer and eliminates laminar gas flow during minimum firing, providing optimized efficiency throughout the firing range (see Figure B7-1 and Figure B7-2).



Figure B9-1. AluFer© Tubes



Figure B9-2. Tube Cross Section

High Efficiency

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

Quality Construction

ISO 9001-2001 certification ensures the highest manufacturing standards. ASME code construction ensures high quality design, safety, and reliability. Units are third-party inspected and are stamped to assure compliance.

Certification

Each unit is tested and certified in accordance with UL/cUL standards and the UL/cUL label is affixed attesting to equipment meeting the latest UL requirements for packaged hot water boilers (UL 795, CAN1-3.1).

Premix Technology

The ClearFire CFW burner utilizes Premix technology to mix both gas fuel and combustion air prior to entering the burner canister, with fuel flow governed by the air flow during firing transitions. Combined with a variable speed fan, this technology provides very low emission levels, exceptionally safe operation, and nearly 100% combustion efficiency. The CFW burner design readily accommodates direct venting of combustion air. An inlet air filter is optional.

Full Modulation

The variable speed fan modulates to provide only the amount of heat required to the boiler. Full modulation reduces on/off cycling and provides excellent load tracking with reduced operating costs. The burner does not require mechanical linkage connections between the fuel input valve and air control. Instead, the microprocessor control adjusts the fan speed in accordance with system demand, determining fuel input without mechanical device positioning. This method of controlling the fuel-air ratio eliminates slippage due to linkages, minimizes burner maintenance, and provides control repeatability. See Figure B9-3.

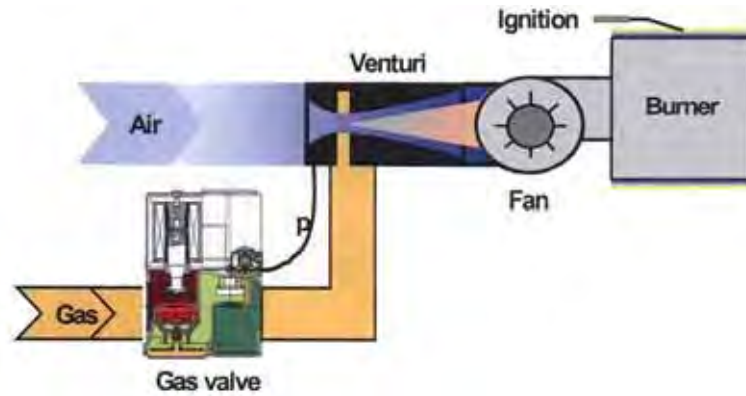


Figure B9-3. Premix Burner Technology

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

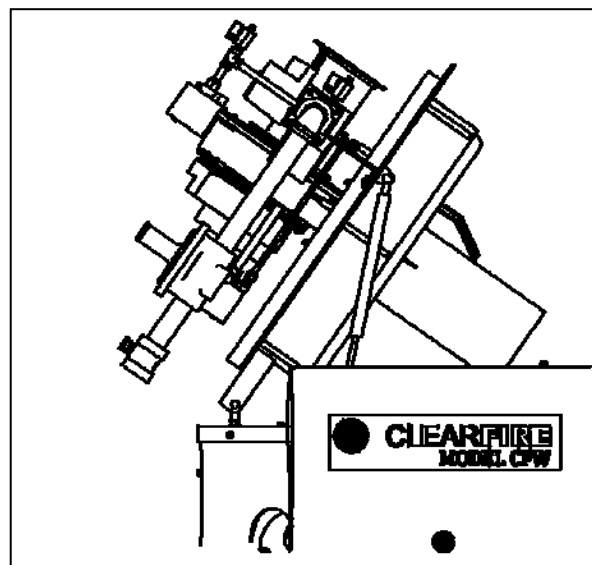


Figure B9-4. Burner maintenance

**Designed for
Commercial Hot
Water Applications**

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

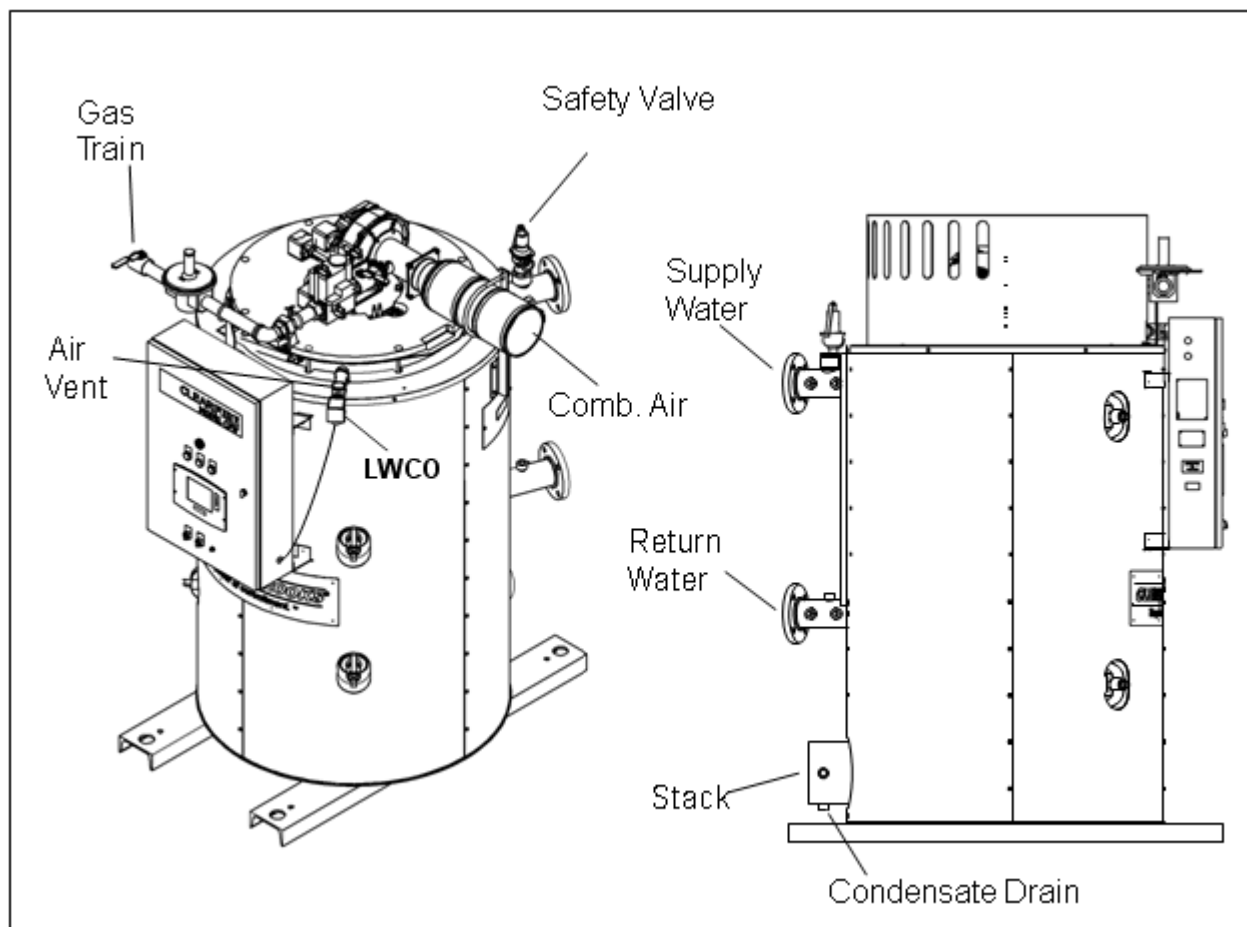


Figure B9-5. CFW connection and controls

PRODUCT OFFERING

Information in this section applies to boiler sizes ranging from 400 - 2400 MBH for operation on natural gas. Fuel oil operation is not available for the model CFW. Standard installation is for indoor use with an optional engineering design for outdoor applications. The complete package has been tested and certified in accordance with UL/cUL. Package is approved and listed and bears the appropriate UL/cUL package boiler label. Dimensions, ratings, and product information may change due to market requirements or product enhancements. The information contained herein is a guide for general purposes only.

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

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

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

2. Boiler trim and controls

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

3. CB Falcon Control System

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

- Two (2) heating loops with PID load control
- Electronic Ignition.
- Flame Supervision.
- Safety Shutdown with time-stamped display of lockout condition.
- Variable speed control of the combustion fan.
- Supervision of low and high gas pressure, air proving, stack back pressure, high limit, and low water.
- Real-time data trending.
- Modbus communication capability
- Lead/Lag for up to 8 boilers

Table B9-1. Operating Conditions - CB Falcon

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

B. Main Electrical Connection - 115V/single phase/50/60Hz

C. Demand switch - Local/Remote/Off.

D. Combustion Air Proving Switch

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

- System Identification and Access
- Central Heat
- Outdoor Reset
- DHW - Domestic Hot Water
- Warm Weather Shutdown
- Demand Priority
- Modulation
- Pump Configuration
- Statistics
- High Limits

- Stack Limit
- Delta T Limits
- T-Rise Limit
- Heat Exch. High Limit
- Anti-condensation
- Frost Protection
- Annunciation
- Burner Control Interlocks
- Burner Control Timings & Rates
- Burner Control Ignition
- Burner Control Flame Failure
- System Configuration
- Fan Configuration
- Sensor Configuration
- Lead Lag Slave Configuration
- Lead Lag Master Configuration

G. Falcon Control Access - There are three levels of access to the 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 C-B manual part no. 750-269.



Figure B9-6. CB Falcon Display/Operator Interface

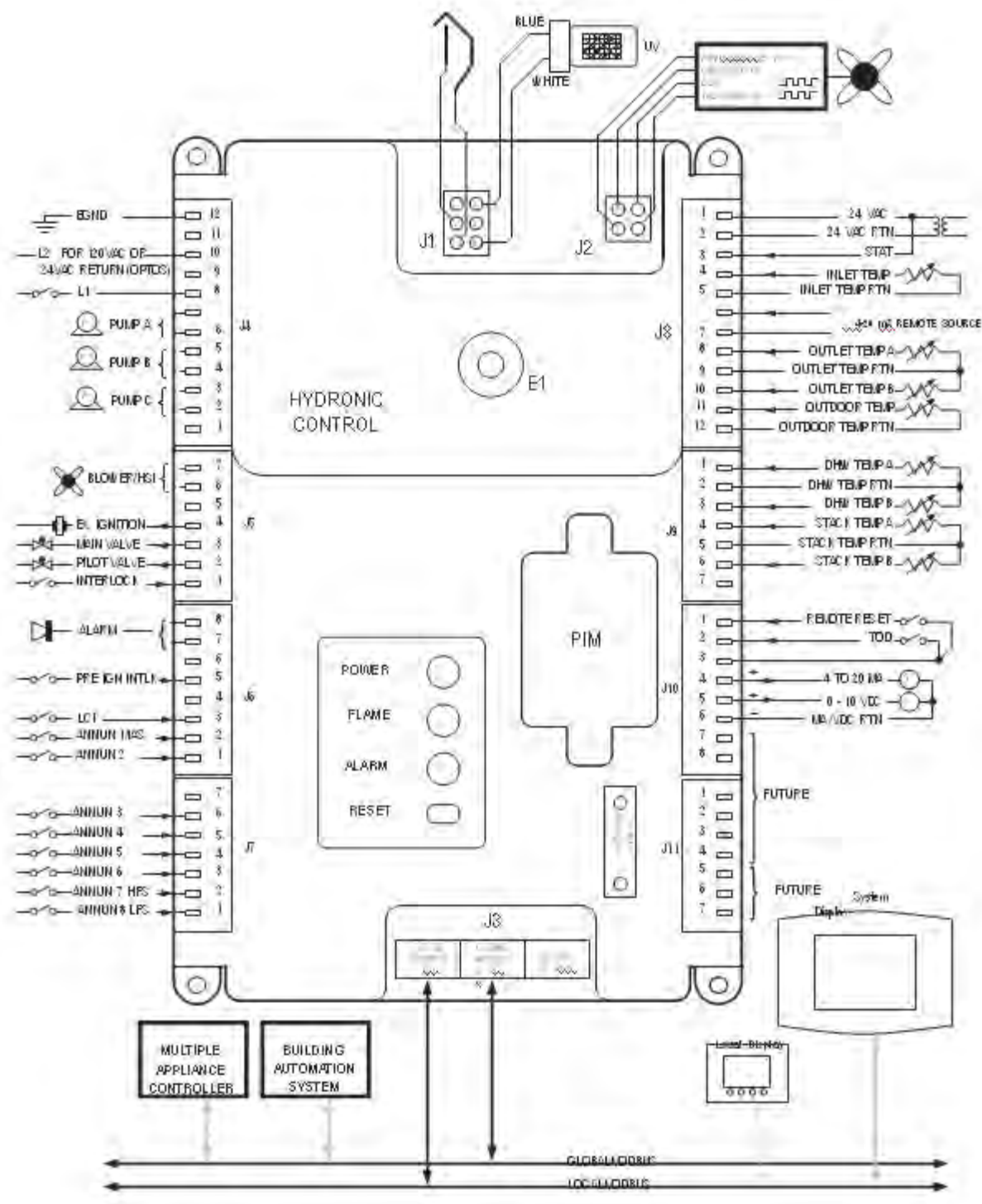


Figure B9-7. CB Falcon pinout

4. Forced draft burner

- A. The burner is a "Pre-mix" design consisting of a unitized venturi, single body dual safety gas valve, blower, and burner head (canister).
- B. Full modulation is accomplished with a variable speed fan for up to 5:1 turndown ratio (boiler sizes 1500 to 2400) or 4:1 turndown on sizes 400 to 1000.
- C. For near flameless combustion, the burner utilizes a Fecralloy metal fiber head (canister).
- D. Noise level at maximum firing is less than 70 dBA regardless of boiler size. E. When boiler is operating on natural gas, NO_x emissions will be less than 20 PPM regardless of boiler size.
- F. As an option, the burner can utilize direct vent combustion air.
- G. Ignition of the main flame is via direct spark, utilizing high voltage electrodes and a separate electrode for flame supervision.
- H. To ensure adequate combustion air is present prior to ignition, and to ensure the fan is operating, a combustion air proving switch is provided.
- I. For ease of inspection and maintenance, the blower is hinged for easy swing away from the boiler permitting full inspection of the burner components, front tube sheet and furnace.
- J. A flame observation port is located at the top of the boiler.

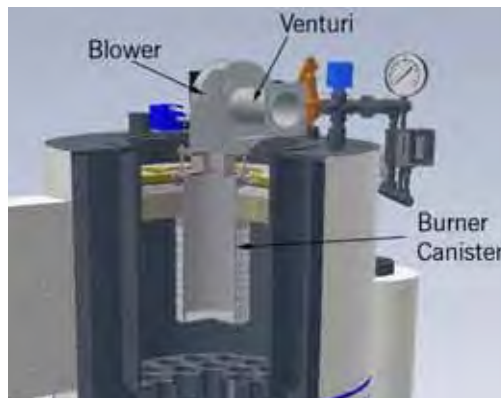


Figure B9-8. CFW Burner

5. Burner Gas Train

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

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

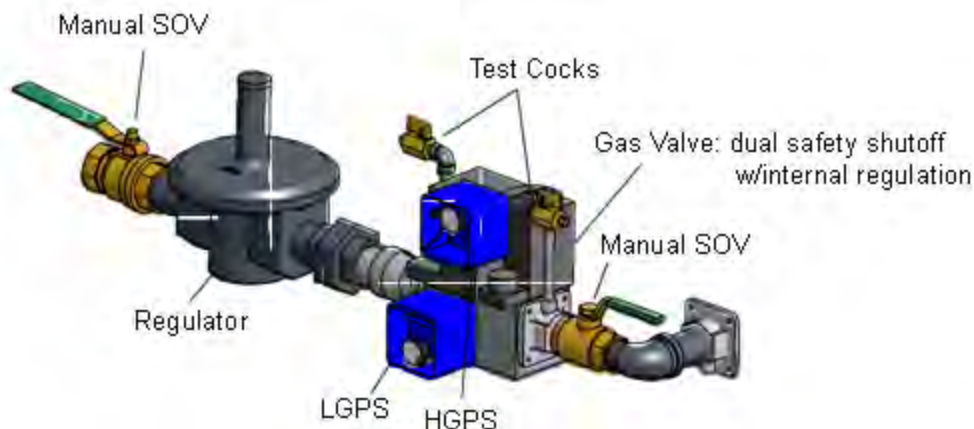


Figure B9-9. Gas Train

6. Boiler control panel

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

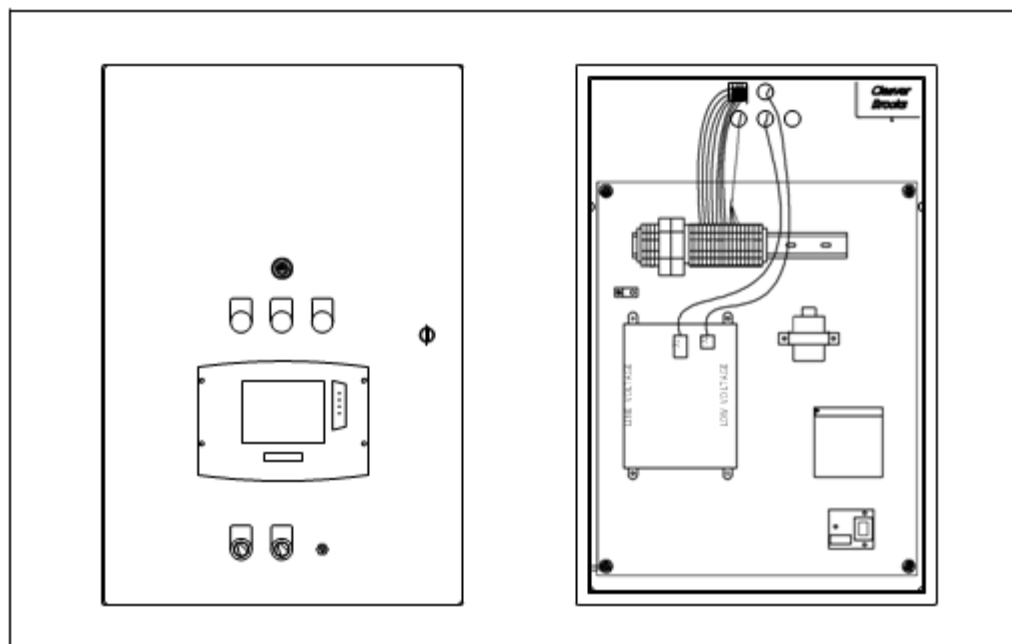


Figure B9-10. CFW electrical panel

Optional Equipment

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

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

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFW are shown in Figure B9-11 and Table B9-2. Connection sizes are given in Table B9-2 and ratings of each boiler size are noted in Table B9-3. Additional information is shown in the following tables and illustrations:

Table B9-4 Minimum required gas pressure

Table B9-5 Altitude corrections

Table B9-6 Heating Surface

Table B9-7 Safety Valve Outlet Size

Table B9-8 Clearances

Figure B9-11. Model CFW Dimension Diagram

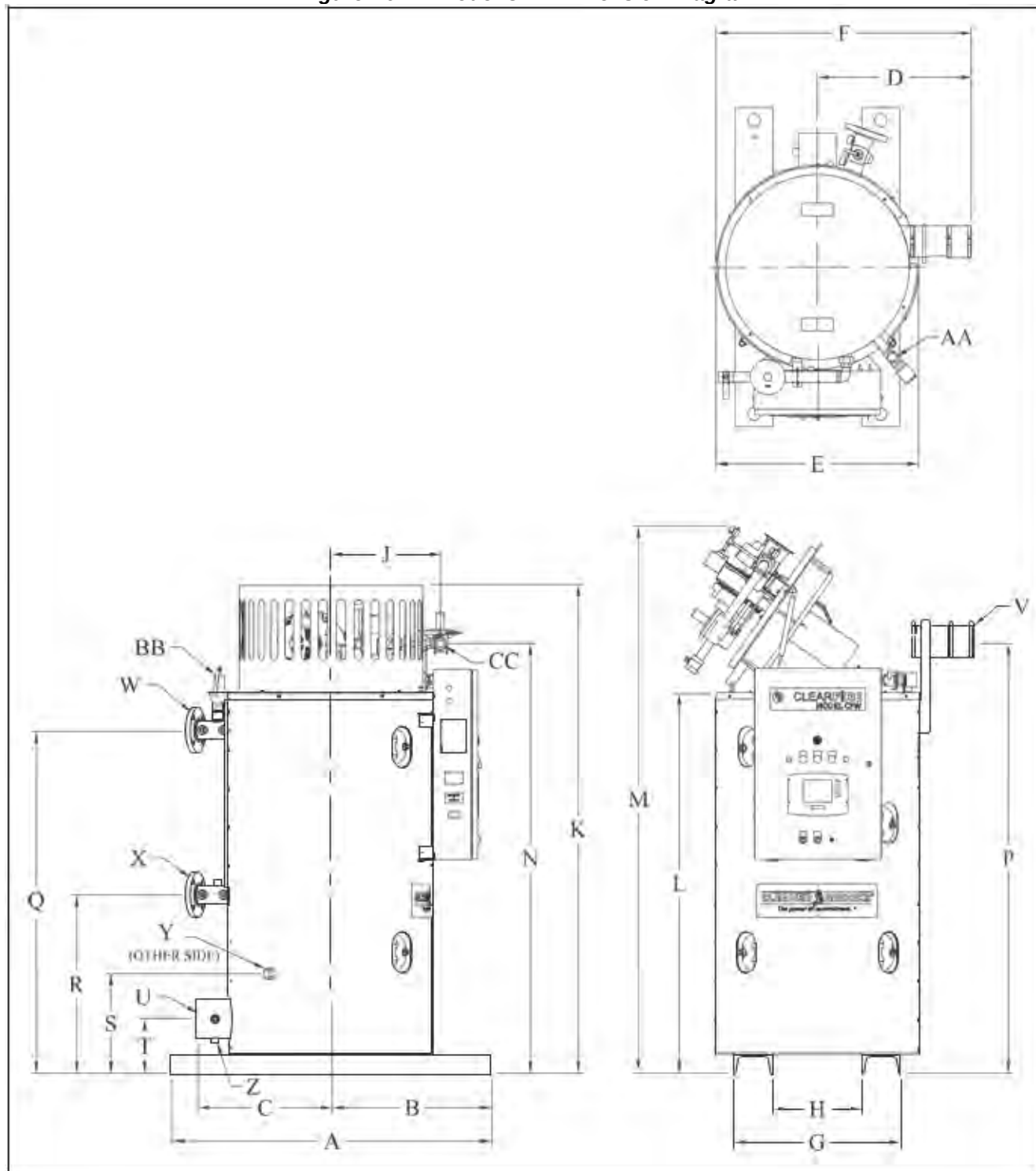


Table B9-2. Model CFW Dimensions

		BOILER RATING						
DIMENSIONS		400	500	750	1000	1500	2000	2400
Overall Length	A	50	50	55	55	56	68	68
Centerline to Boiler Front	B	25	25	29	29	28	35	35
Centerline to Stack Outlet	C	21	21	24 3/4	24 3/4	25 1/2	28 1/2	28 1/2
Centerline to Combustion Air Inlet	D	24 1/2	24 1/2	24 1/2	24 1/2	27	37 1/4	37 1/4
Boiler O.D.	E	32	32	39	39	41	47	47
Overall Width	F	40 1/2	40 1/2	44	44	47 1/2	60 3/4	60 3/4
Base, Outside of Channel	G	26	26	28	28	30	36	36
Base, Inside of Channel	H	14	14	16	16	18	24	24
Centerline to Gas Inlet	J	17 1/4	17 1/4	19 1/4	19 1/4	20 1/4	22	22
Overall Height	K	76 1/2	82 1/2	76 1/2	82 1/2	88	88	94
Vessel Height	L	59 1/2	65 1/2	59 1/2	65 1/2	70	67	73
Burner Door Clearance (Open)	M	85 1/2	91 3/4	84 3/4	90 3/4	99 3/4	101	107
Floor to Gas Inlet	N	67 1/4	73 1/2	67 1/2	73 1/2	79 1/2	79 1/4	85 1/4
Floor to Air Inlet	P	67 1/4	73 1/2	67 1/4	73 1/2	79 1/2	78	84
Floor to Supply Connection	Q	53 1/2	59 1/2	54 1/2	60 1/2	64 3/4	61 1/4	67 1/4
Floor to Return Connection	R	28	31	25 3/4	25 3/4	32 1/4	31 1/2	34 1/2
Floor to Drain	S	15 1/2	15 1/2	14 1/2	14 1/2	17 1/4	19 1/2	19 1/2
Floor to Stack Outlet	T	8 1/2	8 1/2	8	8	9	9 3/4	9 3/4
BOILER CONNECTIONS								
Flue/Stack, Nominal OD	U	6	6	6	6	8	10	10
Sealed Combustion, Air	V	4	4	4	4	6	8	8
Supply Water, Flange	W	2 1/2	2 1/2	2 1/2	2 1/2	3	4	4
Return Water, Flange	X	2 1/2	2 1/2	2 1/2	2 1/2	3	4	4
Boiler Drain	Y	1	1	1	1	1	1 1/4	1 1/4
Condensate Drain	Z	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Air Vent	AA	1	1	1	1	1	1	1
Safety Valve, 125# setting	BB	1	1	1	1	1	1	1
Gas Train	CC	1	1	1	1	1 1/2	1 1/2	1 1/2
WEIGHTS - LBS								
Shipping Weight (125#)		1550	1700	2100	2300	2900	3400	3800
Operating Weight (125#)		2205	2460	3260	3630	4330	5105	5780

Table B9-3. Model CFW Ratings

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

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

Table B9-4. Gas Pressure Requirements

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

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

Note: For altitudes up to 700 feet.

Table B9-5. Altitude Correction for Gas

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

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

Table B9-6. Boiler Heating Surface

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

Table B9-7. Safety Valve Outlet Size

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

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

Table B9-8. Clearances

CFW clearances (inches)

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

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall (Dimension "A") allows for a clear 24" aisle between the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers (Dimension "B") allows for a clear aisle of 24". If space permits, this aisle should be widened.
3. Clearance above boiler 36".

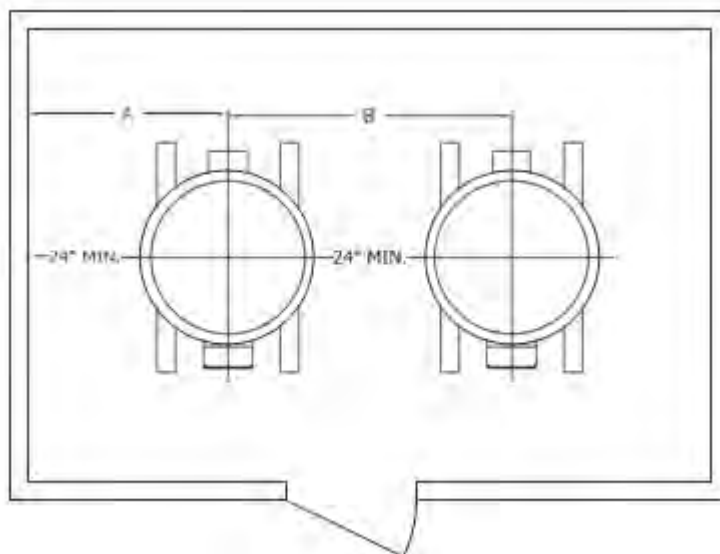
**PERFORMANCE DATA**

Table B9-9 shows predicted fuel-to-water efficiencies for the Model CFW. The specified boiler efficiency is based on the following conditions:

- Natural Gas
Carbon, % by weight = 69.98
Hydrogen, % by weight = 22.31
Sulfur, % by weight = 0.0
Heating Value, Btu/lb = 21,830
- Efficiencies are based on ambient air temperature of 80° F (27° C), relative humidity of 30%, and 15% excess air in the exhaust gas stream.
- Any efficiency verification testing will be based on the stack loss method.

Table B9-9. CFW Predicted Fuel-to-Water Efficiencies

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

The emission data included in Table B9-9 consists of typical controlled emission levels of the Model CFW boiler. Because of the premix burner technology, the standard burner provided with the CFW package provides low emissions as standard without the need for external or special devices.

Table B9-10. CFW Estimated Emission Levels

POLLUTANT	UNITS	
CO	ppm ^A	10
	lb/MMBtu	0.04
NO _x	ppm ^A	20
	lb/MMBtu	0.024
SO _x	ppm ^A	1
	lb/MMBtu	0.001
HC/VOC ₅	ppm ^A	4
	lb/MMBtu	0.004
PM	ppm ^A	-
	lb/MMBtu	0.01

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

Table B9-10 shows predicted sound levels at high fire.

Table B9-11. Predicted sound levels

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

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

ENGINEERING DATA

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

Flow Rates

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

Table B9-12. CFW Maximum Flow Rates

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

Water Quality

Table B9-13. Model CFW Water Quality

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

Stack/Breeching Criteria

General - Boilers are divided into four categories based on the pressure and temperature produced in the exhaust stack and the likelihood of condensate production in the vent. The Model CFW can be considered one of the following:

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

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

Proper design and installation of the flue gas venting is critical to efficient and safe operation of the boiler. The vent should be designed with proper supports and clearances

from combustible materials. Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

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

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

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

Horizontal Thru-Wall Venting - Room Air

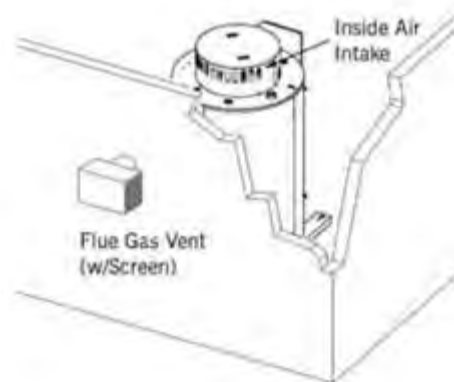


Figure B9-12. Horizontal Venting Thru-Wall Using Inside Air for Combustion

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

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

Installation Code for Gas Burning Appliances and Equipment.

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

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

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

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

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

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

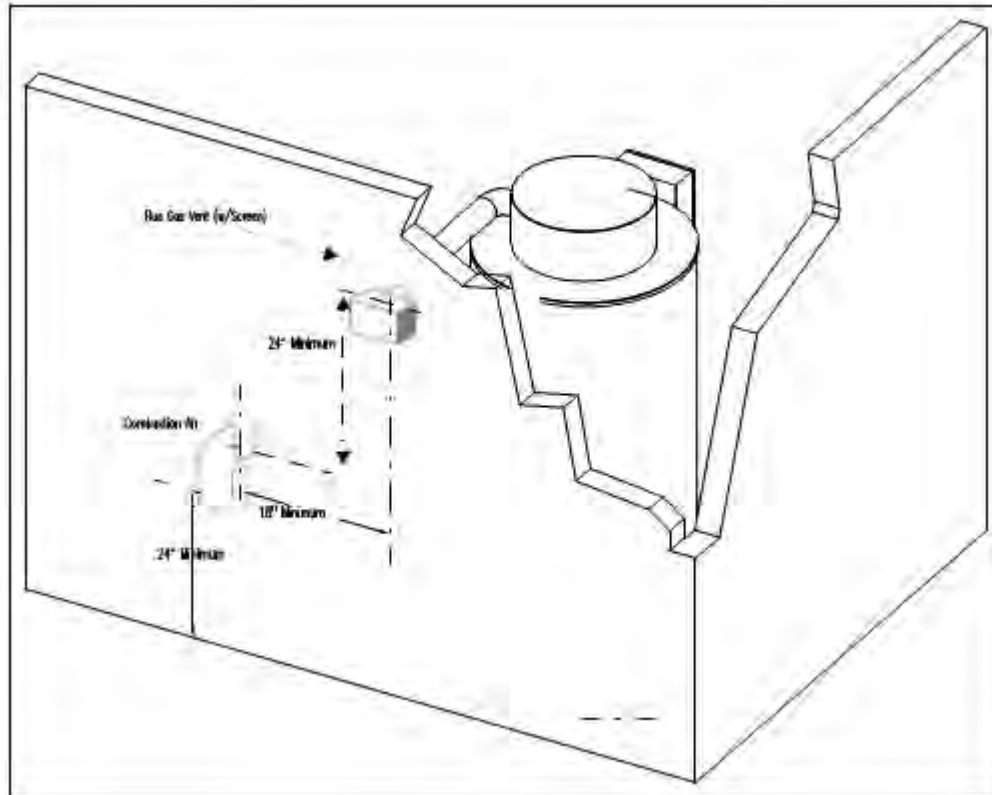


Figure B9-13. Horizontal Thru-wall Direct Venting Installation

Horizontal Thru-Wall Venting - Outside Air These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion gases to the outside.

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

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

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

1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the stack terminal.
2. The stack vent is to be insulated through the length of the horizontal run. For appliances installed in extreme cold climate, it is recommended that:

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

Vertical Venting - Room Air

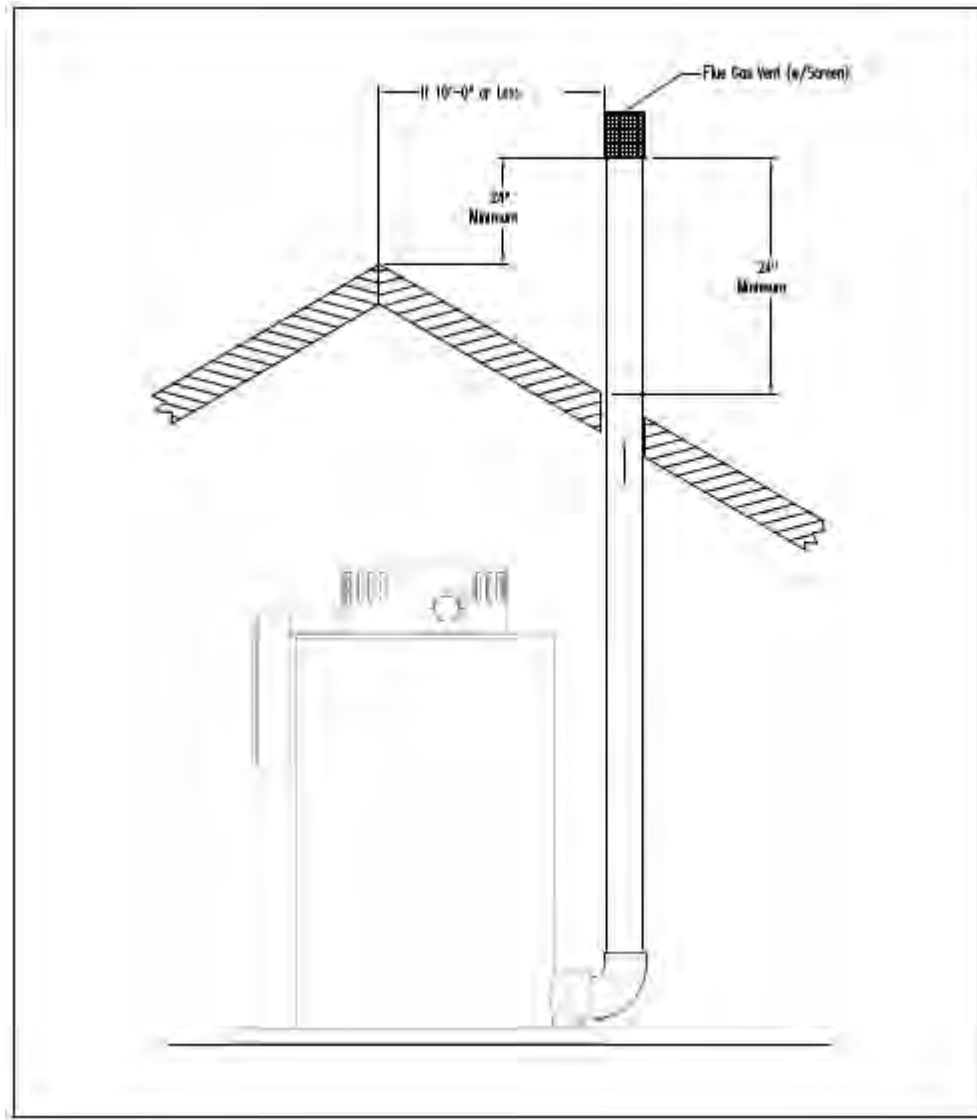


Figure B9-14. Vertical Stack with Indoor Combustion Air

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

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

Vertical Venting – Outside Air

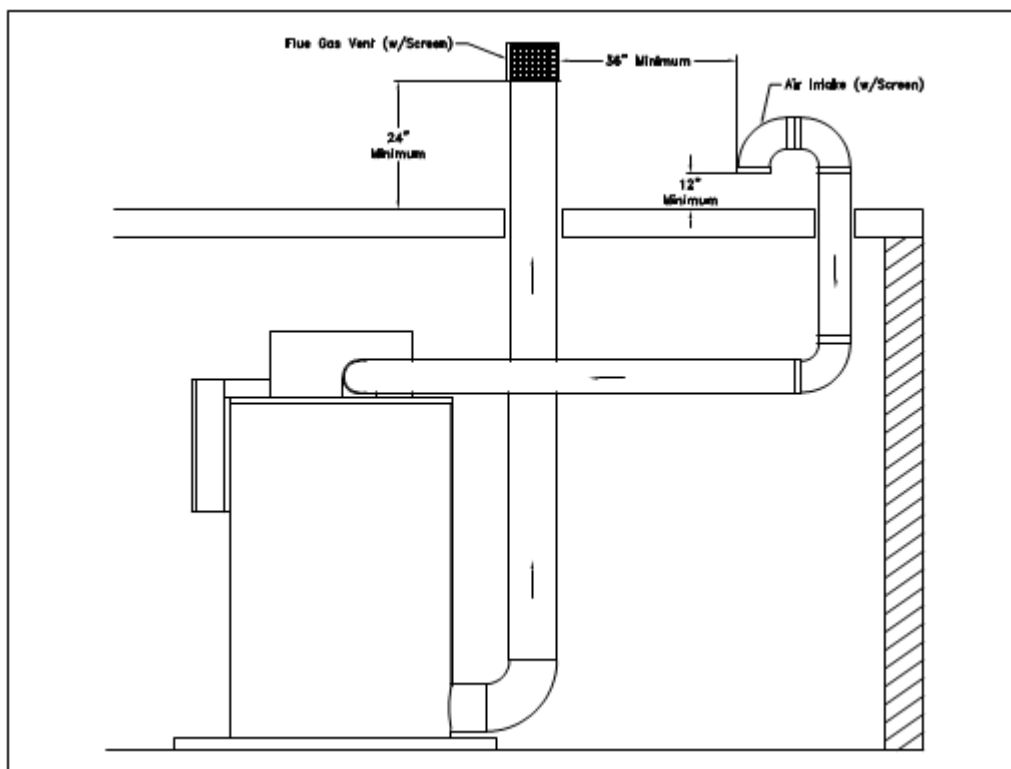


Figure B9-15. Vertical Stack with Direct Vent Combustion

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion products to the outside. A positive pressure venting system is required to prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run; an approved condensate trap must be installed per applicable codes.

Stack And Combustion Air Duct Design Using Direct Vent Combustion

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

NOTES:

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

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

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

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

Each vent termination = 10 equivalent ft.

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

Combustion Air

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

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA54 (the National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B149.1 and B149.2 for Canadian installations.

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

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

Unconfined Spaces

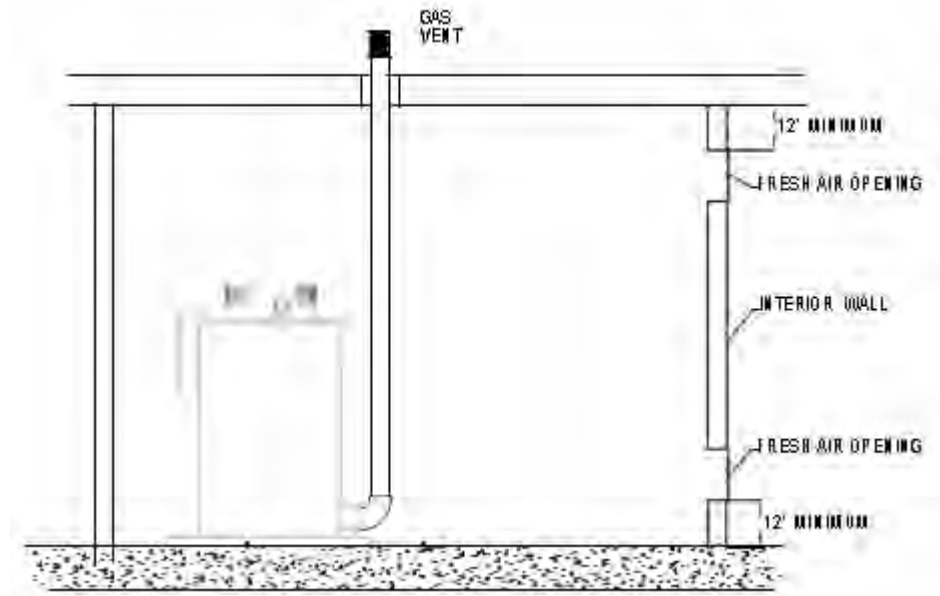
All Air From Inside the Building - If combustion air is drawn from inside the building (the mechanical equipment room does not receive air from outside via louvers or vent openings and the boiler is not equipped with direct vent) and the boiler is located in an unconfined space, use the following guidelines:

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

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

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

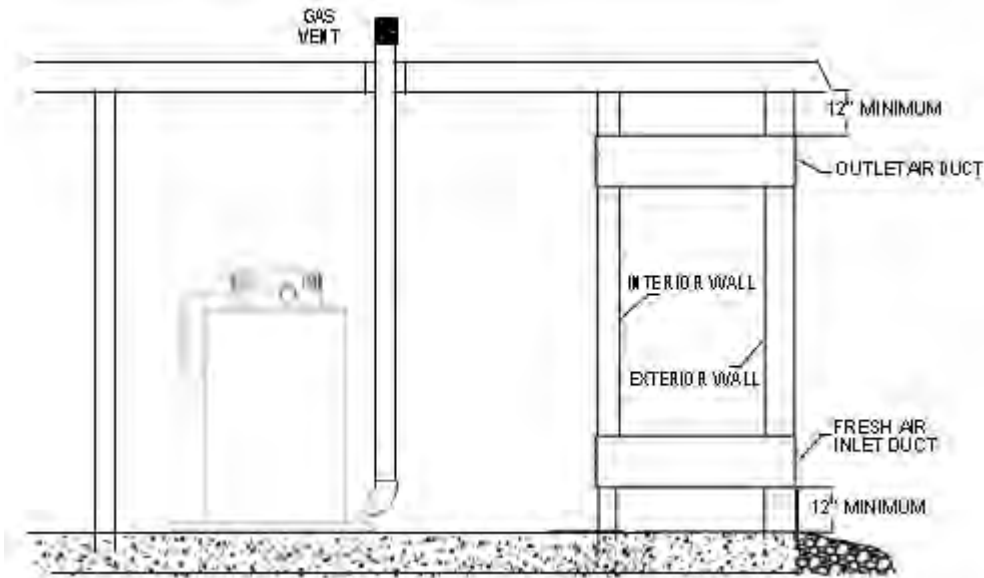
See Figure B7-12; refer to the NFGC for additional information.

Figure B9-16. Inside Air - Two Opening Method

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

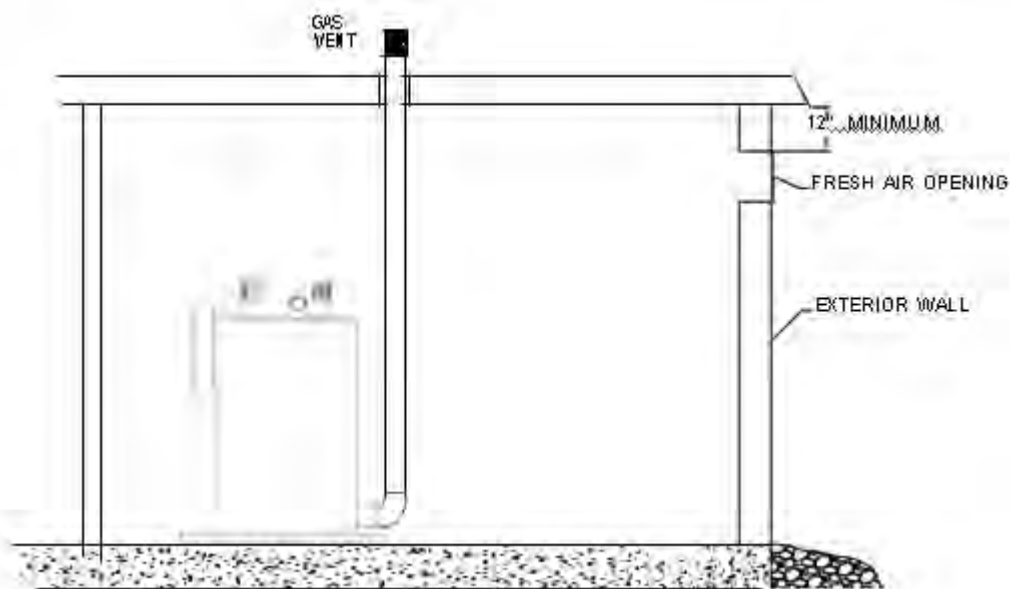
Two Opening Method (Figure B7-13) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches from the bottom of the room.

- A. The opening must be linked directly or by ducts with the outdoors.
- B. Each opening must have a minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the room, when the opening is directly linked to the outdoors or through vertical ducts.
- C. The minimum free area required for horizontal ducts is one square inch per 2,000 Btu per hour of total input rating of all the equipment in the room.

Figure B9-17. Two Opening Ducted Method

One Opening Method (Figure B7-14) - One permanent opening, commencing within 12 inches of the top of the room shall be provided.

- A. The equipment shall have clearances of at least 1 inch from the sides and back and 6 inches from the front of the appliance.
- B. The opening shall directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 Btu's per hour of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the unconfined space.
- C. Refer to the NFPA for additional information.

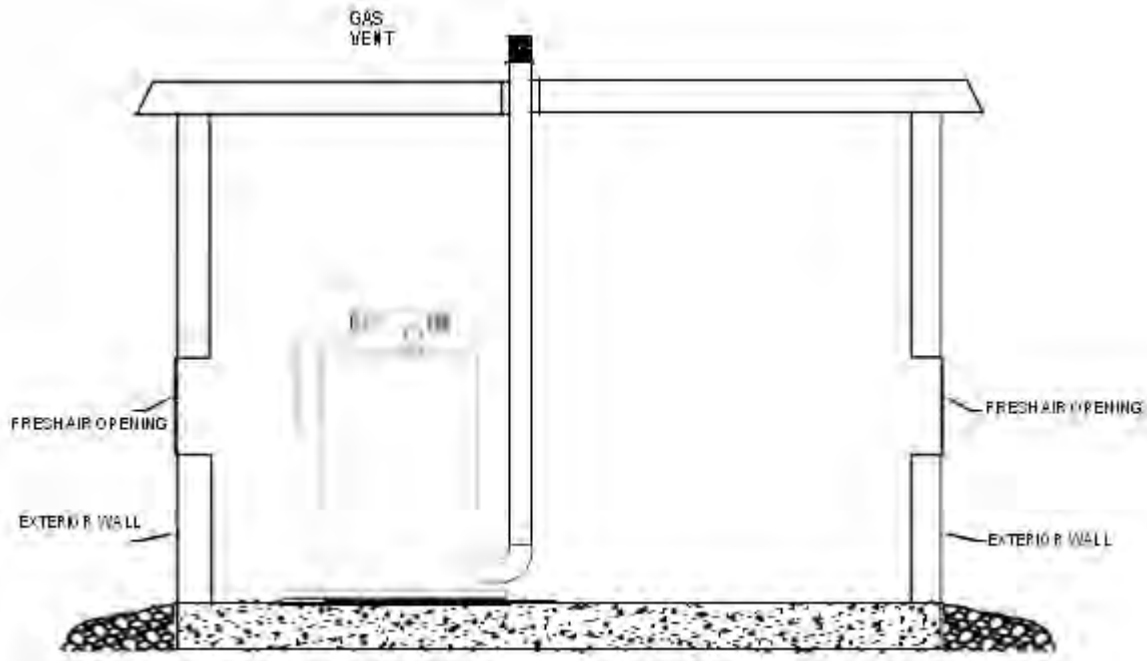
Figure B9-18. One Opening Method

Unconfined Spaces

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

- A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler (see Figure B7-15).

Figure B9-19. Engineered Method



- B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.
- C. A vent fan in the boiler room is not recommended as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.
- D. It is forbidden to have the total area of the air supply openings at less than one square foot.
- E. Size the openings by using the formula (Area in ft² = cfma/fpma), where cfma = cubic feet per minute of air; fpma = feet per minute of air.
- F. Amount of air required (cfm):
1. Combustion Air = 0.25 cfm/kBtuh.
 2. Ventilation Air = 0.05 cfm/kBtuh.
 3. Total Air = 0.3 cfm/kBtuh (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).
- G. Acceptable air velocity in the boiler room (fpm):
1. From floor to 7 feet high = 250 fpm.
 2. Above 7 feet from boiler room floor = 500 fpm.

Example of required air openings (Engineered Method):

Determine the area of the boiler room air supply openings for (2) CFW 2000 boilers at 750 feet elevation. The air openings will be 5 feet above the floor level.

Air required: $2000 \times 2 = 4000$ kBTUh. Air Velocity: From F3 above, $= 4000 \times 0.3 = 1200$ cfm.

Air velocity = 250 fpm from G1 above.

Area required = $\text{cfm}/\text{fpm} = 1200/250 = 4.8$ square feet total.

Area/Opening: 4.8 divided by 2 = 2.4 ft² per opening (2 required).

Notice - Consult local codes, which may supersede these requirements.

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

1. Install combustion air duct in accordance with local codes and the boiler operating and maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. Duct material can be PVC or metallic vent material. It should be air tight to prevent in leakage of air during operation.
4. Maximum pressure drop for the duct shall not exceed 0.25" w.c. negative. If this pressure drop is exceeded a larger size duct is recommended.
5. Multiple boilers may be connected to a single duct with take-offs to each boiler.
6. If the duct will run horizontally to an outside wall, it is recommended that the duct have a slight downward slope away from the burner intake to prevent collected moisture from draining into the burner connection.
7. If the outside air is dust-laden or the installation is near a heavily traveled roadway, it is recommended that an air filter be installed to prevent intake of contaminants that could accumulate on the burner canister.

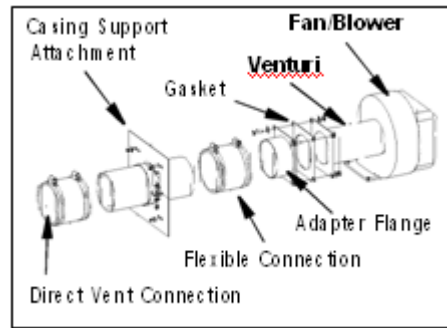


Figure B9-20. Direct Vent Combustion kit

Gas Piping

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

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

Gas Pressure Requirements - For proper and safe operation, each Model CFW boiler requires a stable gas pressure input. The pressure requirements are listed in the O&M manual and current specifications and are added here (Table B7-6) for reference purposes.

The minimum inlet supply pressure must be as noted in Table B7-6 when firing the boiler at low fire and high fire. Actual gas pressure should be measured when the burner is firing using a manometer at the upstream test port connection on the main gas valve. For a multiple unit installation, gas pressure should be set for a single unit first, then the remaining units should be staged on to ensure that gas pressure droop is not more than 3" at the test location described. Fluctuating gas pressure readings could be indicative of a faulty supply regulator or improper gas train size to the boiler.

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

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c. a "full lock-up" type regulator is recommended along with proper overpressure protection (e.g. relief valve). In addition to the regulator, a plug type or "butterball type" gas shutoff cock should be installed upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the unit during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Before starting the unit(s) all piping must be cleaned of all debris to prevent its' entrance into the boiler gas train. Piping should be tested as noted in NFPA 54 and the boiler must be isolated during any tests.

After initial startup, the inlet screen to the gas valve should be checked and cleaned for any debris buildup

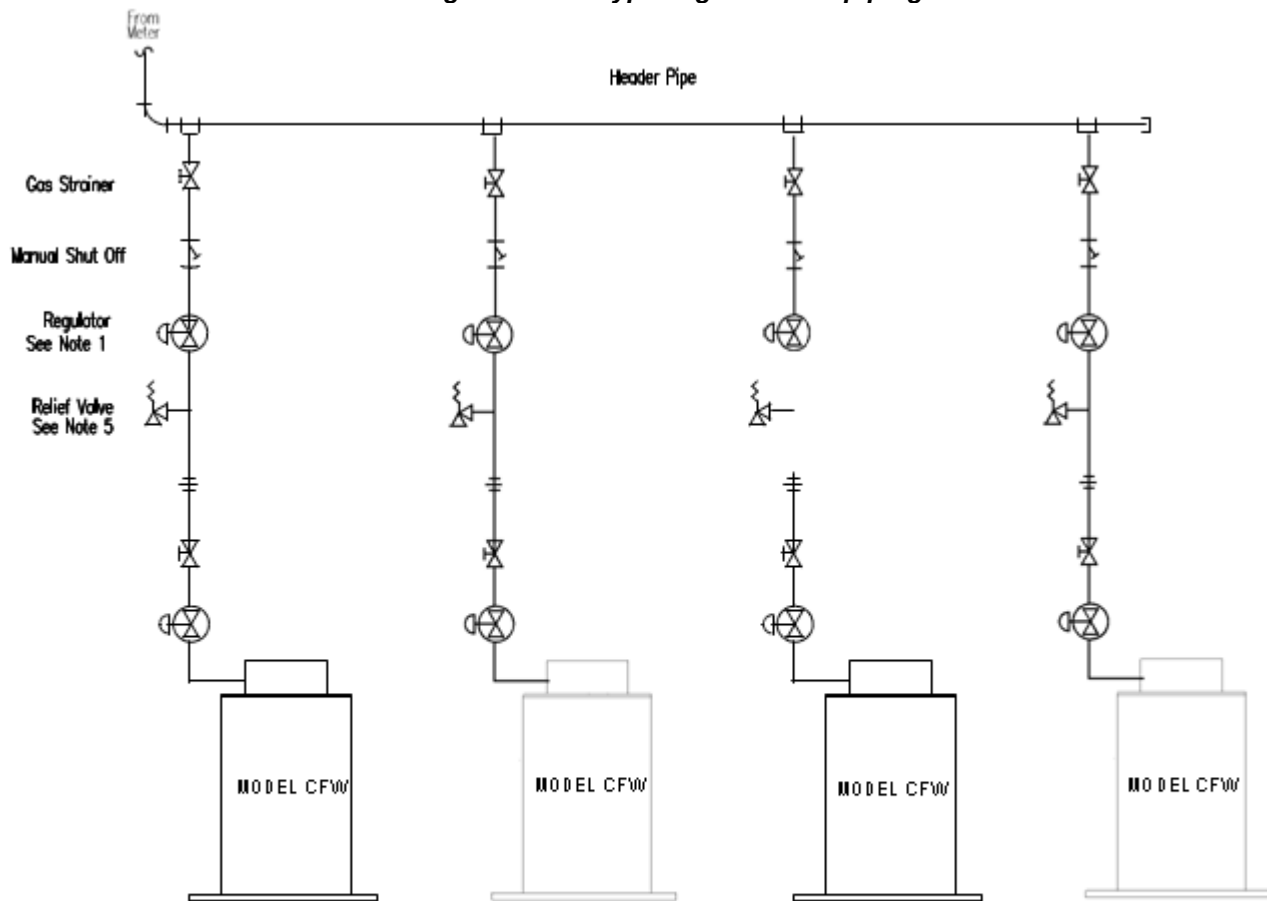
Gas Supply Pipe Sizing - For proper operation of a single unit or a multiple unit installation, we recommend that the gas pipe sizing be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. The gas supplier (utility) should be consulted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

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

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final unit connection. As a minimum guideline, gas piping Tables B9-14 and B9-15 should be used. The data in these tables is from the NFPA 54 source book, 2006 edition.

To verify the input of each device that is connected to the gas piping, obtain the btu/ hr input and divide this input by the calorific value of the gas that will be utilized. For instance, a unit with 1,500,000 btu/hr input divided by a gas calorific value of 1060 will result in a cfh flow of 1,415. The single boiler is approximately 20 feet from the gas supply header source. And with a measured gas supply pressure of 10" w.c. we find from Table B9-14 that a supply pipe size of 2" should be used as a minimum.

Figure B9-18. Typical gas header piping



NOTES:

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

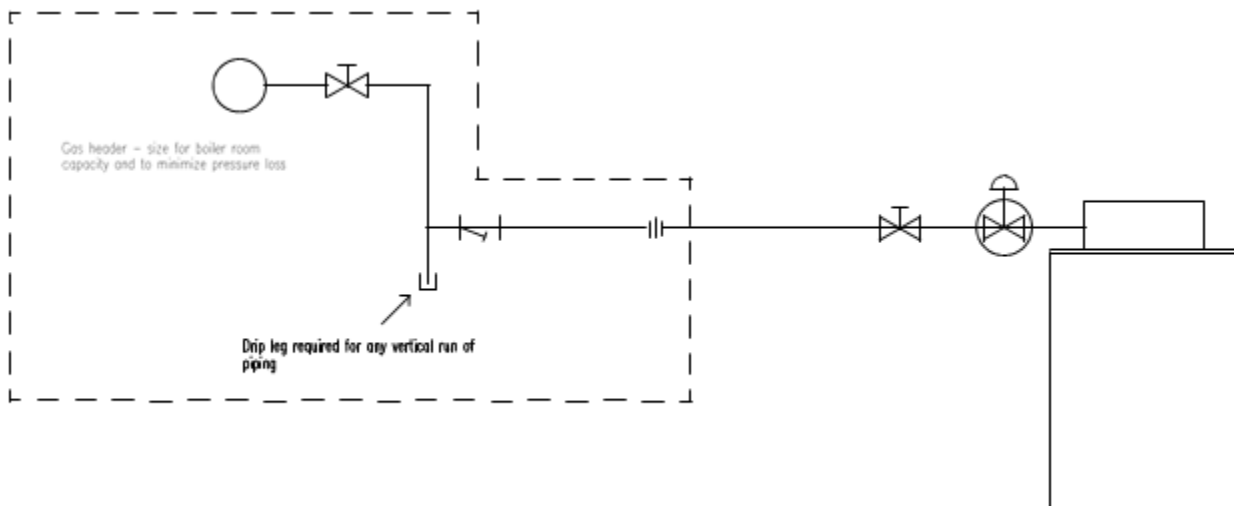


Figure B9-19. Example gas piping <1 psig supply

Gas Header - For multiple unit installations, a single common gas header is recommended with individual takeoffs for each boiler (See Figure B9-22). Boiler gas manifold piping should be sized based on volume requirements and lengths between each boiler and the fuel main header. Table B9-16 indicates the proper sizing for multiple units of equal size, placed on the factory standard center with the indicated take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, determine length of run from the source and determine what size header will be needed for the flow of all units firing. Pipe sizes are based on Table B9-14 with boiler gas line take-off at 20 feet from the header. If pipe runs are greater or if gas pressure is different, refer to Tables B9-14 to B9-21 for pipe sizing.

Table B9-16. Gas pipe sizing for multiple unit manifolds

CFW 400				
# of Units	1	2	3	4
Pipe Size To Boiler	1-1/4"	1-1/4"	1-1/4"	1-1/4"
Header Pipe Size	1-1/4"	1-1/4"	2"	2"

CFW 500				
# of Units	1	2	3	4
Pipe Size To Boiler	1-1/4"	1-1/4"	1-1/4"	1-1/4"
Header Pipe Size	1-1/4"	2"	2"	2-1/2"

CFW 750				
# of Units	1	2	3	4
Pipe Size To Boiler	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Header Pipe Size	1-1/2"	2"	2-1/2"	2-1/2"

CFW 1000				
# of Units	1	2	3	4
Pipe Size To Boiler	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Header Pipe Size	1-1/2"	2"	2-1/2"	3"

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

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

CFW 2400				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 2800				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 3200				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 3600				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 4000				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 4400				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 4800				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 5200				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 5600				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 6000				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 6400				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 6800				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 7200				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 7600				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 8000				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 8400				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 8800				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 9200				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 9600				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

CFW 10000				
# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2-1/2"	3"	3"	4"

SPECIFICATIONS

Model CFW Specifications

PART I. GENERAL Hot Water Boilers – Near Condensing Boiler

1.01 SCOPE

- A. The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and install new factory assembled, low-pressure hot water boilers as described in the specifications herein.
- B. Related Sections include the following:
 - 1. Division 15 Section “Chemical Water Treatment” for feedwater treatment.
 - 2. Division 15 Section “Breechings, Chimneys, and Stacks” for connections to chimneys, and stacks.
 - 3. Division 15 Sections for control wiring for automatic temperature control.

1.02 REFERENCES

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Maintenance Data: Include in the maintenance manuals specified in Division 1.
 - 1. Include parts list, maintenance guide, and wiring diagrams for each boiler.
- G. Other:
 - 1. ASME Section IV – Heating Boilers
 - 2. ANSI Z21.13 – Gas Fired Low Pressure Boilers
 - 3. NFPA 64/ANSI Z221.3 – National Fuel Code
 - 4. FM – Factory Mutual
 - 5. ASME CSD-1 – Controls and Safety Devices
 - 6. XL-GAP (Formerly GE-GAP / IRI)
 - 7. UL or CSA Standards for Gas Fired Boilers
 - 8. UBC – Uniform Building Code
 - 9. UMC – Uniform Mechanical Code
 - 10. NEC – National Electrical Code

1.03. QUALITY ASSURANCE

- A. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, appurtenances, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.
- B. The equipment shall be of the type, design, and size that the manufacturer currently offers for commercial sale and appears in the manufacturer's current catalogue. The equipment shall be new and fabricated from new materials and shall be free from defects in materials and workmanship
- C. The equipment must fit within the allocated space, leaving ample allowance for maintenance and cleaning, and must leave suitable space for easy removal of all equipment appurtenances.
- D. All units of the same classification shall be identical to the extent necessary to ensure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.
- E. To accept unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified. The boiler manufacturer shall be responsible for guarantying that the boiler provides the performance as specified herein.

1.04. SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval by the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. The engineer shall review and stamp submittals. Work may proceed and equipment released for fabrication after contractor receives returned submittals stamped with "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
- C. Shop Drawings - Shop drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
 - 2. Schematic flow diagram of gas valve trains.
 - 3. Schematic wiring diagram of boiler control system of the ladder- type showing all components, interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring by others.
- D. Manufacturer's Warranties: Manufacturer's printed warranties, as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
- E. Manufacturer's Field Service: Manufacturer's printed field service procedures and reports, as specified hereinafter, shall be submitted prior to final acceptance by the engineer. Report forms shall contain all information as required to do start-up and testing as specified in the product section.

1.05. SUBSTITUTIONS / MODIFICATIONS

- A. The bidder must submit in writing to the engineer any request for a proposed deviation, omission, modification, or substitution to this specification for evaluation no later than ten (10) days prior to the bid date.
- B. Technical data, drawings, product samples, and complete data substantiating compliance of proposed substitution with these specifications shall accompany a request for any substitution.
- C. No materials shall be deemed acceptable if not in strict and full compliance with these specifications.
- D. All bidders must bid solely on the specified materials unless acceptance by the engineer of a deviation, omission, modification, or substitution is granted in writing to all bidders prior to the bid date.

1.06. CERTIFICATIONS

- A. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner, and other associated mechanical and electrical equipment have been properly coordinated and integrated to provide a complete and operable boiler package.
 - 3. ASME Certification in the form of ASME Stamp on the product and completed and signed data sheet.
 - 4. ASME CSD-1 compliance in the form of completed data sheet.
 - 5. CSA or UL Certification in the form of an affixed label to the equipment.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.
- B. Contractor's Certification: The contractor shall certify the following:
 - 1. The products and systems installed are in strict compliance with the specifications.
 - 2. The specified field tests have been satisfactorily performed.
- C. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- D. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain dimension and wiring drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.06. DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall be responsible for the timely delivery of the equipment to the jobsite. The contractor shall be responsible for unloading and rigging of the equipment. The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as jobsite conditions during construction.
- B. Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.
- C. Responsibility of making freight claims to be performed by contractor or owner personnel.

PART II. PRODUCTS

2.01 MANUFACTURERS

- A. Contractor shall furnish and install near condensing boiler(s) with input as scheduled on the drawings and performance as noted in these specifications.
- B. Copper fin designs, cast iron or "add-on" secondary exchangers will not be considered.

2.02 GENERAL DESCRIPTION

- A. Each unit shall be a vertical down-fired Firetube type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be factory package. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG. The boiler shall be UL certified as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.

2.03 PERFORMANCE: BOILER SIZE AND RATINGS

- A. The capacity of each unit shall be as indicated on the drawing schedule.
- B. Exit flue gas temperature of the boiler shall not exceed °F gross at maximum hot water supply temperature of °F and return temperature of °F.
- °F. The boiler net output shall be BTU/Hr with an overall fuel-to-water efficiency of % at high fire and % at low fire at above operating temperatures.

C. Performance criteria:

Output	_____ MBTU
Gas Input	_____ MBTU
Design Pressure	_____ PSIG
Operating Pressure	_____ PSIG
Heating Surface (minimum)	_____ Sq. Ft. Fireside
Burner Turndown Ratio	5:1(1500-2400), 4:1(400-1000)
Overall Efficiency (With a hot water supply temperature of 160 °F and return temperature of 140 °F)	_____ % at low fire _____ % at high Fire
NO _x Emission (maximum)	20 PPM (corrected to 3% O ₂)
Electrical	115V / 60H / 1P
Fan Motor	_____ Watts max
Noise level	70 dBA max*
Available Gas Supply Pressure	_____ PSIG
Weight	Dry: _____ Flooded: _____
Seismic Zone	
Altitude	_____ ASL
Code Requirements	ASME / NATIONAL BOARD CSD-1 cULus STATE OF _____ FACTORY MUTUAL (FM) XL-GAP

* Noise Sound Levels: Based on ABMA test code for packaged boilers measured @ 4 ½ feet vertically above the bottom of the base and 3'0" horizontally in front of the end of the burner or front surface of control cabinet. Sound levels dBA on the scale in reference to 0.0002 microbars.

2.04 BOILER DESIGN

- A. Boiler shall be a compact, single-pass, vertical down-fired Firetube type, with carbon steel tubes, tube sheets, and combustion chamber. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with powder coated finish.
- B. The tubes shall be carbon steel and shall be fitted with AluFer internal heat transfer fins for extended heating surface.
- C. The top tubesheet shall be fully accessible without burner disassembly or removal from the boiler. The burner assembly shall be complete with lifting hinges and pneumatic lifters.
- D. The vessel shall be fully insulated with a minimum of 2" of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.
- E. Boiler shall be built to seismic zone requirements and manufacturer shall provide seismic calculations showing tie-down requirements for bolt diameters. Bolts and tie-down shall be by contractor.
- F. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.
- G. The boiler shall be designed for top rear water outlet and bottom rear water inlet; the water inlet (return) shall be equipped with internal baffling. Inlet connection size shall be flanged.
Outlet connection size shall be flanged. The maximum pressure drop through the boiler shall not exceed 0.45 psi with a 20-degree differential and less than 0.05 psi with a 60-degree differential.
- H. A threaded air vent connection shall be furnished at the top of the boiler for field piping to an expansion tank or for the addition of an auto-vent valve when a bladder type expansion tank is utilized.
- I. To drain the boiler, a bottom-threaded connection shall be provided at the rear side of the boiler and field piped by the installing contractor with a manual full size shutoff valve to drain.
- J. Boiler design shall permit operation with a water condition of 8.0 - 9.5 pH range.

2.05 BURNER DESIGN

- A. General: Forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tubes are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on hydraulic piston arms, one on each side to provide open support of the burner assembly.
- B. The burner shall be of the unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity

so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages, damper motor drives and single speed fans shall not be acceptable.

- C. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven fecralloy material creating a 360 degree low temperature radiant flame.
- D. Emissions: The equipment shall be guaranteed to limit NOx emissions to 20 PPM or less. NOx emission levels shall not be exceeded at full operating conditions and at designed turndown of the burner. Proof of such emissions certification shall be made available to the engineer and purchaser and demonstrated at the time of start-up. External flue gas recirculation shall not be accepted for emission control.
- E. Gas Train – As a minimum, the gas train shall meet the requirements of UL and ASME CSD-1 and shall include:
 - 1. Low Gas Pressure Interlock, manual reset.
 - 2. High Gas Pressure Interlock, manual reset.
 - 3. Upstream and downstream manual test cocks.
 - 4. 'Butter Ball' type manual shutoff valve upstream of the main gas valve.
 - 5. Unibody double safety gas valve assembly.
 - 6. Gas Pressure Regulator
 - 7. Union connection to permit burner servicing.
- F. Combustion Air Proving Switch shall be furnished to ensure

2.06 BOILER TRIM

- A. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler air vent outlet. Size shall be in accordance with code requirements and set to open at 125 psig (or less if system design pressure is lower).
- B. Temperature and pressure gauge shall be mounted on the water outlet.
- C. Solid state low water cut-off probe with manual reset and test switch shall be provided.
- D. Manual Reset High Limit Temperature sensor; range not to exceed 240 0 F and shall be an integral device of the Boiler Burner Control and UL recognized as a limit control.
- E. Outlet water supply sensing probe for operating limit and modulation setpoint.
- F. Return water-sensing probe for operating limit and modulation setpoint.

2.07 BOILER CONTROLS

- A. The Boiler shall include a Falcon microprocessor-based Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.

- B. Controller shall provide for both flame safeguard and boiler control through separate power supplied CPU's (to meet NFPA) and shall perform the following functions:
1. Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition, and post purge. Flame rod or UV scanner to prove combustion.
 2. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent 15 lockouts. The control shall be connected to a color touchscreen display that will retrieve this information.
 3. Safety Shutdown with display of lockout condition.
 4. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
 5. Gas pressure supervision, high and low.
 6. Combustion Air Proving Supervision.
 7. The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
 8. Controller shall be equipped with a touch screen display for configuration set up, trouble shooting, and operational display.
 9. Include the capability to control system circulating pump and provide PID modulating control of 2 heating loops.
 10. Outdoor reset control.
 11. Anti-condensation routine to increase the firing rate (and optionally shut off the pump) when the temperature is below a configurable setpoint.
 12. Remote set point / remote modulation.
 13. Modbus communication capability.
- C. All parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.
- D. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to UL requirements.
- E. Electrical power supply shall be 120 volts, 50/60 cycle, single phase for the fan and 120 volts for control circuit requirements.
- F. When multiple boilers are to be installed together, a system integration control shall be provided to stage up to 8 boilers. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority, and a system digital display. The control shall force each boiler to a lower fire, before allowing any boiler to operate at high fire. This allows for inverse efficiency (lower fire rate, higher efficiency). The control shall monitor supply water temperature, return water temperature and shall communicate between boilers via RS-485 wiring.

2.08 BOILER FLUE VENTING

- A. The Boiler shall be UL certified as an indirect or direct vent boiler. Venting shall be accomplished with Category III or IV vent piping installed in accordance with applicable national and local codes.
- B. For direct venting, the boiler shall have the combustion air intake supply ducted with PVC pipe from the outside. Vibration isolation components are not required.

2.09 MANUFACTURER'S FIELD SERVICES

- A. General: The boiler supplier's factory authorized service organization shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. A detailed written record of the start up performance, including burner setting data over the entire load range shall be furnished to the engineer before final acceptance. All labor, equipment, and test apparatus shall be furnished by the authorized service organization. All equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.
- B. Equipment inspection: Boiler representative to provide _____ hours of jobsite assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. All shipped loose components, such as safety valves, to be mounted on boiler by boiler provider after contractor has set boiler in building.
- C. Pre start-up walk through: Boiler representative shall spend _____ hours at jobsite reviewing installation with mechanical contractor to be conducted approximately 1 week prior to startup.
- D. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization, and shall include the following:
1. Demonstrate that boiler, burner, controls, and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 2. Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x, and overall boiler efficiency.
 3. Auxiliary Equipment and Accessories: Observe and check all pumps, valves, draft fans, electric motors and other purtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non compliance with referenced standards or overloading as applicable.
 4. Commissioning Requirements:
 - a. Fireside inspection
 - b. Set up fuel train and combustion air system
 - c. Set up operating set points
 - d. Check all safeties, including flame safeguard, LWCO, airflow, fuel pressures, high limits.
 - g. Set up and verify efficiencies at 20%, 50%, 75%, and 100%
 - h. Set up and verify burner turndown.

- E. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single hour continuous session to accommodate operator's availability on site.

2.10 OPERATING & MAINTENANCE MANUALS

- A. Provide two (2) Operating and Maintenance manuals including cut- away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.
- B. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

2.11 WARRANTY DATA

- A. The pressure vessel shall be guaranteed against thermal shock for 5 years when utilized in a closed loop hydronic heating system with a temperature differential of 100 °F or less.
- B. All parts not covered by the above warranties shall carry a 1 year warranty from startup, or 18 months from shipment, whichever occurs first. This shall include all electrical components and burner components.

PART III. EXECUTION

3.01 GENERAL

Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced personnel previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.02. INSTALLATION

- A. Install equipment in strict compliance with manufacturer's installation instructions.
- B. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
- C. Maintain manufacturer's recommended clearances around sides and over top of equipment.
- D. Install components that were removed from equipment for shipping purposes.
- E. Install components that were furnished loose with equipment for field installation.
- F. Provide all interconnecting electrical control and power wiring.
- G. Provide all fuel gas vent and service piping.
- H. Provide all piping for boiler pipe connections.

3.03. FIELD TESTING

- A. The manufacturer's representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced at the time of initial start-up if found to be inoperative.
- B. All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's authorized service representative.

3.04. START-UP, INSTRUCTION AND WARRANTY SERVICE

- A. The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

Warranty service shall be in accordance with the manufacturer's warranty statement unless other provisions have been agreed to during project bidding.

CLEARFIRE - MODEL CFH
10-60 HP
Steam Horizontal Boiler



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FEATURES AND BENEFITS

General

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

Advanced Technology

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



Figure B6-1. AluFer© Tubes



Figure B6-2. Tube Cross Section

High Efficiency

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

Quality Construction

ISO 9001-2001 certification ensures the highest manufacturing standards.

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

Certification

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

Premix Technology

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

Full Modulation

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

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

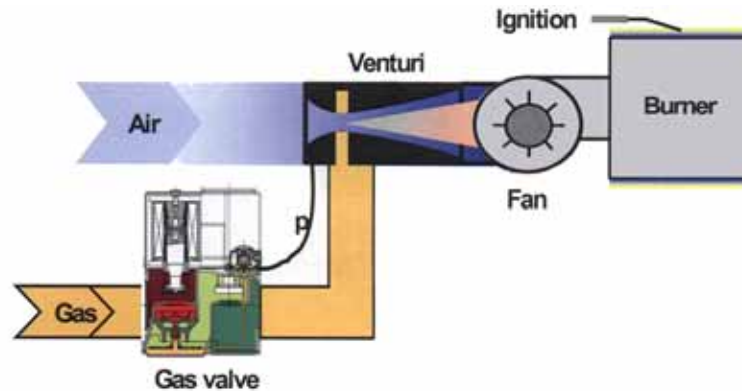


Figure B6-3. Premix Burner Technology

Ease of Maintenance

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



Figure B6-4. Burner maintenance

Designed for commercial steam applications

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

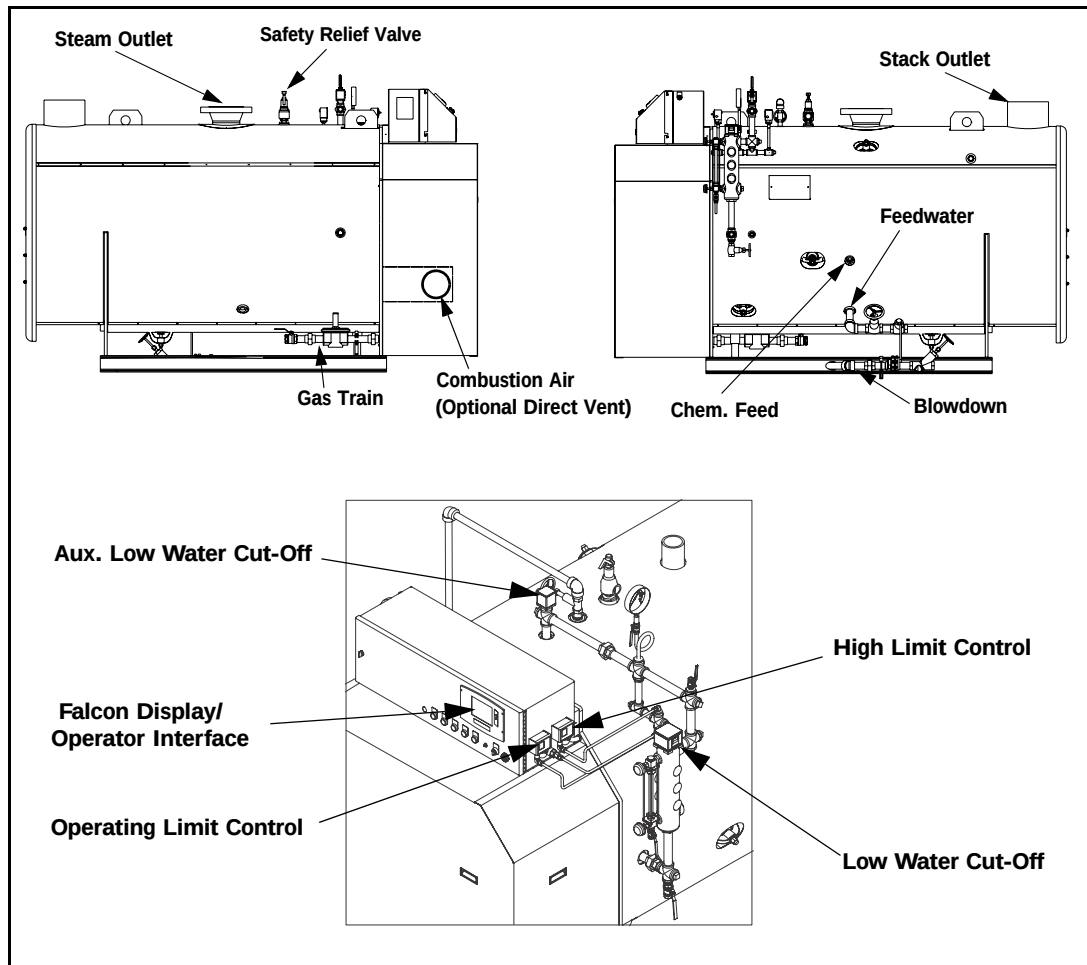


Figure B6-5. Model CFH Steam Boiler

PRODUCT OFFERING

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

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

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

Standard Equipment

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

A. The Boiler

- A. Each boiler (pressure vessel) size is designed and built for a Maximum Allowable Working Pressure (MAWP) of 15 psig in accordance with ASME Section IV (bearing the “H” stamp) or 150 psig in accordance with ASME Section I (bearing the “S” stamp).
- B. The vessel is insulated with a 2” thick blanket and mounted on a base frame. A powder-coated 18 gauge steel casing covers the insulation.
- C. Vessel connections are furnished for:
 - Steam outlet
 - Bottom drain or blowoff
 - Surface blowoff
 - Chemical feed
 - Feedwater makeup
 - High water level overflow
- D. For waterside inspection, handholes are provided.
- E. Two lifting lugs are provided for rigging purposes.
- F. The combustion exhaust is located at the top rear.

B. Boiler trim and controls

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

C. Falcon Control System

- A. Control Description - The Falcon control is an integrated burner management and modulation control with a touch-screen display/operator interface.
- B. Functionality - The controller incorporates the following functions:
 - PID load control.
 - Burner sequencing with safe start check, pre-purge, direct spark ignition, and post purge.
 - Electronic ignition.
 - Flame Supervision.
 - Safety shutdown with time-stamped display of lockout condition - last 15 lockouts stored in memory.
 - Variable speed control of the combustion air fan.

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

Table B6-1. Operating Conditions - Falcon

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

Table B6-2. Falcon burner sequence

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

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

D. Demand switch - Local/Remote/Off.

E. Combustion Air Proving Switch

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

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

• System Identification and Access	• Anti-condensation Configuration
• Central Heat Configuration	• Frost Protection Configuration
• Outdoor Reset Configuration	• Annunciation Configuration
• DHW - Domestic Hot Water Configuration	• Burner Control Interlocks
• Modulation Configuration	• Burner Control Timings & Rates
• Pump Configuration	• Burner Control Ignition
• Statistics Configuration	• Burner Control Flame Failure
• High Limits	• System Configuration
• Stack Limit	• Fan Configuration
• Other Limits	• Lead Lag Configuration

H. Falcon Control Access - There are three levels of access to the 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 Falcon for a particular installation, and is password-protected.
- OEM Level - read/change all parameters; for factory configuration of boiler-specific parameters. Password-protected and restricted to CB or factory authorized service personnel.

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



Figure B6-6. Falcon Display/Operator Interface

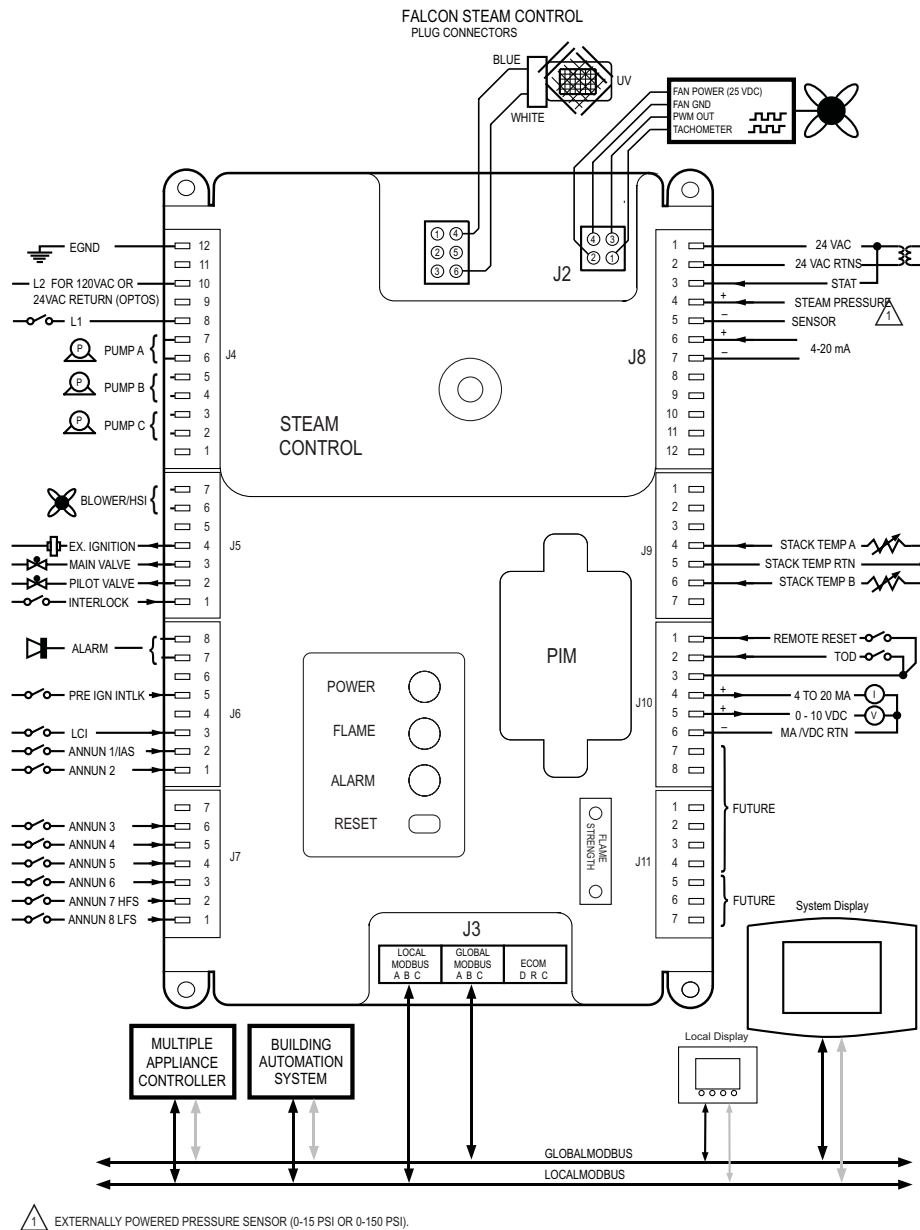


Figure B6-7. Falcon pinout

D. Forced draft burner

- The burner is a "Pre-mix" design consisting of a unitized venturi, single body dual safety gas valve, blower, and burner head (canister).
- Full modulation is accomplished with a variable speed fan for up to 5:1 turndown ratio on 40 horsepower boilers and larger (4:1 turndown on 30 horsepower and less).
- For near flameless combustion, the burner utilizes a Fecralloy metal fiber head (canister).

- D.Noise level at maximum firing is less than 70 dBA regardless of boiler size.
- E. When boiler is operating on natural gas, NOx emissions will be less than 20 PPM regardless of boiler size; certified for California and Texas low emissions requirements.
- F. As an option, the burner can utilize direct vent combustion air.
- G.Ignition of the main flame is via direct spark, utilizing high voltage electrodes and a separate electrode for flame supervision.
- H.To ensure adequate combustion air is present prior to ignition and to ensure the fan is operating, a combustion air proving switch is provided.
- I. For ease of inspection and maintenance, the burner is hinged for easy swing away from the boiler permitting full inspection of the burner components, front tube sheet and furnace.
- J. A flame observation port is located in the burner door.



Figure B6-8. ClearFire-H burner

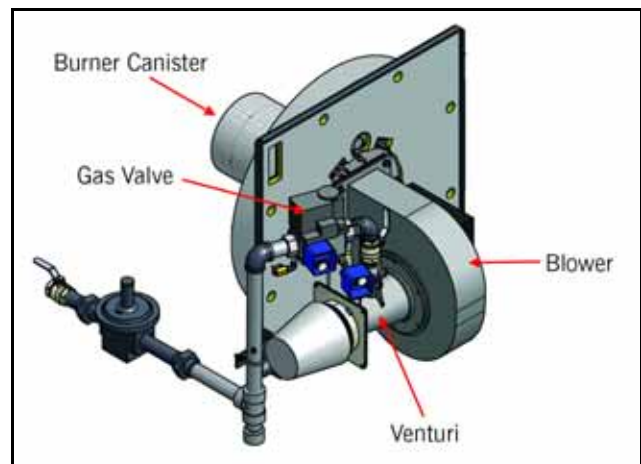


Figure B6-9. Burner Components

E. Burner Gas Train

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

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

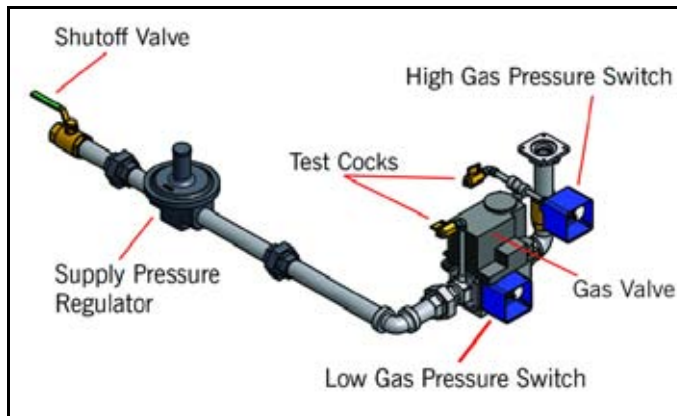


Figure B6-10. Gas Train

F. Boiler control panel

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

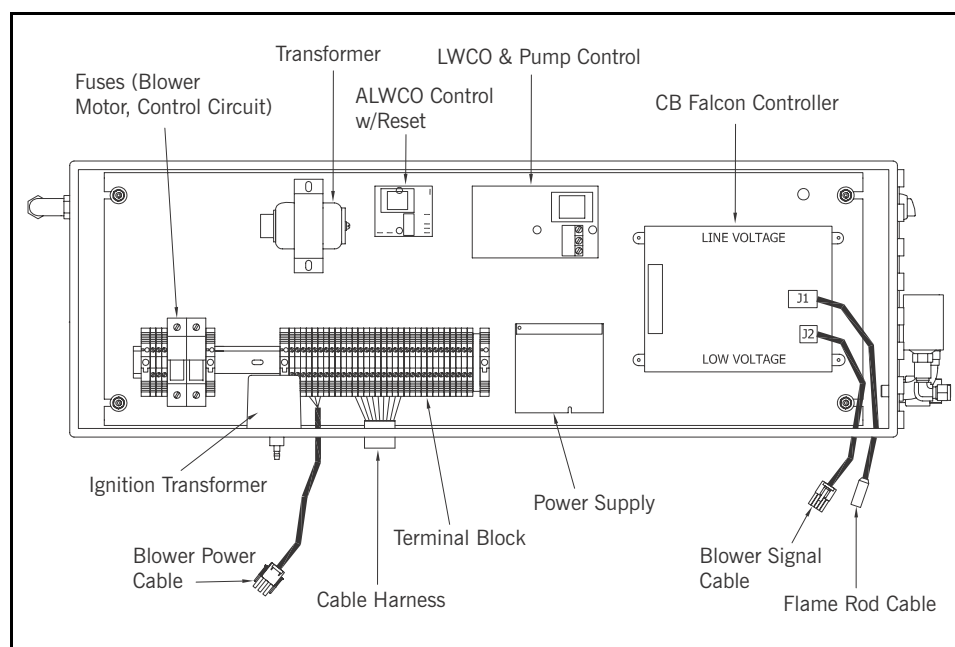


Figure B6-11. Model CFH electrical panel

Optional Equipment

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

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

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFH are shown in Figure B6-12 and Tables B6-3 (U.S. dimensions) and B6-4 (metric). Connection sizes are given in Table B6-5 and ratings of each boiler size are noted in Table B6-6. Additional information is shown in the following tables and illustrations:

Table B6-7 Recommended steam nozzle sizes

Table B6-8 Minimum required gas pressure

Table B6-9 Safety valve outlet sizes

Table B6-10, Figure B6-13 Boiler room width

Figure B6-14 Lifting lug locations

Table B6-11, Figure B6-15 Boiler mounting piers

Figure B6-12. Model CFH Steam Boiler Dimensions

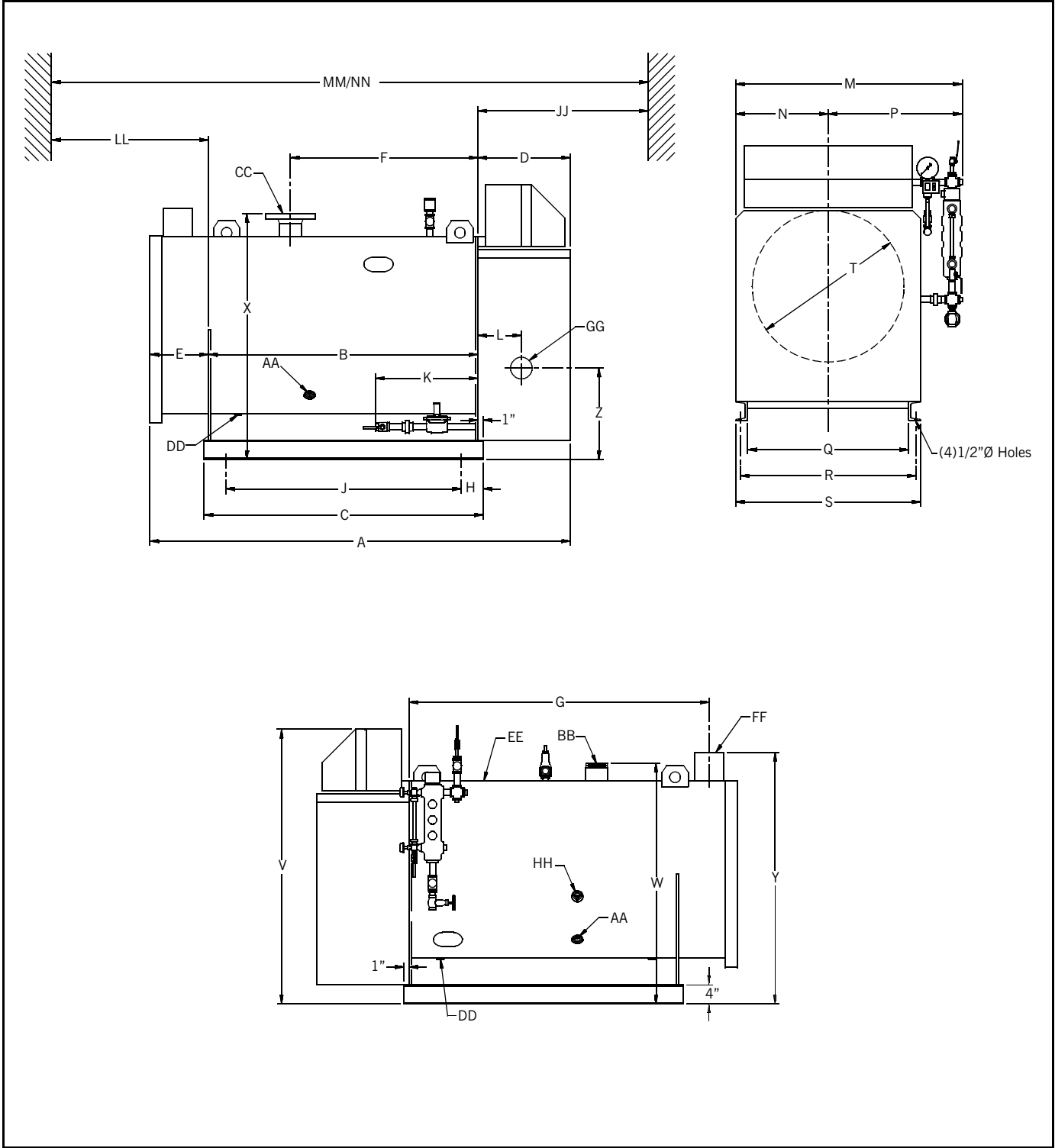


Table B6-3. Model CFH Steam Boiler Dimensions

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

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

Table B6-4. Model CFH Steam Boiler Metric Dimensions

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

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

Table B6-5. Model CFH Steam Boiler Connection Sizes

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

A. Connections are 150# F.F. Flanged

Table B6-6. Model CFH Steam Ratings

Boiler H.P.	10	15	20	25	30	40	50	60
Ratings								
Rated Capacity - Steam (lbs. steam/hr from & at 212° F.)	345	518	690	863	1,035	1,380	1,725	2,070
Rated Steam Capacity [kg/hr from and at 100 C]	156.5	234.5	313	391	469.5	626	782	939
Output Btu/hr	334,750	502,125	669,500	836,875	1,004,250	1,339,000	1,673,750	2,008,500
Output Kcal/Hr	84,168	126,535	168,714	210,892	253,071	337428	421,785	506,142
Output KW	97	145	194	243	291	388	485	582
Approximate Fuel Consumption At Rated Capacity [Input]								
Natural Gas [ft³/hr] - 15# Steam ^A	394	591	788	985	1,181	1,575	1,969	2,363
Natural Gas [m³/hr] - 15# Steam ^A	11.1	16.7	22.3	27.9	33.4	44.6	55.7	66.9
Natural Gas [ft³/hr] - 150# Steam ^B	408	612	816	1,020	1,225	1,633	2,041	2,449
Natural Gas [m³/hr] - 150# Steam ^B	11.5	17.3	23.1	28.9	34.7	46.2	57.8	69.3
Propane Gas [ft³/hr] - 15# Steam ^A	157	236	315	394	473	630	788	945
Propane Gas [m³/hr] - 15# Steam ^A	4.4	6.7	8.9	11.1	13.4	17.8	22.3	26.8
Propane Gas [ft³/hr] - 150# Steam ^B	163	245	327	408	490	653	817	980
Propane Gas [m³/hr] - 150# Steam ^B	4.6	6.9	9.3	11.5	13.9	18.5	23.1	27.8
Power Requirements - 60 Hz (Single Phase, 115 VAC)								
Blower Motor Size (Watts) ^{C,D}	255	335	335	335	335	750	1,200	1,200
Minimum Ampacity								
Blower Motor	3.3	4	4	4	4	8.5	13.5	13.5
Blower Motor Fuse	4.5	6	6	6	6	12	15	15
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4

Notes:

A. Input calculated at nominal 85% efficiency with Nat. Gas @ 1000 Btu/ft³ and Propane @ 2500 Btu/ft³.B. Input calculated at nominal 82% efficiency with Nat. Gas @ 1000 Btu/ft³ and Propane @ 2500 Btu/ft³.

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

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

Table B6-7. Model CFH Recommended Steam Nozzle Size

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

NOTES:

1. Steam nozzle sizes given in inches.

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



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

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

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

Table B6-9. Model CFH Gas Pressure Requirements

Boiler HP	Inlet pipe size (inches)	Gas valve size (inches)	Minimum pressure required at gas train connection		Max. pressure inches w.c.
			Low Fire	High Fire	
10	1	0.5	7.2" w.c.	5.2" w.c.	28
15	1	0.75	7.3" w.c.	5.3" w.c.	
20	1	0.75	7.5" w.c.	5.5" w.c.	
25	1	1	7.7" w.c.	5.7" w.c.	
30	1.25	1	8.5" w.c.	6.8" w.c.	
40	1.25	1.25	11.0" w.c.	8.0" w.c.	
50	1.5	1.25	10.0" w.c.	7.0" w.c.	
60	1.5	1.25	10.0" w.c.	8.0" w.c.	

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

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

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

NOTES:

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

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

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

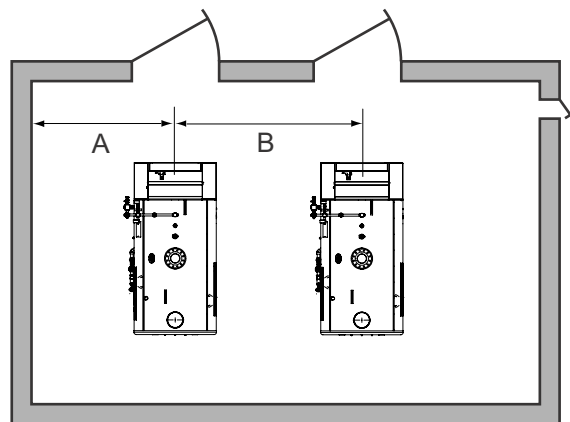
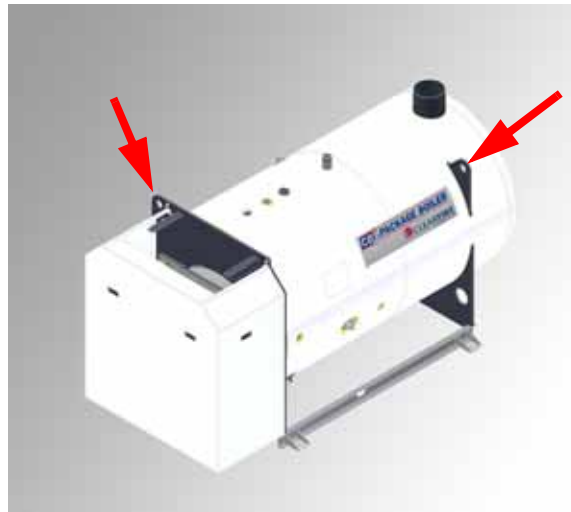
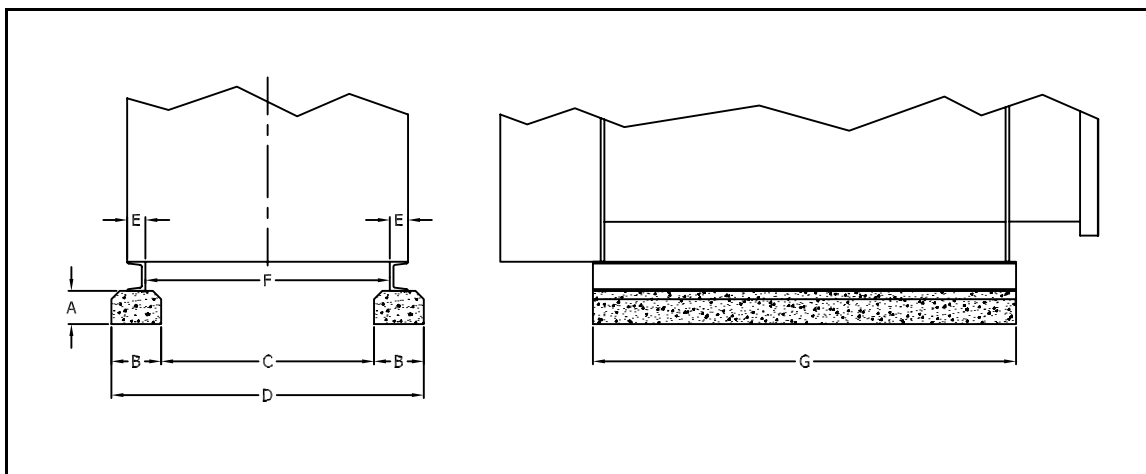
Figure B6-13. Boiler Room Width

Figure B6-14. Model CFH Lifting Lugs*Table B6-11. Model CFH Boiler Mounting Piers*

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

NOTE:

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

Figure B6-15. Model CFH Mounting Piers

PERFORMANCE DATA

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

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

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

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

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

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

Table B6-13. Model CFH Radiation and Convection Losses

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

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

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

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

POLLUTANT	UNITS	
CO	ppm*	50
	lb/MMBtu	0.04
NO _x	ppm*	20
	lb/MMBtu	0.024
SO _x	ppm*	1
	lb/MMBtu	0.001
HC/VOC	ppm*	10
	lb/MMBtu	0.004
PM	ppm*	-
	lb/MMBtu	0.01

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

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

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

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

ENGINEERING DATA

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

Feedwater

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

Table B6-16. Model CFH Boiler Feedwater Flow Rates

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

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

Parameter	Boiler Water Limit
pH	8.3 - 10.5
Iron	0.1 ppm
Oxygen	0.1 mg/liter
Specific Conductivity	2000 μ mho/cm
Suspended Solids	300 ppm
Total Hardness	0 ppm as CaCO ₃

Blowdown

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

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

Table B6-18. Model CFH Blowdown Tank Sizing Information

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

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

Stack/Breeching Criteria

General - The ClearFire Model CFH is a Category III Boiler according to ANSI Z21.13. This code defines a Category III boiler as one that operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore the stack must be a positive pressure design.

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

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

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

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

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

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler

room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA54 (the National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B14 9.1 and B14 9.2 for Canadian installations.

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

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

Unconfined Spaces

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

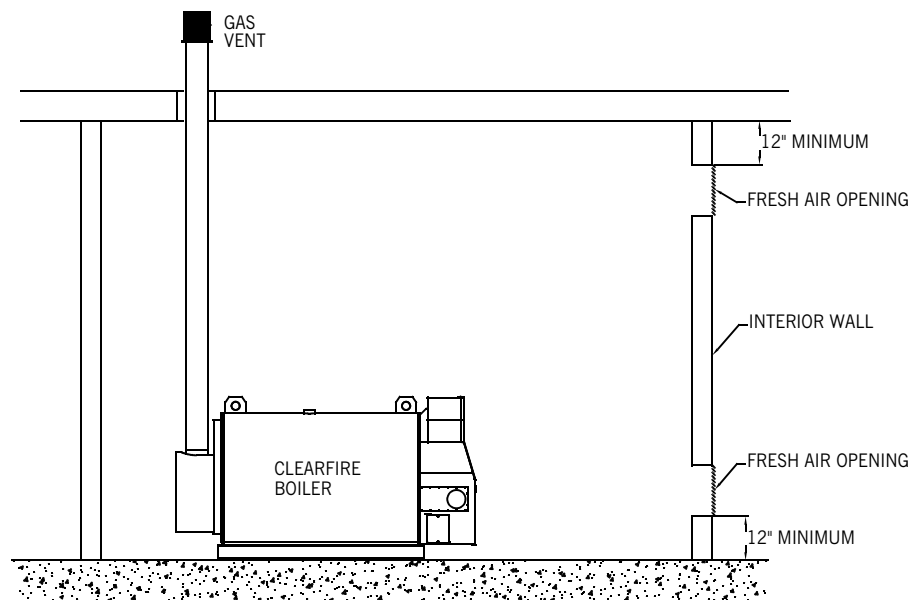
The mechanical equipment room must be provided with two permanent openings linked directly with additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. Note: An "unconfined space" is defined as a space whose volume is more than 50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

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

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

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

Figure B6-16. Inside Air - Two Opening Method



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

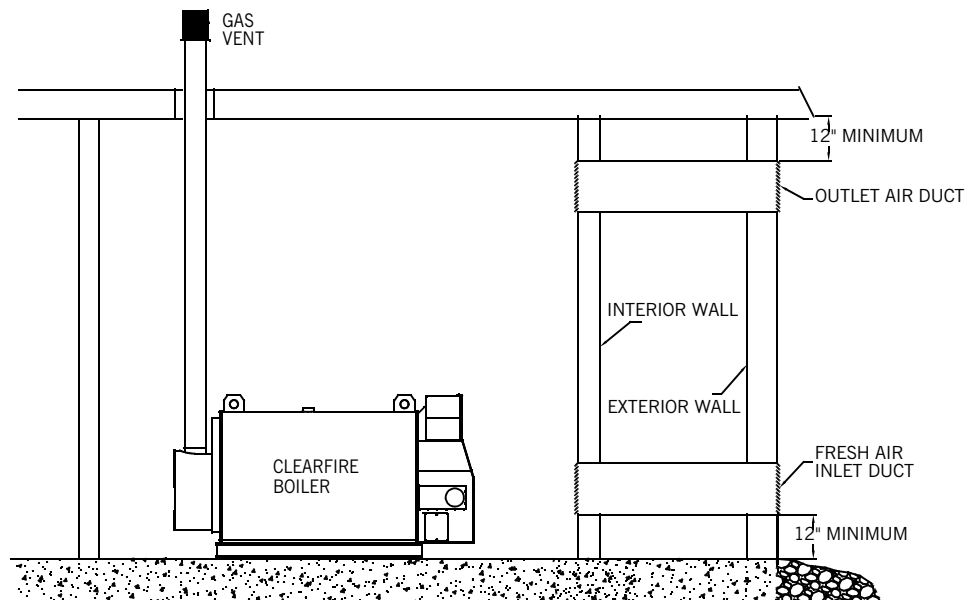
Two Opening Method (Figure B6-17) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches from the bottom of the room.

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

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

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

Figure B6-17. Two Opening Ducted Method

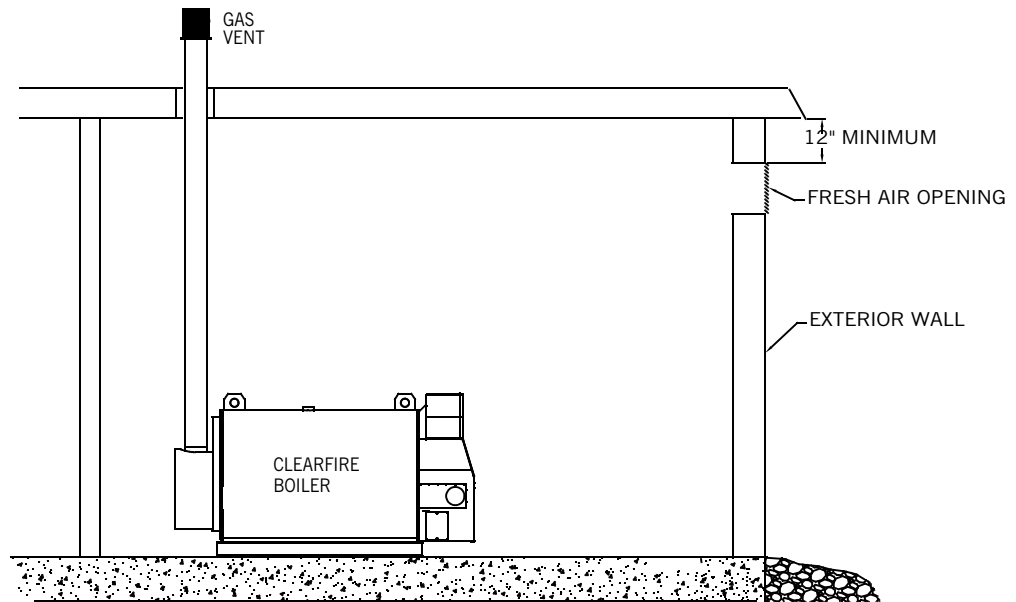


One Opening Method (Figure B6-18) - One permanent opening, commencing within 12 inches of the top of the room shall be provided.

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

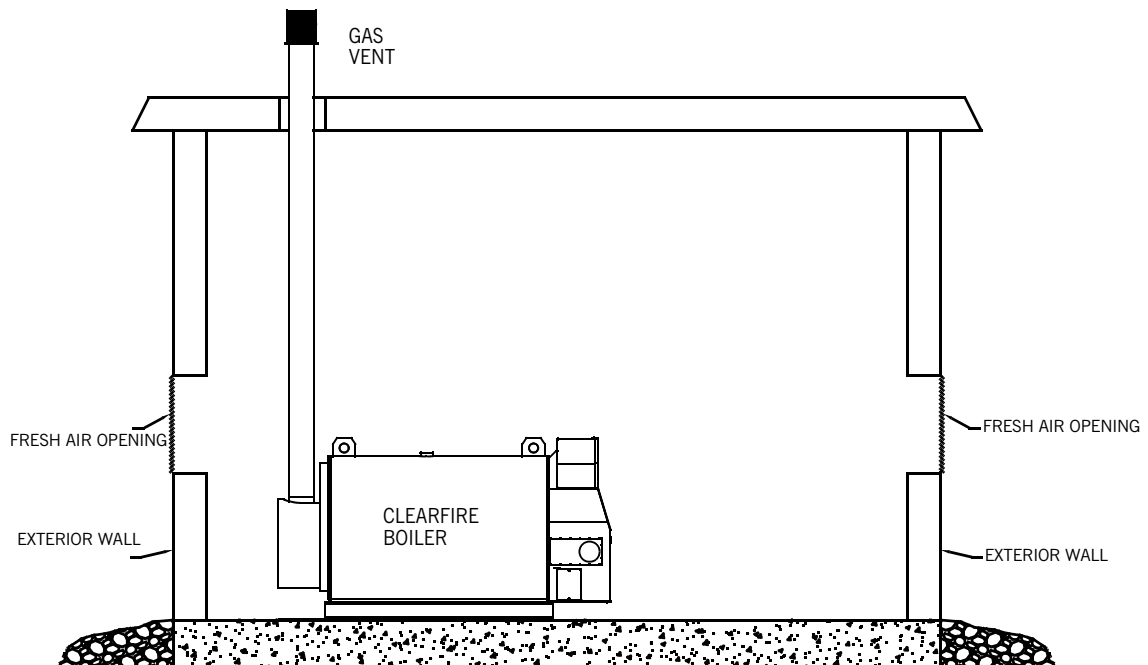
B. The opening shall directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 Btu's per hour of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the unconfined space.

C. Refer to the NFGC for additional information.

Figure B6-18. One Opening Method**Unconfined Spaces**

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

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

Figure B6-19. Engineered Method

- B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.
- C. A vent fan in the boiler room is not recommended as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.
- D. It is forbidden to have the total area of the air supply openings at less than one square foot.
- E. Size the openings by using the formula ($\text{Area in ft}^2 = \text{cfm}_a / \text{fpm}_a$), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.
- F. Amount of air required (cfm):
1. Combustion Air = Maximum boiler horsepower (bhp) times 8 cfm.
 2. Ventilation Air = Maximum boiler horsepower (bhp) times 2 cfm.
 3. Total Air = 10 cfm per bhp (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).
- G. Acceptable air velocity in the boiler room (fpm):
1. From floor to 7 feet high = 250 fpm.
 2. Above 7 feet from boiler room floor = 500 fpm.

Example of required air openings (Engineered Method):

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

Total boiler horsepower (bhp): $60 \times 2 = 120$ bhp

From F.3 above, total air required = $120 \text{ bhp} \times 10 = 1200$ cfm.

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

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

Area/Opening: 4.8 divided by $2 = 2.4 \text{ ft}^2$ per opening (2 required).

Notice

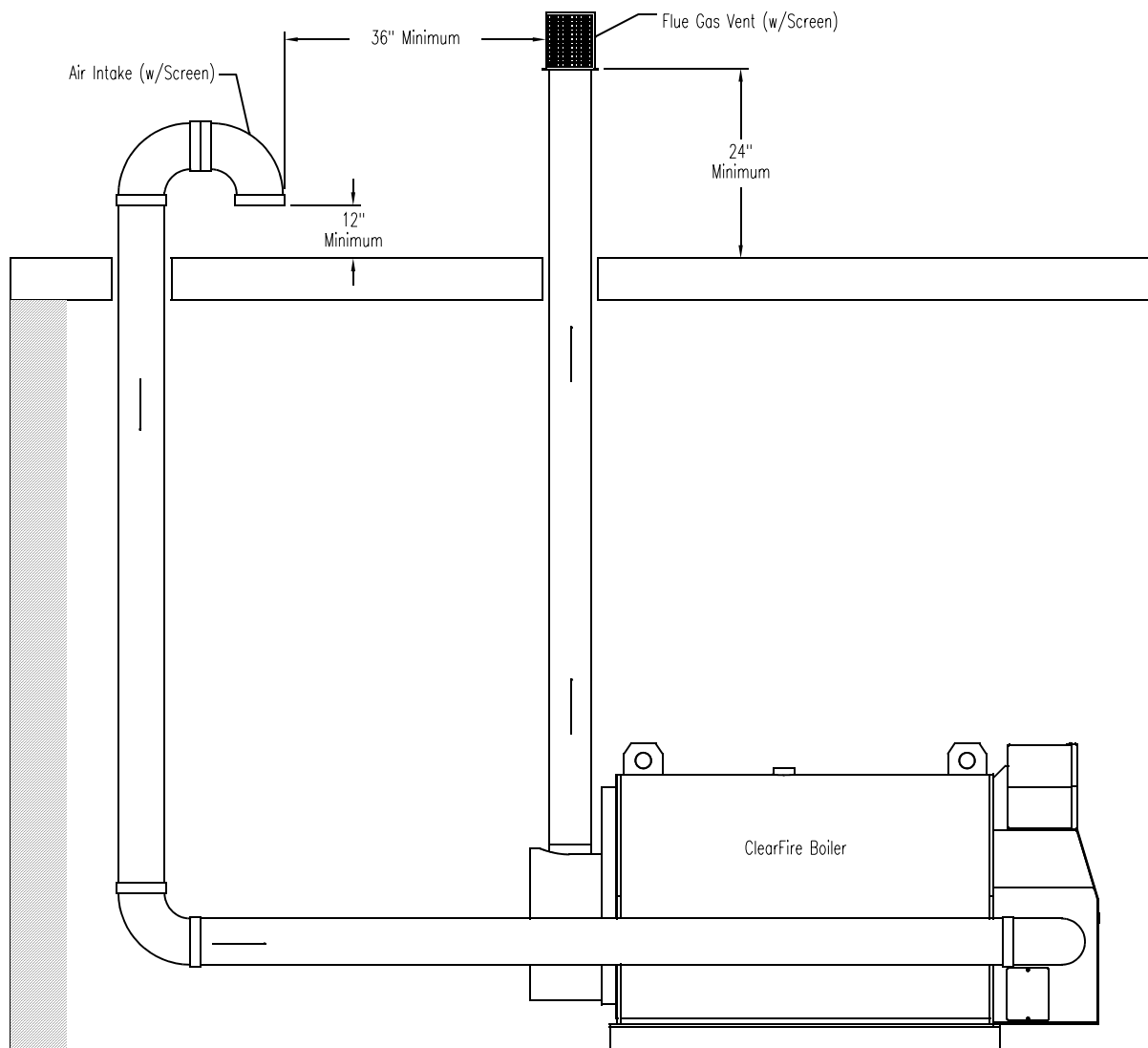
Consult local codes, which may supersede these requirements.

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

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

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

Figure B6-20. Direct Vent Combustion



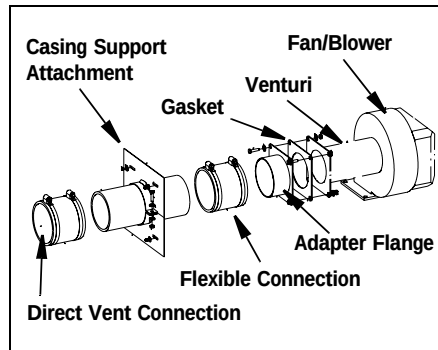


Figure B6-21. Air Inlet Extension kit for Direct Vent combustion

Gas Piping

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

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

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

The minimum inlet supply pressure must be as noted in Table B6-7 when firing the boiler at low fire and high fire. Actual gas pressure should be measured when the burner is firing using a manometer at the upstream test port connection on the main gas valve. For a multiple unit installation, gas pressure should be set for a single unit first, then the remaining units should be staged on to ensure that gas pressure droop is not more than 1" w.c. and never below the required pressure. Fluctuating gas pressure readings could be indicative of a faulty supply regulator or improper gas train size to the boiler.

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

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c. a "full lock-up" type regulator is recommended along with proper overpressure protection (e.g. relief valve). In addition to the regulator, a plug type or "butterball type" gas shutoff cock should be installed upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the unit during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Before starting the unit(s) all piping must be cleaned of all debris to prevent its entrance into the boiler gas train. Piping should be tested as noted in NFPA 54 and the boiler must be isolated during any tests.

After initial startup, the inlet screen to the gas valve should be checked and cleaned for any debris buildup.

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

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

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final unit connection. As a minimum guideline, gas piping Tables B6-19 through B6-23 should be used. The data in these tables is from the NFPA 54 source book, 2006 edition.

To verify the input of each device that is connected to the gas piping, obtain the btu/hr input and divide this input by the calorific value of the gas that will be utilized. For instance, a 40 HP unit with 1,613,253 btu/hr input divided by a gas calorific value of 1060 will result in a cfh flow of 1,522. The single boiler is approximately 20 feet from the gas supply header source. And with a measured gas supply pressure of 10" w.c. we find from Table 19 that a supply pipe size of 2" should be used as a minimum.

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

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

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

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

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

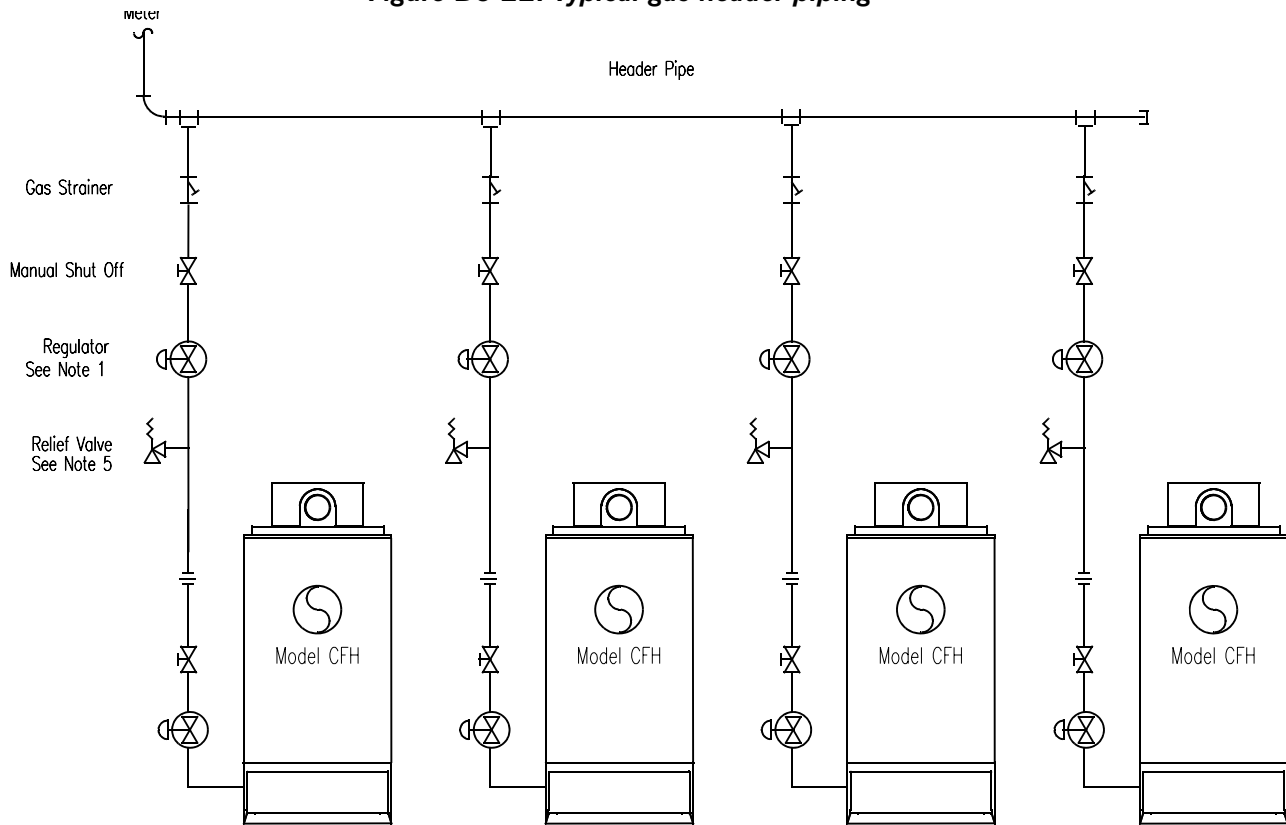
Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	57,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	954	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
1000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
**Fuel: Natural Gas									
**Inlet Pressure: 2.0 psi									
**Pressure Drop: 1.0 psi									
**Specific Gravity: 0.60									

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

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	75,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,300	20,300	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,300
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
500	283	593	1,120	2,290	3,430	6,610	10,300	18,600	38,000
1000	195	407	897	1,380	2,360	4,550	7,240	12,000	26,100
1500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
**Fuel: Natural Gas									
**Inlet Pressure: 3.0 psi									
**Pressure Drop: 2.0 psi									
**Specific Gravity: 0.60									

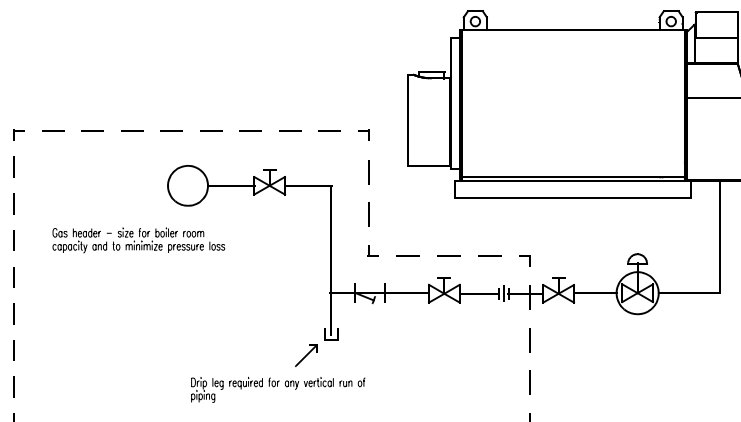
Table B6-23. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
1000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400
**Fuel: Natural Gas									
**Inlet Pressure: 5.0 psi									
**Pressure Drop: 3.5 psi									
**Specific Gravity: 0.60									

Figure B6-22. Typical gas header piping

NOTES:

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

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

Gas Header - For multiple unit installations, a single common gas header with individual takeoffs for each boiler is recommended (See Figure B6-22). Boiler gas manifold piping should be sized based on the volume requirements and lengths between boilers and the fuel main header. Tables B6-24 through B6-31 indicate the proper sizing for multiple units of equal size, placed on the factory standard center with the noted take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, determine length of run from the source and determine what size header will be needed for the flow of all units firing. Pipe sizes are based on Table B6-19 with boiler gas line take-off at 20 feet from the header. If pipe runs are greater or if gas pressure is different, refer to the tables for pipe sizing.

Pipe sizing for multiple unit manifolds

Table B6-24. CFH 10 HP Boilers

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

Table B6-25. CFH 15 HP Boilers

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

Table B6-26. CFH 20 HP Boilers

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

Table B6-27. CFH 25 HP Boilers

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

Table B6-28. CFH 30 HP Boilers

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

Table B6-29. CFH 40 HP Boilers

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

Table B6-30. CFH 50 HP Boilers

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

Table B6-31. CFH 60 HP Boilers

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

SPECIFICATIONS

ClearFire Model CFH

PRODUCT SPECIFICATIONS

1.0 GENERAL BOILER DESIGN

- A. The boiler shall be a Cleaver-Brooks Model CFH 700, single pass horizontal commercial firetube design or approved equal. It shall be mounted on a heavy-duty steel frame with premix forced draft burner and burner controls as a complete package from one manufacturer.
- B. Approvals - The complete package including the burner shall be Underwriters Laboratories, Inc. listed and the official UL/cUL label shall be affixed to the package attesting to its certification.
- C. As a preassembled package, the standard boiler shall be factory fire tested.
- D. The complete package as shipped, shall be ready for connections to water, fuel, blowdown, and exhaust venting. Certain items may be shipped loose to prevent their damage such as the safety valves and gauges.
- E. The specified boiler shall have an output rating of _____ horsepower when fired with Natural Gas (LP Gas) with a gas supply pressure of _____" w.c. Power supply to the boiler shall be 115/1/60. Design pressure shall be [15 or 150]# steam. Operating characteristics shall be [____] psig steam. Steam boilers shall be supplied with _____ degrees F make-up water @ ____%.
- F. Performance: shall be as specified in Paragraph 5 below.

1.1 BOILER SHELL

- A. The boiler shell must be constructed in accordance with the ASME Code, either Section I for high-pressure steam or Section IV for low-pressure steam. The vessel must be subjected to the required inspections of the Code conducted by an independent third party inspector. A signed inspection sheet shall be provided to the purchaser and the appropriate ASME symbol shall be affixed or stamped onto the boiler.
 - 1. Boiler shall be mounted on base rails suitable for transporting by fork lift.
 - 2. Burner housing shall be hinge-mounted to allow tube inspection.
 - 3. Each carbon steel boiler tube shall utilize the AluFer heat transfer design technology for high efficiency and reduction in overall size of the vessel and shall be a minimum of 0.105 tube wall thickness.
 - 4. To facilitate waterside inspection, 3 hand holes shall be provided.
 - 5. An observation port for flame inspection shall be provided.

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

1.2 BOILER SHELL TAPPINGS/OPENINGS

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

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

- A. Water Column
 1. A water column shall be furnished complete with gauge glass and water column blowdown valve.
 - a. Feedwater Pump control - shall be integral with the water column via probe control device and electronics for on/off pump operation.
 - b. Low Water cutoff - shall be integral with the water column via probe control device and solid state electronics mounted and wired in the control panel.
- B. An Auxiliary Low Water Cutoff shall be provided. It shall be located on the top centerline of the boiler using an internal probe and shall be of the manual reset design.
- C. For safety steam pressure lockout a high limit pressure control, manual reset shall be provided. The device shall be mercury free.
- D. To provide steam demand tracking a steam pressure transmitter shall be provided that provides an input signal for burner positioning in accordance to steam demand.
- E. A 3" Steam Pressure Gauge shall be piped onto the trim piping, including an inspectors test cock.
- F. In accordance with the A.S.M.E. Code an approved A.S.M.E. rated and stamped safety valve shall be provided and set at [15 or 150]#.

3.0 BURNER AND BURNER CONTROLS

- A. Mode of Operation - To minimize short cycling and provide highest efficiency the burner for the specified boiler shall be of the electronic modulation with a turndown ratio of 5:1 for Natural Gas for sizes of 40 horsepower and greater, and 4:1 for sizes below 40 horsepower. On/off or low/ high burner operation shall not be accepted.
- B. The burner shall be enclosed in a NEMA 1 type enclosure. A lift off top cover shall be provided to gain access to the burner and controls.
- C. Design - The burner design shall be of the linkage-less premix technology wherein the fuel and air are mixed in the fan housing assembly prior to entering the burner canister. Separately driven linkage or servo motor driven fuel and air valves shall not be permitted.
 - 1. Fan housing shall utilize non-sparking material and shall be approved for premix operation.
 - 2. The fan shall be driven by a variable speed motor which shall react to output demand requirements via the demand control Motor shall be a high efficiency DC Brushless type. Continuous speed synchronous motors will not be acceptable.
- D. Ignition of the fuel shall be of the direct spark design; separate pilot gas train is not required. Dual ignition electrodes shall used for the spark generated from the panel mounted ignition transformer.
- E. Combustion shall take place on the surface of the burner canister. The canister shall be constructed of Fecralloy material and stainless steel and shall be warranted for five years against failure from defects or poor workmanship.
- F. Air Filter - shall be fitted to the intake air venturi to filter the incoming air supply when using boiler room air. The air filter shall be designed to be easily cleaned and re-used.
- G. Fuel - The burner shall be designed for operation with natural gas or LP gas. Gas Train, shall be located at the front of the burner and along the left side of the boiler. In accordance with UL/cUL and ASME CSD-1, the following components shall be furnished:
 - 1. Single body dual solenoid safety shutoff valve incorporating the following:
 - a. The valve shall be a 1:1 ratio valve with an integral trim regulator and shall operate in relation to the fan speed. An air sensing line shall be connected from the air inlet venturi (mounted to the fan motor) and to the gas valve for control of gas input.
 - b. As fan speed increases a negative pressure will be applied to the valve, allowing the valve to open further, permitting more fuel to flow into the venturi for mixing. As fan speed is reduced, fuel input shall be reduced accordingly. Air shall always lead fuel from low to high or high to low.

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

H. Flame Safety

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

4.0 CONTROL PANEL

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

- A. The Boiler shall include a Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processor modulating device, complete with sequence indication, fault reset, mode selection, and configurable parameter settings. It shall be mounted at the front of the boiler panel for easy access and viewing. The controller combines flame supervision, burner sequencing, modulating control, and operating limit control.
- B. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:
 1. Burner sequencing with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.
 2. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent 15 faults. The control shall be connected to a touchscreen display interface that will retrieve this information.
 3. Safety Shutdown with display of error.
 4. Modulating control of the variable speed fan for fuel/air input relative to load requirements.

5. Gas pressure supervision, high and low.
 6. Combustion Air Proving Supervision.
 7. High Air Pressure (back draft too high) supervision.
 8. The active steam pressure and set-point pressure shall be displayed at all times. Output shall be modulating PID set point control via analog signal.
 9. Controller shall be capable of Modbus communication to interface with PC or Building Energy Management System.
- C. All parameter input control set-points shall be factory pre-configured with jobsite conditions programmed at the time of initial operation.
- D. Demand switch.
- E. Provide terminals for control interface wiring, customer connections, and connections for incoming power.
- F. Install solid state circuit boards for water level controls.
- G. Selectable Options: Alarm Light Package to provide indication of Low Water, Flame Failure, Load Demand, Fuel Valve On, including a horn with silencing for alarm conditions.

5.0 PERFORMANCE

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

- A. Efficiency - Fuel to Steam Efficiency shall be guaranteed at 85% for 15# steam. For 150# steam operating at 125# the guaranteed Fuel to Steam Efficiency shall be 83% and 85% with optional flue gas economizer. Efficiency rating shall account for radiation and convection losses.
- B. Emissions - NO_x emissions shall be less than 20 PPM corrected to 3% O₂ and less than 10 PPM CO over the operating range of the burner turndown. If emissions exceed this level, the boiler manufacturer shall correct at their expense until this level is achieved on a repeatable basis.
- C. Noise - Sound shall not exceed 70 dBA at high fire when measured 3 feet in front of the burner.
- D. Radiation losses shall be less than 0.5% of the rated input at maximum firing.
- E. Steam quality shall be 99.5% at maximum firing regardless of operating pressure.

6.0 WARRANTY

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

7.0 OPTIONAL ECONOMIZER PACKAGE

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

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

CLEARFIRE - MODEL CFV
10-60 HP
Steam Vertical Boiler



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FEATURES AND BENEFITS

General

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

Advanced Technology

Heat is transferred through 3" OD carbon steel tubes with patented AluFer© extended heating surfaces. The AluFer© tube design provides for optimum heat transfer and eliminates laminar gas flow during minimum firing, providing optimized efficiency throughout the firing range (see Figure B7-1 and Figure B7-2).



Figure B7-1. AluFer© Tubes



Figure B7-2. Tube Cross Section

High Efficiency

With the AluFer© extended heating surface tubes, the Model CFV steam boiler will provide fuel-to-steam efficiency of up to 81% operating at 125 psig (up to 85% with optional economizer).

Quality Construction

ISO 9001-2001 certification ensures the highest manufacturing standards.

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

Certification

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

Premix Technology

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

Full Modulation

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

positioning. This method of controlling the fuel-air ratio eliminates slippage due to linkages, minimizes burner maintenance, and provides control repeatability. See Figure B7-3.

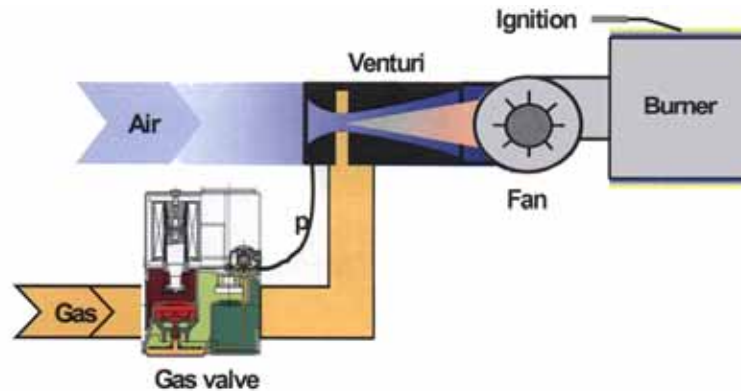


Figure B7-3. Premix Burner Technology

Ease of Maintenance

The blower is easily removed to allow inspection or service of the burner canister, tubes, and tube sheets (see Figure B7-4). A union connection provides easy disconnect from the fuel train. All burner components are easily accessed for inspection and maintenance.

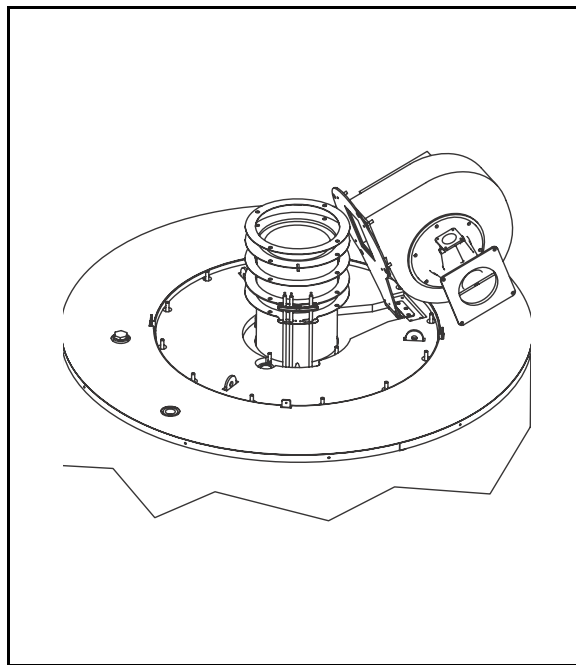


Figure B7-4. Burner maintenance

Designed for commercial steam applications

The CFV packaged boiler is designed for 150 psig MAWP (Maximum Allowable Working Pressure) and is constructed of durable ASTM grade steel materials. Figure B7-5 shows the component and connection locations.

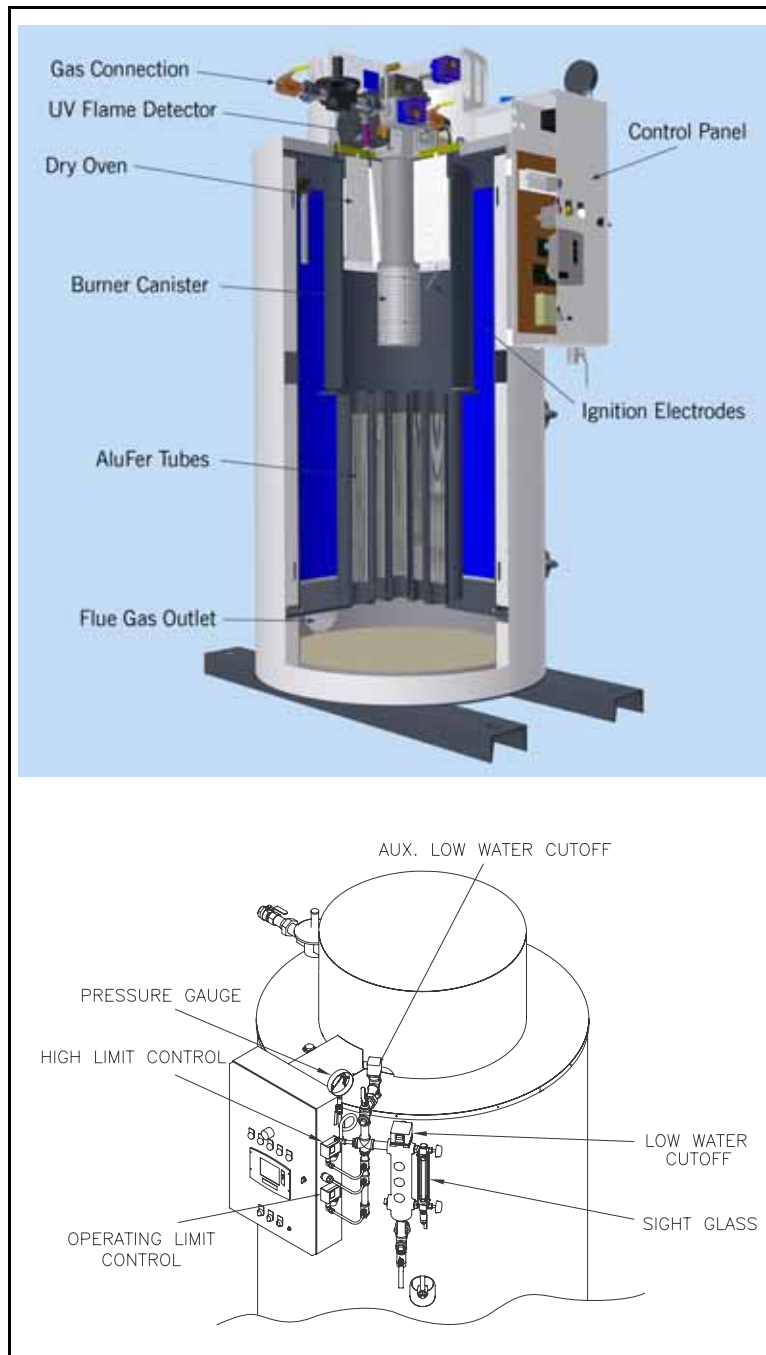


Figure B7-5. CFV connections and controls

PRODUCT OFFERING

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

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

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

Standard Equipment

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

1. The Boiler

- A. Each boiler (pressure vessel) size is designed and built for a Maximum Allowable Working Pressure (MAWP) of 150 psig in accordance with ASME Section I (bearing the "S" stamp).
- B. The vessel is insulated with a 2" thick blanket and mounted on a base frame. A 304 stainless steel casing covers the insulation.
- C. Vessel connections are furnished for:
 - Steam outlet
 - Bottom drain or blowoff
 - Surface blowoff
 - Chemical feed
 - Feedwater makeup
 - High water level overflow
- D. For waterside inspection, handholes are provided.
- E. The combustion exhaust is located at the top rear.

2. Boiler trim and controls

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

3. CB Falcon Control System

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

B. Functionality - The controller incorporates the following functions:

- PID load control.
- Burner sequencing with safe start check, pre-purge, direct spark ignition, and post purge.
- Electronic ignition.
- Flame Supervision.
- Safety shutdown with time-stamped display of lockout condition - last 15 lockouts stored in memory.
- Variable speed control of the combustion air fan.
- Supervision of low and high gas pressure, air proving, stack back pressure, and low water.
- Alarm output
- Remote enable & remote modulation or set point.
- First-out annunciator.
- Diagnostics.
- Real-time data trending (w/System Display).
- (3) pump/auxiliary relay outputs.
- Modbus communication.
- Outdoor temperature reset.
- Anti-short-cycling mode
- Time-of-day (night setback) operation
- Three levels of access to control configuration:
 - End-user
 - Installer/Service Engineer (password protected)
 - OEM Manufacturer (password protected)
- Lead Lag for up to 8 boilers with optional kit

Table B7-1. Operating Conditions - Falcon

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

Table B7-2. Falcon burner sequence

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

C. Main Electrical Connection - 115V/single phase/60Hz (50Hz available)

D. Demand switch - Local/Remote/Off.

E. Combustion Air Proving Switch

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

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

• System Identification and Access	• Anti-condensation Configuration
• Central Heat Configuration	• Frost Protection Configuration
• Outdoor Reset Configuration	• Annunciation Configuration
• DHW - Domestic Hot Water Configuration	• Burner Control Interlocks
• Modulation Configuration	• Burner Control Timings & Rates
• Pump Configuration	• Burner Control Ignition
• Statistics Configuration	• Burner Control Flame Failure
• High Limits	• System Configuration
• Stack Limit	• Fan Configuration
• Other Limits	• Lead Lag Configuration

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

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

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

For additional information regarding service and setup of the burner controller, refer to CB manual part no. 750-269.



Figure B7-6. Falcon Display/Operator Interface

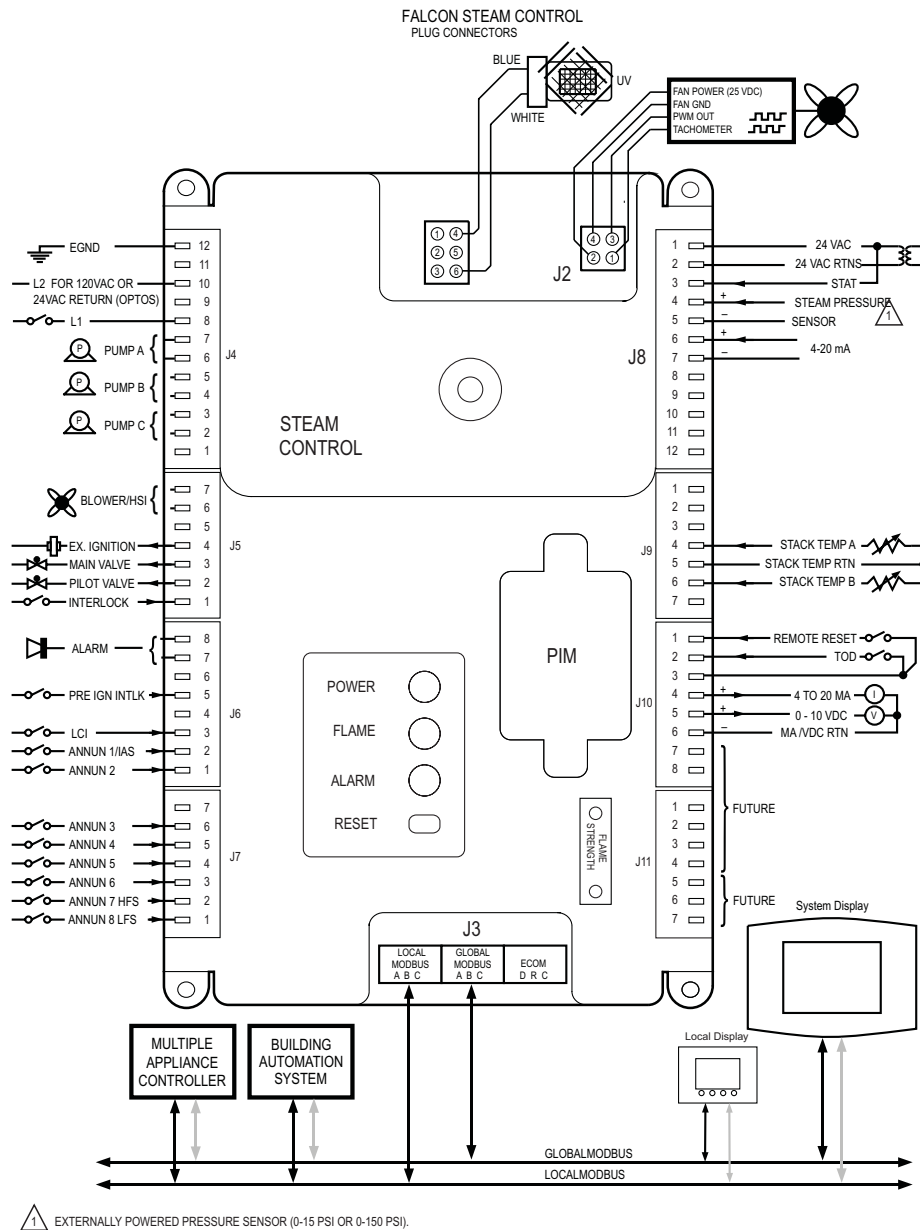


Figure B7-7. CB Falcon pinout

4. Forced draft burner

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

- B. Full modulation is accomplished with a variable speed fan for up to 5:1 turndown ratio on 40 horsepower boilers and larger (4:1 turndown on 30 horsepower and less).
- C. For near flameless combustion, the burner utilizes a Fecralloy metal fiber head (canister).
- D. Noise level at maximum firing is less than 70 dBA regardless of boiler size.
- E. When boiler is operating on natural gas, NOx emissions will be less than 20 PPM regardless of boiler size; certified for California and Texas low emissions requirements.
- F. As an option, the burner can utilize direct vent combustion air.
- G. Ignition of the main flame is via direct spark, utilizing high voltage electrodes and a 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 provided.
- I. For ease of inspection and maintenance, the blower is hinged for easy swing away from the boiler permitting full inspection of the burner components, front tube sheet and furnace.
- J. A flame observation port is located at the top of the boiler.

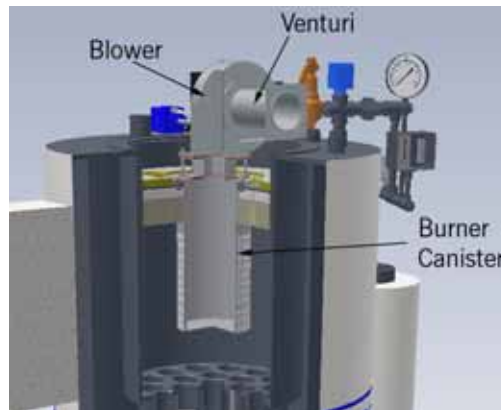


Figure B7-8. CFV Burner

5. Burner Gas Train

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

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

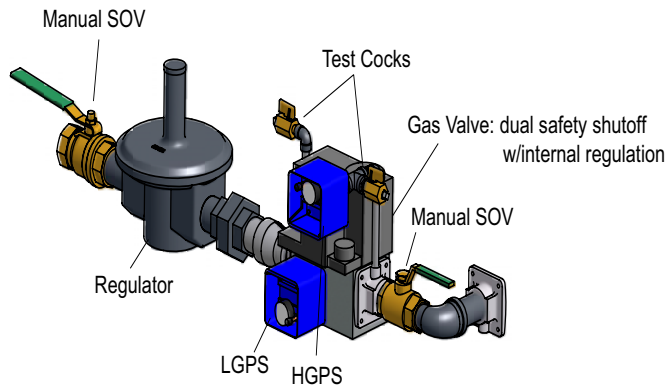


Figure B7-9. Gas Train

6. Boiler control panel

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

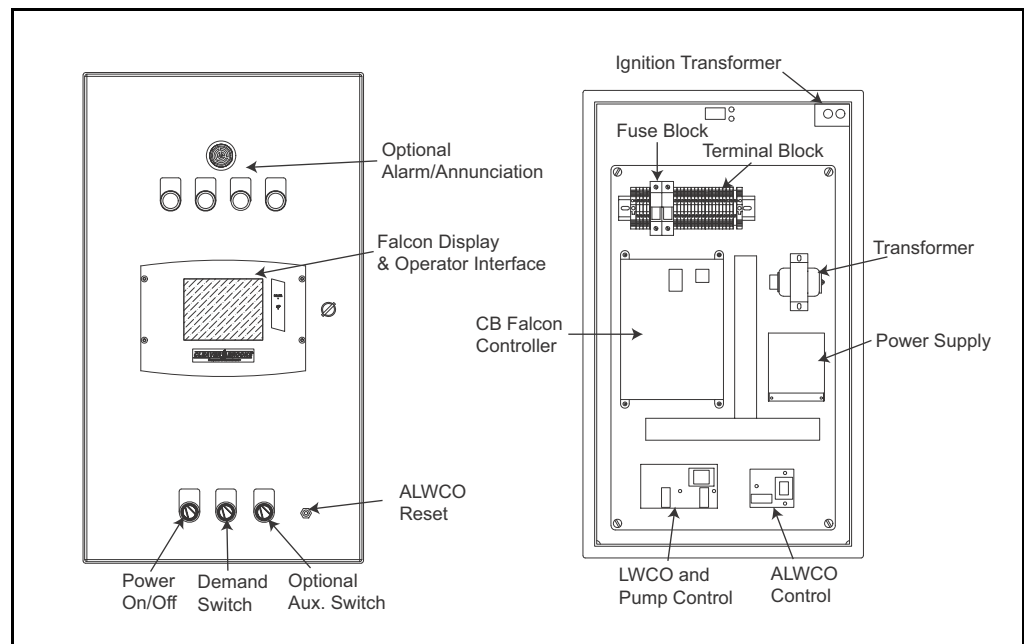


Figure B7-10. CFV electrical panel

Optional Equipment

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

- Bottom blowdown valves, shipped loose or mounted and piped
- Surface blowoff valve, shipped loose or mounted and piped

- Feedwater stop and check valves, shipped loose or mounted and piped
- Surface blowoff skimmer tube
- Steam stop valve, shipped loose or mounted and piped
- ASME hydro test of boiler piping
- Modbus communications
- Alarm light package
- Direct vent combustion air provision

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFV are shown in Figure B7-11 and Table B7-3. Connection sizes are given in Table B7-3 and ratings of each boiler size are noted in Table B7-4. Additional information is shown in the following tables and illustrations:

Table B7-5 Recommended steam nozzle sizes

Table B7-6 Minimum required gas pressure

Table B7-7 Safety valve outlet sizes

Table B7-8 Boiler room width

Figure B7-11. Model CFV Steam Boiler Dimensions

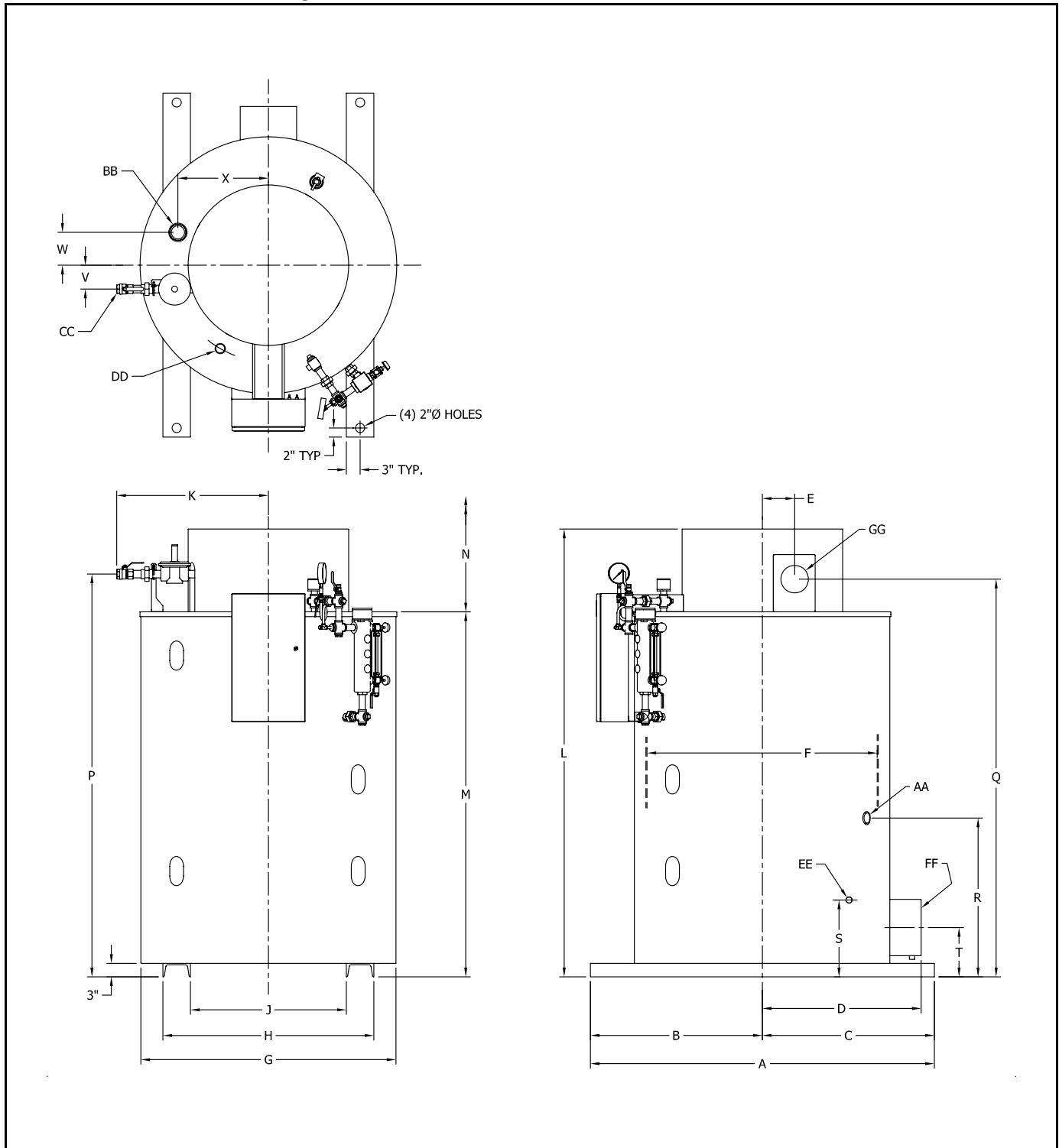


Table B7-3. Model CFV Steam Boiler Dimensions

		Boiler Horsepower							
Dimension		10	15	20	25	30	40	50	60
LENGTHS									
Overall	A	50	50	55	55	68	68	75	75
Centerline to Boiler Front	B	25	25	29	29	35	35	37.5	37.5
Centerline to Boiler Rear	C	25	25	26	26	33	33	37.5	37.5
Centerline to Stack Outlet	D	22.5	22.5	24.5	24.5	30.5	30.5	34.5	34.5
Centerline to Combustion Air Inlet	E	4	4	4	4	4	7	7	7
Boiler I.D.	F	27	27	34	34	42	42	51	51
WIDTHS									
Overall	G	32	32	39	39	47	47	56	56
Base, Outside of Channel	H	26	26	28	28	36	36	46	46
Base, Inside of Channel	J	14	14	16	16	24	24	34	34
Centerline to Gas Inlet	K	26	26	26	26	26	33	33	33
HEIGHTS									
Overall	L	84	90	84	90	86.5	92.5	99	105
Vessel	M	73	77	73	79	72	78	81	87
Top of Boiler Clearance	N	24	24	24	24	24	36	36	36
Floor to Gas Inlet	P	77	83	77	83	78.5	88.5	89.25	95.25
Floor to Air Inlet	Q	77	83	77	83	78.5	87.5	88.25	94.25
Floor to Feedwater Inlet	R	30	30	27	27	29.5	29.5	34.5	34.5
Floor to Drain/Blowdown	S	15.5	15.5	15	15	17	17	20	20
Floor to Stack Outlet	T	8.5	8.5	8.5	8.5	9	9	11	11
BOILER CONNECTIONS									
Horizontal Centerline to Gas Inlet	V	5	5	4.25	4.25	4.25	5.25	5.25	5.25
Horizontal Centerline to Steam Outlet	W	2	2	5	5	6.5	6.5	7.25	7.25
Vertical Centerline to Steam Outlet	X	11.4	11.5	14	14	17.5	17.5	19.75	19.75
Feedwater	AA	1	1	1	1	1	1	1-1/4	1-1/4
Steam Outlet	BB	1-1/2	1-1/2	1-1/2	1-1/2	2	2	3	3
Gas Inlet	CC	1	1	1	1	1-1/4	1-1/4	1-1/2	1-1/2
Surface Blowoff	DD	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Drain / Blowdown	EE	1	1	1	1	1	1	1-1/4	1-1/4
Stack O.D.	FF	6	6	6	6	8	8	10	10
Combustion Air Inlet ^A	GG	4	4	4	4	6	6	8	8
WEIGHTS - LBS									
Water Weight (Normal)		710	815	1195	1365	1795	2050	2715	3090
Approx. Dry Weight		2000	2120	2540	2780	3690	4030	5280	5740

Table B7-4. Model CFV Steam Ratings

Boiler H.P.	10	15	20	25	30	40	50	60
Ratings								
Rated Capacity - Steam	345	518	690	863	1,035	1,380	1,725	2,070
Output (1000 Btu/hr)	335	502	669	837	1,004	1,339	1,674	2,008
Fireside Heating Surface (sq.ft.)	84	103	128	159	208	258	312	388
Approximate Fuel Consumption At Rated Capacity								
Natural Gas Input (cfh) - 150# Steam ^A	413	620	826	1,033	1,240	1,653	2,066	2,479
Power Requirements - 60Hz	(Single Phase, 115 VAC)							
Blower Motor Size (Watts) ^B	335	335	335	335	335	750	1,200	1,200

Notes:

A. Input calculated at nominal 81% efficiency for 1000 Btu gas content

B. For altitudes above 700 ft, contact your local Cleaver Brooks authorized representative for verification of blower motor size.

Table B7-5. Model CFV Recommended Steam Nozzle Size

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

NOTES:

1. Steam nozzle sizes given in inches.

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

Table B7-6. Model CFV Gas Pressure Requirements

Boiler HP	Inlet pipe size (inches)	Minimum pressure required at gas train connection		Max. pressure inches w.c.
		Low Fire	High Fire	
10	1	7.2" w.c.	5.2" w.c.	28
15	1	7.3" w.c.	5.3" w.c.	
20	1	7.5" w.c.	5.5" w.c.	
25	1	7.7" w.c.	5.7" w.c.	
30	1.25	8.5" w.c.	6.8" w.c.	
40	1.25	11.0" w.c.	8.0" w.c.	
50	1.5	10.0" w.c.	7.0" w.c.	
60	1.5	10.0" w.c.	8.0" w.c.	

Table B7-7. Model CFV Steam Boiler Safety Valve Outlet Size

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

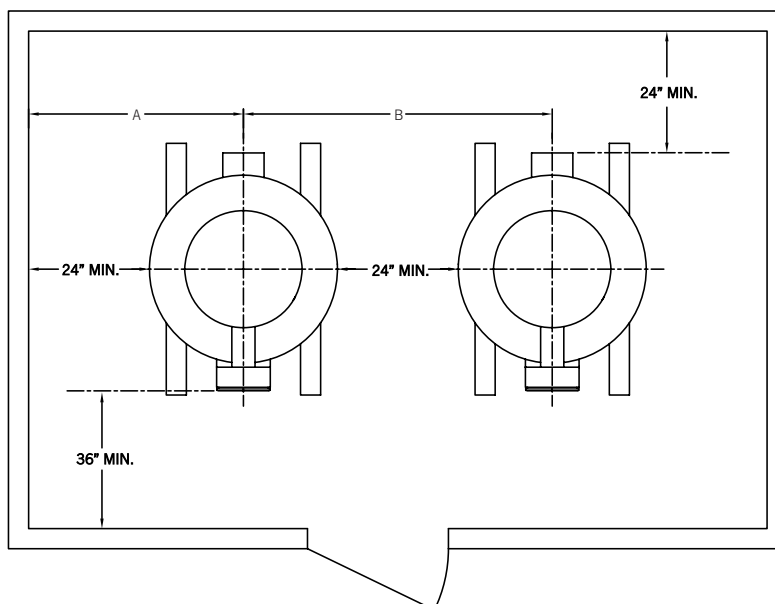
NOTE: Valve manufacturers are K unkle, Consolidated or Conbraco, depending on availability.

Table B7-8. Clearances

BOILER HP	10-15	20-25	30-40	50-60
DIM. "A"	40	44	48	52
DIM. "B"	62	63	71	80

NOTES:

1. Recommended Minimum Distance Between Boiler and Wall. Dimension "A" allows for a clear 24" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended Minimum Distance Between Boilers. Dimension "B" between boilers allows for a clear aisle of 24". If space permits, this aisle should be widened.
3. Clearance above boiler 36".



PERFORMANCE DATA

Table B7-9 shows predicted fuel-to-steam efficiencies for the Model CFV.

The specified boiler efficiency is based on the following conditions:

- Natural Gas
Carbon, % by weight = 69.98
Hydrogen, % by weight = 22.31
Sulfur, % by weight = 0.0
Heating Value, Btu/lb = 21,830
- Efficiencies are based on ambient air temperature of 80 ° F (27 ° C), relative humidity of 30%, and 15% excess air in the exhaust gas stream.
- Efficiencies are based on the manufacturer's published radiation and convection losses; see Table B7-10.
- Any efficiency verification testing will be based on the stack loss method.
- Nominal feedwater temperature of 190° F (88 ° C) or greater.

Table B7-9. Predicted Fuel-to-Steam Efficiencies

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
10	81.8	82.3	82.2	82.1
15	81.7	82.2	82.0	81.8
20	81.5	81.6	81.2	80.7
25	81.6	81.9	81.6	81.2
30	81.8	82.3	82.2	82.0
40	81.8	82.4	82.3	82.2
50	81.4	81.6	81.1	80.6
60	81.6	81.9	81.6	81.3

Table B7-10. Model CFV Radiation and Convection Losses

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

The emission data included in Table B7-11 consists of typical controlled emission levels of the Model CFV boiler. Because of the premix burner technology, the standard burner provided with the CFV package provides low emissions as standard without the need for external or special devices.

Table B7-12 shows predicted sound levels at high fire.

Table B7-11. Model CFV Boilers: Natural Gas, Estimated Emission Levels

POLLUTANT	UNITS	
CO	ppm ^A	50
	lb/MMBtu	0.04
NO_x	ppm ^A	20
	lb/MMBtu	0.024
SO_x	ppm ^A	1
	lb/MMBtu	0.001
HC/VOC₅	ppm ^A	10
	lb/MMBtu	0.004
PM	ppm ^A	-
	lb/MMBtu	0.01

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

Table B7-12. Predicted sound levels

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

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

ENGINEERING DATA

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

Feedwater

Steam boilers require make-up water for steam production. This make-up can be a combination of condensate return and raw make-up or in some instances, 100% raw make-up. Proper treatment of make-up water is essential to the longevity and performance of the boiler. Table B7-13 shows the rate of make-up required and Table B7-14 shows the water quality guidelines.

Table B7-13. Feedwater flow rates

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

Feedwater flow is at maximum firing rate, 212°F steaming capacity

Table B7-14. Model CFV Water Quality

Constituent	Level
Hardness	1.0 ppm max.
Iron	0.1 ppm max.
pH	8.3 - 10.5
Suspended Solids	300 ppm max.

Blowdown

As steam is produced, unwanted solids are left behind in the water and become concentrated within the vessel. If these constituents are allowed to adhere to the heat transfer surfaces they will impede the flow of energy. Their removal requires proper blowdown - either bottom, surface, or both. Table B7-15 shows the recommended blowdown tank requirements for bottom blowdown. The surface blowdown requirement is relative to the water quality and to the level of TDS control desired by the water treatment specialist. Local codes will dictate the manner of treating blowdown effluent.

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

Table B7-15. Model CFV Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
10	3
15	3
20	6
25	6
30	8
40	8
50	12
60	12

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

Stack/Breeching Criteria

General - The ClearFire Model CFV is a Category III Boiler according to ANSI Z21.13. This code defines a Category III boiler as one that operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore the stack must be a positive pressure design.

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

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

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

Whenever two or more CFV boilers are connected to a common breeching /stack, a

mechanical draft control system may be required to ensure proper draft at all times. Cleaver-Brooks recommends individual stacks for multiple boiler installations.

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

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA54 (the National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B14 9.1 and B14 9.2 for Canadian installations.

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

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

Unconfined Spaces

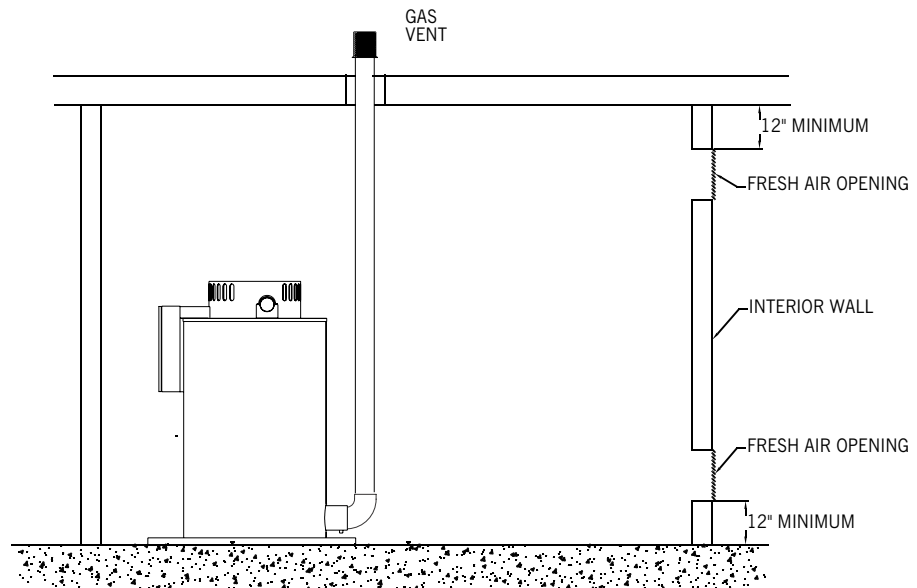
All Air From Inside the Building - If combustion air is drawn from inside the building (the mechanical equipment room does not receive air from outside via louvers or vent openings and the boiler is not equipped with direct vent) and the boiler is located in an unconfined space, use the following guidelines:

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

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

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

See Figure B7-12; refer to the NFGC for additional information.

Figure B7-12. Inside Air - Two Opening Method

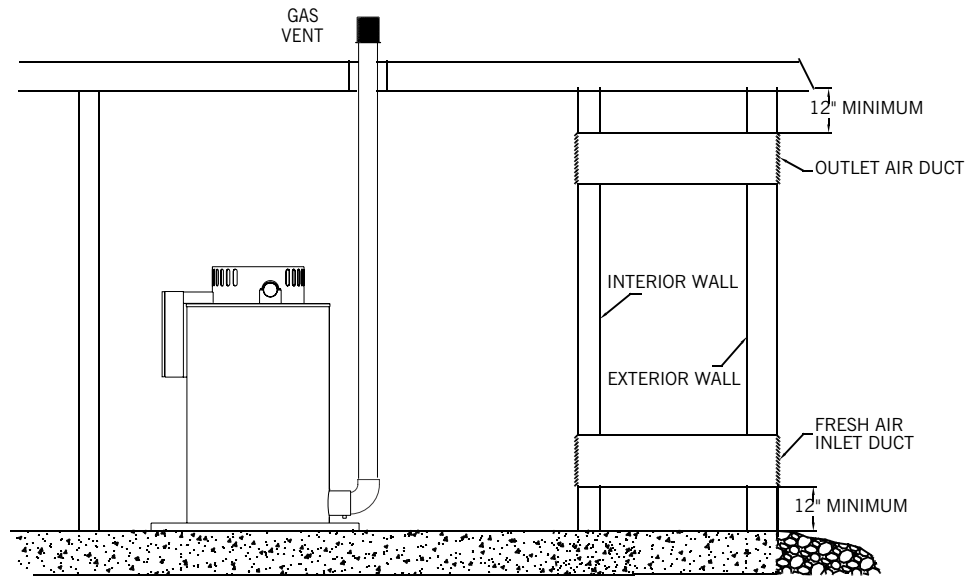
All Air From Outdoors - If all combustion air will be received from outside the building (the mechanical room is linked with the outdoors), the following methods can be used:

Two Opening Method (Figure B7-13) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches from the bottom of the room.

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

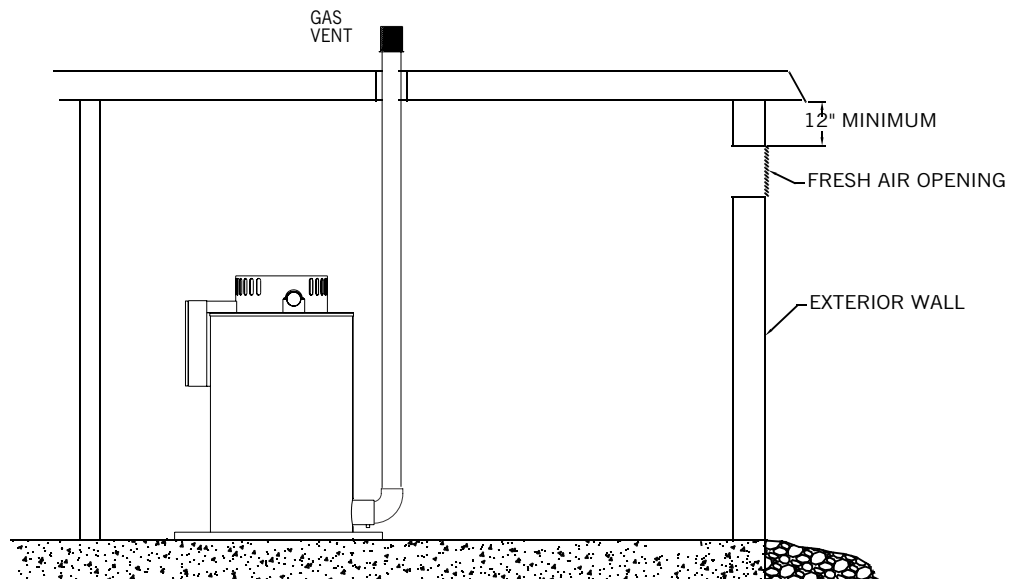
B. Each opening must have a minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the room, when the opening is directly linked to the outdoors or through vertical ducts.

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

Figure B7-13. Two Opening Ducted Method

One Opening Method (Figure B7-14) - One permanent opening, commencing within 12 inches of the top of the room shall be provided.

- A. The equipment shall have clearances of at least 1 inch from the sides and back and 6 inches from the front of the appliance.
- B. The opening shall directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 Btu's per hour of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the unconfined space.
- C. Refer to the NFGC for additional information.

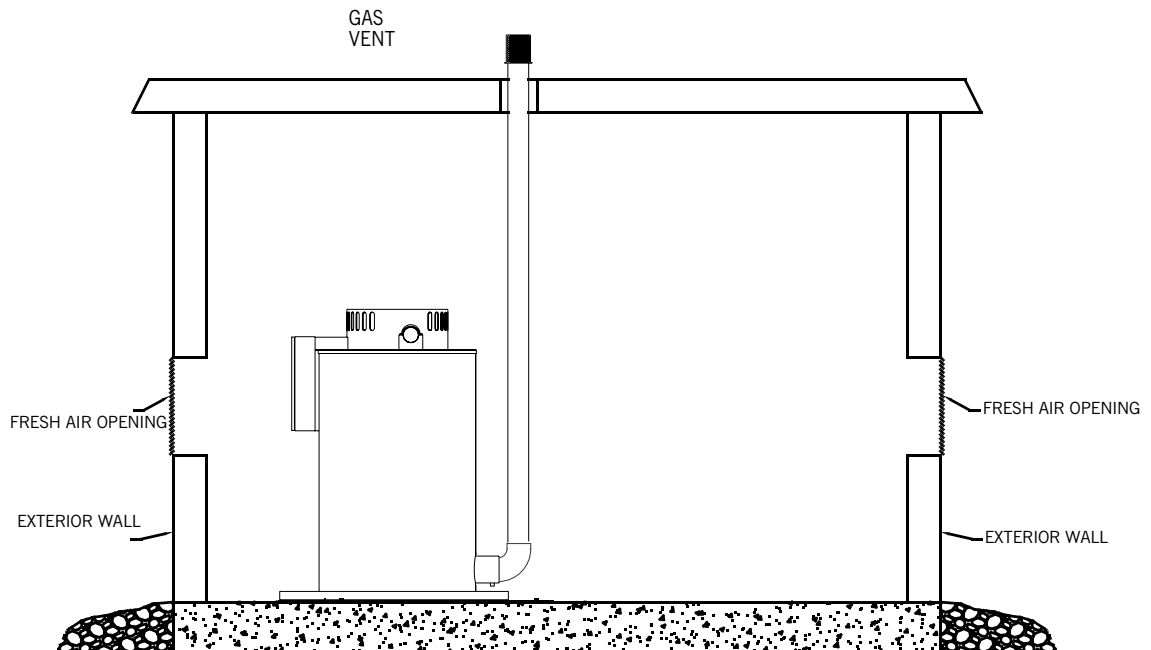
Figure B7-14. One Opening Method

Unconfined Spaces

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

A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler (see Figure B7-15).

Figure B7-15. Engineered Method



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

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

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

E. Size the openings by using the formula ($\text{Area in ft}^2 = \text{cfm}_a / \text{fpm}_a$), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.

F. Amount of air required (cfm):

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

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

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

Example of required air openings (Engineered Method):

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

Total boiler horsepower (bhp): $60 \times 2 = 120$ bhp

From F.3 above, total air required = $120 \text{ bhp} \times 10 = 1200$ cfm.

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

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

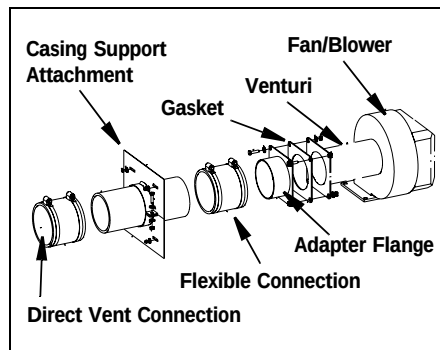
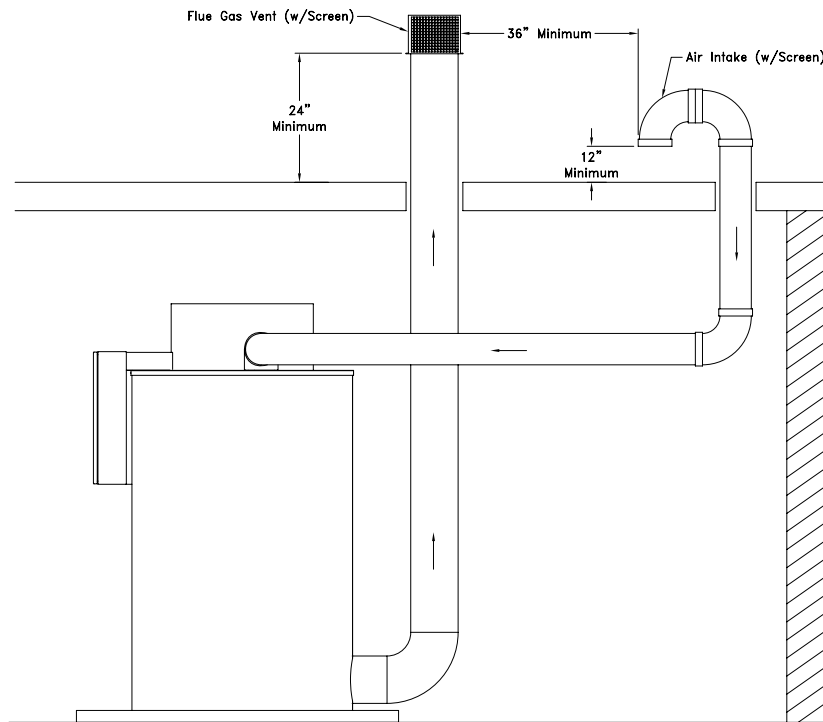
Area/Opening: 4.8 divided by $2 = 2.4 \text{ ft}^2$ per opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

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

1. Install combustion air duct in accordance with local codes and the boiler operating and maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. Duct material can be PVC or metallic vent material. It should be air tight to prevent in leakage of air during operation.
4. Maximum pressure drop for the duct shall not exceed 0.25" w.c. negative. If this pressure drop is exceeded a larger size duct is recommended.
5. Multiple boilers may be connected to a single duct with take-offs to each boiler.
6. If the duct will run horizontally to an outside wall, it is recommended that the duct have a slight downward slope away from the burner intake to prevent collected moisture from draining into the burner connection.
7. If the outside air is dust-laden or the installation is near a heavily traveled roadway, it is recommended that an air filter be installed to prevent intake of contaminants that could accumulate on the burner canister.

Figure B7-16. Direct Vent Combustion**Figure B7-17. Direct Vent Combustion kit**

Gas Piping

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

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

Gas Pressure Requirements - For proper and safe operation, each Model CFV boiler requires a stable gas pressure input. The pressure requirements are listed in the O&M

manual and current specifications and are added here (Table B7-6) for reference purposes.

The minimum inlet supply pressure must be as noted in Table B7-6 when firing the boiler at low fire and high fire. Actual gas pressure should be measured when the burner is firing using a manometer at the upstream test port connection on the main gas valve. For a multiple unit installation, gas pressure should be set for a single unit first, then the remaining units should be staged on to ensure that gas pressure droop is not more than 1" w.c. and never below the required pressure. Fluctuating gas pressure readings could be indicative of a faulty supply regulator or improper gas train size to the boiler.

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

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c. a "full lock-up" type regulator is recommended along with proper overpressure protection (e.g. relief valve). In addition to the regulator, a plug type or "butterball type" gas shutoff cock should be installed upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the unit during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Before starting the unit(s) all piping must be cleaned of all debris to prevent its' entrance into the boiler gas train. Piping should be tested as noted in NFPA 54 and the boiler must be isolated during any tests.

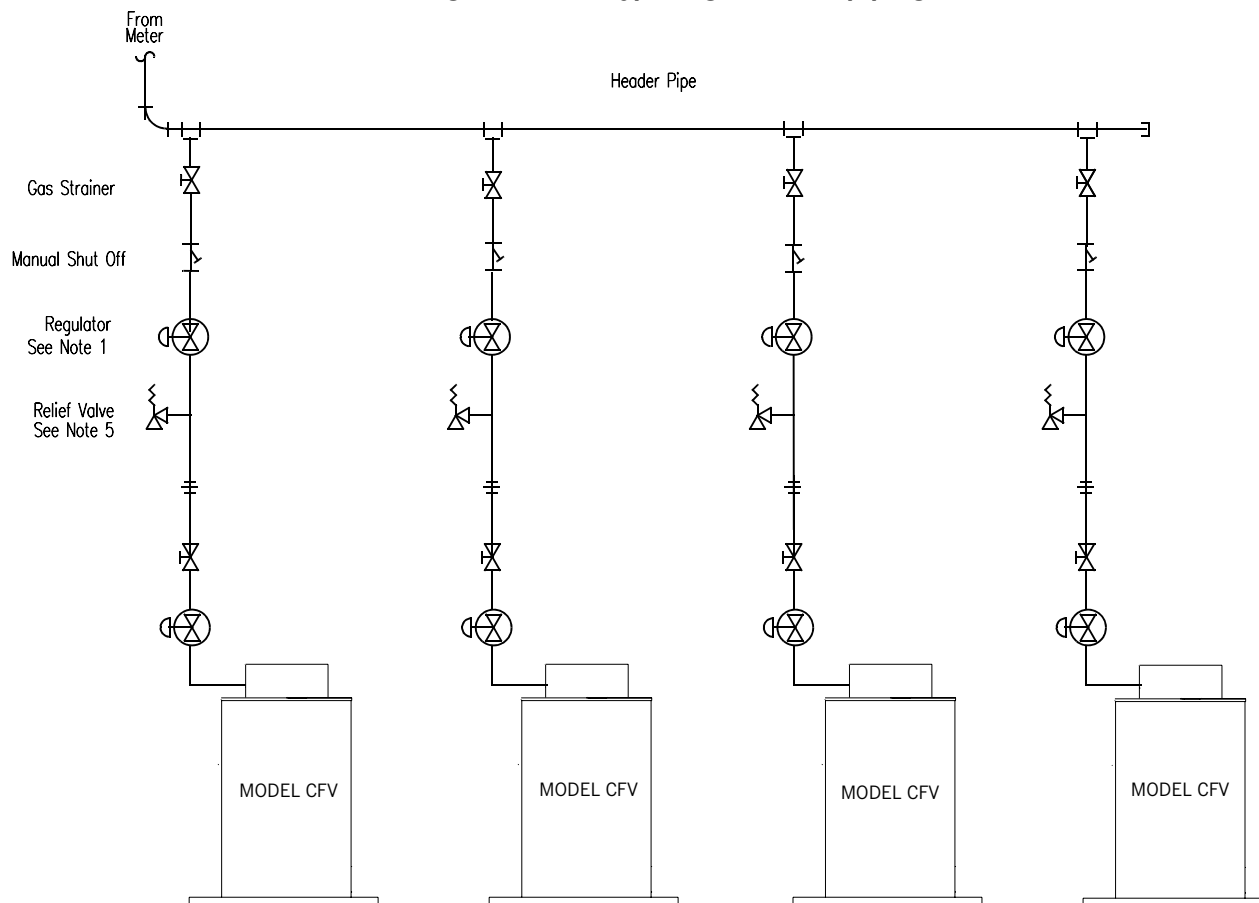
After initial startup, the inlet screen to the gas valve should be checked and cleaned for any debris buildup

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

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

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final unit connection. As a minimum guideline, gas piping Tables B7-16 through B7-21 should be used. The data in these tables is from the NFPA 54 source book, 2006 edition.

To verify the input of each device that is connected to the gas piping, obtain the btu/hr input and divide this input by the calorific value of the gas that will be utilized. For instance, a 40 HP unit with 1,613,253 btu/hr input divided by a gas calorific value of 1060 will result in a CFV flow of 1,522. The single boiler is approximately 20 feet from the gas supply header source. And with a measured gas supply pressure of 10" w.c. we find from Table 16 that a supply pipe size of 2" should be used as a minimum.

Figure B7-22. Typical gas header piping**NOTES:**

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

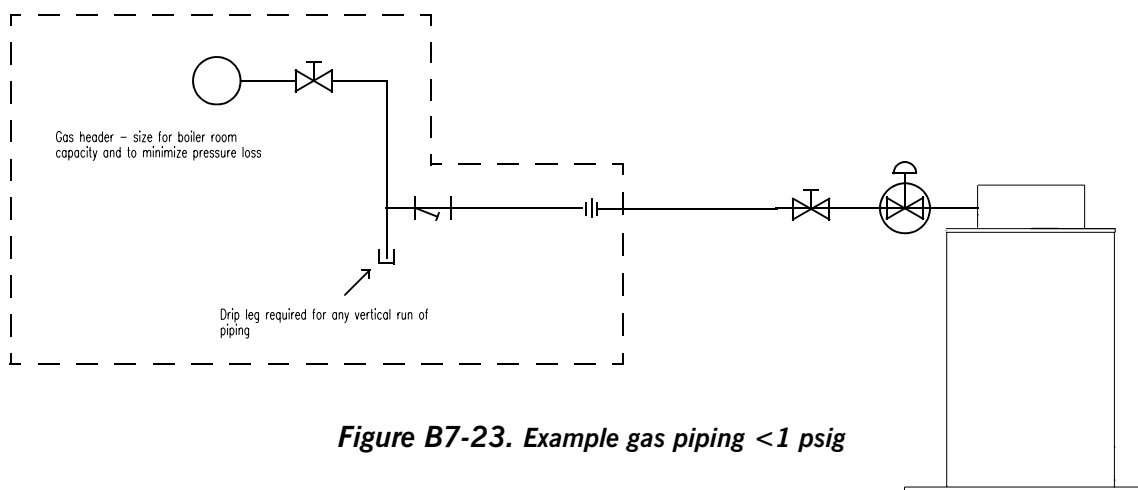
**Figure B7-23. Example gas piping <1 psig**

Table B7-16. Gas line capacity - Schedule 40 metallic pipe

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

Table B7-17. Gas line capacity - Schedule 40 metallic pipe

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

Table B7-19. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (CFV)								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	57,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	954	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
1000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
**Fuel: Natural Gas									
**Inlet Pressure: 2.0 psi									
**Pressure Drop: 1.0 psi									
**Specific Gravity: 0.60									

Table B7-20. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (CFV)								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	75,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,300	20,300	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,300
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
500	283	593	1,120	2,290	3,430	6,610	10,300	18,600	38,000
1000	195	407	897	1,380	2,360	4,550	7,240	12,000	26,100
1500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
**Fuel: Natural Gas									
**Inlet Pressure: 3.0 psi									
**Pressure Drop: 2.0 psi									
**Specific Gravity: 0.60									

Table B7-21. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (CFV)								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
1000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400
**Fuel: Natural Gas									
**Inlet Pressure: 5.0 psi									
**Pressure Drop: 3.5 psi									
**Specific Gravity: 0.60									

Gas Header - For multiple unit installations, a single common gas header is recommended with individual takeoffs for each boiler (See Figure B7-22). Boiler gas manifold piping should be sized based on volume requirements and lengths between each boiler and the fuel main header. Tables B7-22 through B7-29 indicate the proper sizing for multiple units of equal size, placed on the factory standard center with the indicated take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, determine length of run from the source and determine what size header will be needed for the flow of all units firing. Pipe sizes are based on Table B7-16 with boiler gas line take-off at 20 feet from the header. If pipe runs are greater or if gas pressure is different, refer to the Tables for pipe sizing.

Pipe sizing for multiple unit manifolds

Table B7-22. CFV 10 HP Boilers

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

Table B7-23. CFV 15 HP Boilers

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

Table B7-24. CFV 20 HP Boilers

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

Table B7-25. CFV 26 HP Boilers

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

Table B7-26. CFV 30 HP Boilers

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

Table B7-27. CFV 40 HP Boilers

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

Table B7-28. CFV 50 HP Boilers

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

Table B7-29. CFV 60 HP Boilers

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

SPECIFICATIONS

MODEL CFV PRODUCT SPECIFICATIONS

1.0 GENERAL BOILER DESIGN

- A. The boiler shall be a Cleaver-Brooks Model CFV 700, single pass vertical commercial Firetube design or approved equal. It shall be mounted on a heavy-duty steel frame with premix forced draft burner and burner controls as a complete package from one manufacturer.
- B. Approvals - The complete package including the burner shall be Underwriters Laboratories, Inc. listed and the official UL/cUL label shall be affixed to the package attesting to its certification.
- C. As a preassembled package, the standard boiler shall be factory fire tested.
- D. The complete package as shipped, shall be ready for connections to water, fuel, blowdown, and exhaust venting. Certain items may be shipped loose to prevent their damage such as the safety valves and gauges.
- E. The specified boiler shall have an output rating of _____ horsepower when fired with Natural Gas [LP Gas] with a gas supply pressure of _____" w.c. Power supply to the boiler shall be 115/1/60 or 50Hz. Design pressure shall be 150# steam. Operating characteristics shall be [____] psig steam. Steam boilers shall be supplied with _____ degrees F make-up water @ _____%.
- F. Performance: shall be as specified in Paragraph 5 below.

1.1 BOILER SHELL

- A. The boiler shell must be constructed in accordance with the ASME Code, either Section I for high-pressure steam or Section IV for low-pressure steam. The vessel must be subjected to the required inspections of the Code conducted by an independent third party inspector. A signed inspection sheet shall be provided to the purchaser and the appropriate ASME symbol shall be affixed or stamped onto the boiler.
 - 1. Boiler shall be mounted on base rails suitable for transporting by fork lift.
 - 2. Burner housing shall be removable or hinge-mounted (50-60 HP) to allow tube inspection.
 - 3. Each carbon steel boiler tube shall utilize the AluFer heat transfer design technology for high efficiency and reduction in overall size of the vessel and shall be a minimum of 0.105 tube wall thickness.
 - 4. To facilitate waterside inspection, 3 hand holes shall be provided.
 - 5. An observation port for flame inspection shall be provided.
 - 6. Boiler insulation shall consist of 2-inch fiberglass blanket, which shall be covered with a 304 SS sheet metal jacket. This jacket and insulation design shall permit field removal and reattachment if necessary for inspection, etc.
 - 7. The entire boiler and base frame shall be factory painted.
 - 8. Exhaust vent shall be located at the rear of the boiler and shall be a slip connection. Stack support shall be by means other than the boiler connection.

1.2 BOILER SHELL TAPPINGS/OPENINGS

- A. The following boiler vessel tappings/openings shall be furnished:

1. Steam supply by NPT connection for high-pressure steam.
2. Bottom blowdown.
3. Feedwater Make-up.
4. Surface blowoff.
5. Chemical Feed.
6. High Water Level Overflow Drain to discharge water in the boiler if water level reaches an unacceptable level.

2.0 STEAM BOILER TRIM (All piping and devices per ASME CSD-1)

A. Water Column

1. A water column shall be furnished complete with gauge glass and water column blowdown valve.
 - a. Feedwater Pump control - shall be integral with the water column via probe control device and electronics for on/off pump operation.
 - b. Low Water cutoff - shall be integral with the water column via probe control device and solid state electronics mounted and wired in the control panel.
- B. An Auxiliary Low Water Cutoff shall be provided. It shall be located on the top centerline of the boiler using an internal probe and of the manual reset design.
- C. For safety steam pressure lockout a high limit pressure control, manual reset shall be provided. The device shall be mercury free.
- D. To provide steam demand tracking a steam pressure transmitter shall be provided that provides an input signal for burner positioning in accordance to steam demand.
- E. A 3" Steam Pressure Gauge shall be piped onto the trim piping, including an inspectors test cock.
- F. In accordance with the A.S.M.E. Code an approved A.S.M.E. rated and stamped safety valve shall be provided and set at 150#.

3.0 BURNER AND BURNER CONTROLS

- A. Mode of Operation - to minimize short cycling and provide highest efficiency the burner for the specified boiler shall be of the electronic modulation with a turndown ratio of 5:1 for Natural Gas for sizes of 40 horsepower and greater, and 4:1 for sizes below 40 horsepower. On/off or low/high burner operation shall not be accepted.
- B. The burner shall be enclosed in a NEMA 1 type enclosure. A lift off top cover shall be provided to gain access to the burner and controls.
- C. Design - The burner design shall be of the linkage-less premix technology wherein the fuel and air are mixed in the fan housing assembly prior to entering the burner canister. Separately driven linkage or servo motor driven fuel and air valves shall not be permitted.
 1. Fan housing shall utilize non-sparking material and shall be approved for premix operation.
 2. The fan shall be driven by a variable speed motor which shall react to output demand requirements via the demand control Motor shall be a high efficiency DC Brushless type. Continuous speed synchronous motors will not be acceptable.
- D. Ignition of the fuel shall be of the direct spark design; separate pilot gas train is not required. Dual ignition electrodes shall used for the spark generated from the panel mounted ignition transformer.

- E. Combustion shall take place on the surface of the burner canister. The canister shall be constructed of Fecralloy material and stainless steel and shall be warranted for five years against failure from defects or poor workmanship.
- F. Air Filter - shall be fitted to the intake air venturi to filter the incoming air supply when using boiler room air. The air filter shall be designed to be easily cleaned and re-used.
- G. Fuel - The burner shall be designed for operation with natural gas or LP gas. Gas Train, shall be located at the front of the burner and along the left side of the boiler. In accordance with UL/cUL and ASME CSD-1, the following components shall be furnished:
 - 1. Single body dual solenoid safety shutoff valve incorporating the following:
 - a. The valve shall be a 1:1 ratio valve with an integral trim regulator and shall operate in relation to the fan speed. An air sensing line shall be connected from the air inlet venturi (mounted to the fan motor) and to the gas valve for control of gas input.
 - b. As fan speed increases a negative pressure will be applied to the valve, allowing the valve to open further, permitting more fuel to flow into the venturi for mixing. As fan speed is reduced, fuel input shall be reduced accordingly. Air shall always lead fuel from low to high or high to low.
 - 2. Manual fuel shutoff valve - shall be located downstream of the gas valve and used for CSD-1 leak testing.
 - 3. Gas Pressure Interlocks - one shall be provided for sensing high gas pressure and one provided to sense low gas pressure. Each control shall be of the manual reset type.
 - 4. Gas Pressure Regulator - shall be provided upstream of the gas valve to provide regulated pressure to the gas train from the gas supply. This regulator shall be suitable for a maximum of 1 psig gas pressure. If gas pressure exceeds 1 psig, a gas pressure relief valve shall be furnished and upstream pressure regulator that is of the full lockup type.
 - 5. Manual Shutoff Valves - shall be provided upstream of the gas regulator to manually close off the gas supply when servicing the gas train or isolating the boiler. A shutoff valve shall be provided at the burner for tightness checking of the gas valve.
 - 6. Combustion Air Proving Switch shall be provided to prove, prior to modulation that the fan is operating properly.

H. Flame Safety

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

4.0 CONTROL PANEL - A NEMA 1 type enclosure is furnished and located at the front of the boiler above the burner to house the following components:

- A. Falcon controller combining flame supervision, burner sequencing, modulating control, and operating limit control.
- B. Falcon touchscreen display/operator interface
- C. Boiler Control Circuit On/Off switch.
- D. Demand switch.
- E. Terminals for control interface wiring, customer connections, and connections for incoming power.
- F. Solid state circuit boards for water level controls.
- G. Selectable Options:

Alarm Light Package to provide indication of Low Water, Flame Failure, Load Demand, Fuel Valve On, including a horn with silence switch for alarm conditions.

- H. When multiple boilers are to be installed together, a system integration control shall be provided to stage up to 8 boilers. The control shall include automatic selection of needed boilers based on demand. The control shall force each boiler to a lower fire before allowing any boiler to operate at high fire, thus allowing 'inverse efficiency' (higher efficiency at lower firing rates). The control shall monitor supply header pressure and shall communicate with boilers via RS-485 wiring.

5.0 PERFORMANCE

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

- A. Efficiency - For 150# steam operating at 125#, the guaranteed Fuel to Steam Efficiency shall be 81%. Efficiency rating shall account for radiation and convection losses.
- B. Emissions - NO_x emissions shall be less than 20 PPM corrected to 3% O₂ and less than 10 PPM CO over the operating range of the burner turndown. If emissions exceed this level, the boiler manufacturer shall correct at their expense until this level is achieved on a repeatable basis.
- C. Radiation losses shall be less than 0.5% of the rated input at maximum firing.
- D. Steam quality shall be 99.5% at maximum firing regardless of operating pressure.

6.0 WARRANTY

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

FLEXIBLE WATERTUBE BOILERS

1.5 – 12.0 MMBTU/H
Steam and Hot Water



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Table B1-18. Model FLX Combustion Air Requirements.....	B1-25

This section contains information on the Flexible Watertube boiler. The product model name is “FLX” for factory-assembled boilers, and “FLE” for field-erectable boilers. It is available in sizes ranging from 1.5 to 12 MMBtu/hr input.

Cleaver-Brooks offers the Model FLX “bent-tube” boiler to meet today’s demanding commercial user’s needs. The flexible watertube design has distinct advantages, including resistance to thermal shock and easy boiler maintenance. In addition Model FLX boilers offer high operating efficiency. These combined factors equate to a real increase on the return from your boiler room investment.

FEATURES AND BENEFITS

A.S.M.E. Construction:

- Built in accordance with the ASME Code, ensures design integrity for long life.
- Ensures safety and reliability with third party inspection of standards compliance.

Underwriters Package Label [UL/cUL]:

- Ensures the complete package [burner/boiler] has been tested and certified to the UL standards of safety and controls requirements.

High Turndown Burner:

- For standard emissions [uncontrolled], up to 10:1 turndown on Gas firing, reduces inefficient on/off operation, reducing fuel consumption.
- Boiler stays on line during low load conditions for optimum efficiency and performance.
- Airfoil damper design eliminates low fire excess air spikes, increasing combustion efficiency.
- Boiler/burner by single manufacturer eliminating divided responsibility.

Hinged Burner Design:

- Standard for all sizes of the Elite series and sizes 400 and greater on the Premium series, optional for Premium series sizes 350 and less.
- Burner assembly is attached to the front boiler wall with integral hinges, permits burner swing out for ease of service, maintenance, and inspection.

Swedge-Fitted Tube Attachment:

- Eliminates welded tube attachment to each drum providing ease of tube replacement.
- Eliminates rolling or welding of tube replacement, reduces maintenance costs.

Thermal Stress Protection:

- 25 Year Thermal Shock Warranty ensures tube integrity against thermal stress, associated with hydronic heating systems.
- Bent tube design provides ability to withstand thermal stress of tubes during rapid load swings and cold water returns.

Removable Side Panel Casing:

- Sectional side panels easily remove to provide access to each tube eliminates total casing removal for tube access.
- Reduces maintenance time and costs.

Field Assembly Option:

- Boiler can be erected on the project site where access space is minimized.
- Pressure vessel parts, tubes, burner and controls can fit through a standard doorway, elevator shaft or reduced side wall opening or window.

PRODUCT OFFERING

Information in this section applies to steam and hot water boiler sizes ranging from 1.5 to 12 MMBtu/hr input, as shown in Table B1-1.

The Flexible Watertube Boiler is a five-pass steel boiler with flexible tubes formed and arranged to direct the flow of combustion gases through the boiler. The pressure vessel conforms to Section I or Section IV of the ASME Code, and consists of the formed tubes and the external downcomer connected to the top and bottom drums. The heated area of the pressure vessel is contained within a gas-tight, insulated casing that is composed of removable, formed-steel panels. The boiler/burner package is manufactured by Cleaver-Brooks and UL/cUL approved as a package.

Table B1-1. Model FLX Watertube Boiler Sizes

MODEL	CAPACITY INPUT BTU/HR	HEAT OUTPUT BTU/HR	EQUIV HP
FLX-150	1,500,000	1,200,000	36
FLX-200	2,000,000	1,600,000	48
FLX-250	2,500,000	2,000,000	60
FLX-300	3,000,000	2,400,000	72
FLX-350	3,500,000	2,800,000	84
FLX-400	4,000,000	3,200,000	96
FLX-450	4,500,000	3,600,000	108
FLX-500	5,000,000	4,000,000	119
FLX-550	5,500,000	4,400,000	132
FLX-600	6,000,000	4,800,000	143
FLX-700	7,000,000	5,600,000	167
FLX-800	8,000,000	6,400,000	191
FLX-900	9,000,000	7,200,000	215
FLX-1000	10,000,000	8,000,000	239
FLX-1100	11,000,000	8,800,000	263
FLX-1200	12,000,000	9,600,000	287

NOTES:

1. Standard design pressure: 160 psig Hot Water, 15 psig Steam, and 150 psig Steam.
2. Also available as field erect and designated as Model FLE

Standard Equipment: Equipment described below is for the standard factory package offering.

1. Boiler:

- A. All boilers are designed and constructed in accordance with the ASME Code.
- B. Each vessel is mounted on an integral base frame; refractories for the boiler and burner are installed.
- C. Each vessel receives a factory hydro test with third party witness.
- D. ASME Code Stamped and National Board Registered.
- E. For Canadian installations, appropriate CRN Stamping.

Notice

Hot water boilers with design pressures up to 160 psig, and with design temperatures less than 250 °F, are constructed under Section IV of the ASME Code, and 'H' stamped for low- pressure heating boilers.

Notice

Steam boilers with design pressure of 15 psig, and maximum allowable operating pressure of <15 psig, are constructed under Section IV of the ASME Code, and 'H' stamped for low pressure heating boilers.

Notice

Steam boilers with design pressure of 150 psig are constructed under Section I of the ASME code and "S" stamped for high pressure steam boilers.

2. Forced Draft Burner, Cleaver-Brooks ProFire™ V Series:

- A. Mounted on a hinged backing plate for easy access to furnace.
Note: Standard on all sizes Elite Series and sizes 400 and larger Premium Series.
- B. Pressure atomizing type for No. 2 oil burner. This includes the oil pump.
- C. Stainless steel flame-retention type combustion head for gas, with UV scanner and gas pressure regulator.
- D. External access to flame scanner for ease of maintenance.

3. Water/Steam Controls:

- A. ASME safety relief valve(s).
- B. Pressure and temperature gauges for hot water boilers. C. Pressure gauge for steam boilers.
- D. Operating and limit controls:
- E. High limit control - manual reset.
- F. Operating limit control - automatic reset. G. Modulating or proportional controller.
- H. Low water cutoff:
 - Probe type - hot water.
 - Float type main and probe type auxiliary for steam.
- K. Pump Control - steam boilers.

4. Altitude: Standard boilers attain full ratings at altitudes up to 2,000 feet.
Altitude compensation for most models is available for altitudes up to 10,000 ft above sea level.

Optional Equipment

1. Boiler Options

- Auxiliary low water cut-off (hot water).
- Stack thermometer.
- Insulated downcomer(s). (Standard for Elite Series)
- Drain valves.
- Additional screwed tappings.
- Packaged for field erection.

2. Burner/Control Options

- Special burner modulation controls.
- Low NOx burner.
- Optional flame safeguard controller.
- Lead/lag system.
- High altitude design - up to 10,000 ft.
- Special insurance and code requirements (e.g., XL-GAPS, FM, ASME CSD-1).
- Alarm Horn/silence switch.
- Special motor requirements (TEFC, high efficiency).
- Remote contacts.
- Additional relay points and indicator lights.
- Main disconnect (fusible/circuit breaker).
- Optional NEMA enclosures.
- Key lock panel.
- System pump interlock.
- Low fire hold controls.
- Assured low fire cut-off.
- Flow switches.
- High stack temperature cut-off/alarm.
- Remote emergency shutoff (115V).

3. Fuel Options

- Special gas pressure regulator.
- Oversized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Digester Gas.
- Remote oil pump set.
- Special pilot.
- Direct spark oil ignition.
- Automatic fuel changeover.

DIMENSIONS AND RATINGS

Figure BB 1-FLX Steam Dimension Drawing

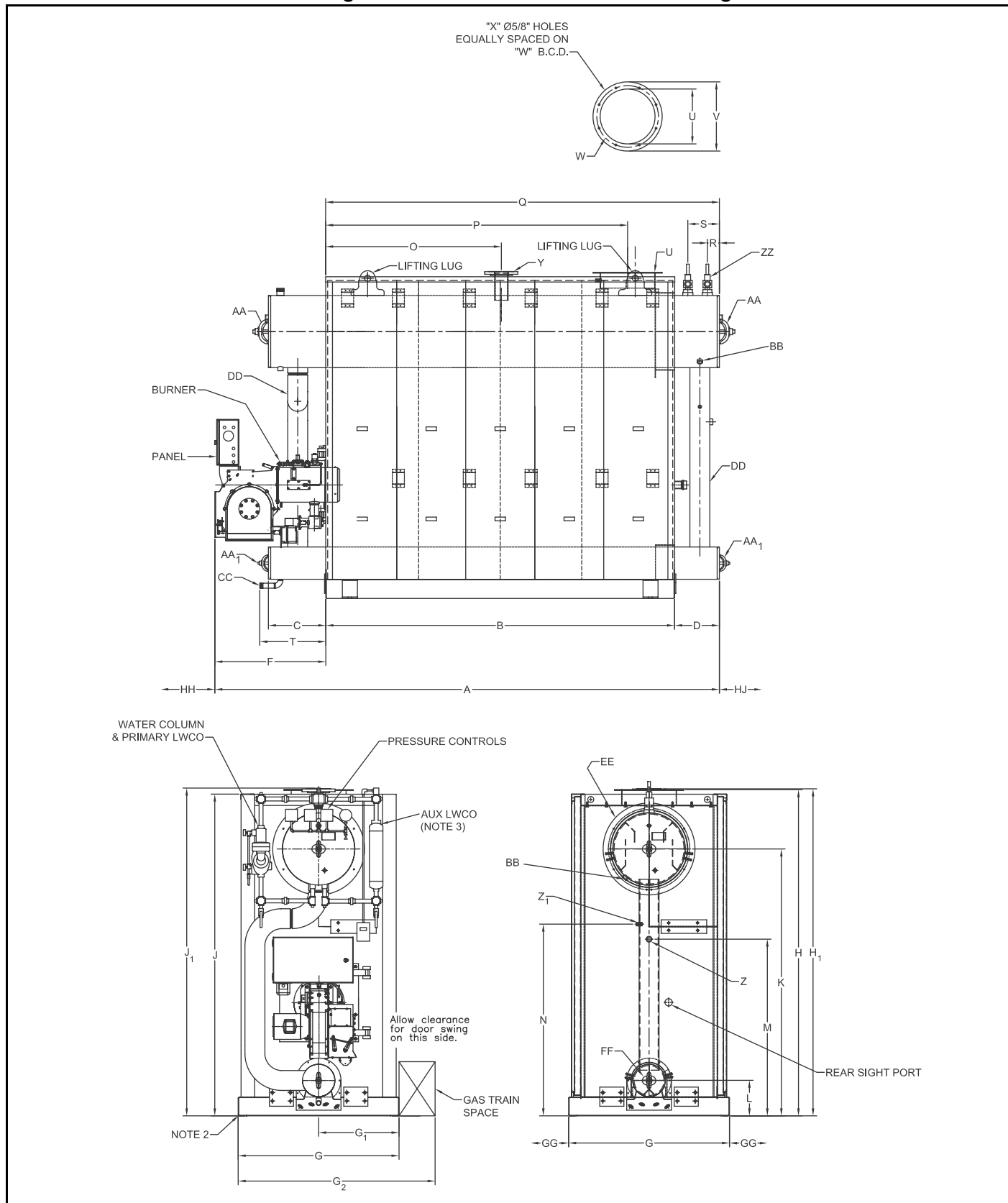


Table B1-2. FLX Steam Dimensions Sizes 150-500

		BOILER SIZE - NOTE 1							
	Dim.	150	200	250	300	350	400	450	500
LENGTHS Inches									
Overall	A	108	108	108	114	114	139	139	139
Boiler Base Frame	B	68	68	68	74	74	94	94	94
Front Extension Lower Drum	C	15	15	15	15	15	17	17	17
Rear Extension Lower Drum	D	13	13	13	13	13	13	13	13
Burner Extension	F	27	27	27	27	27	31	31	31
WIDTHS Inches									
Boiler Base Frame [See Note 2]	G	42	42	42	46	46	48	48	48
Centerline to Casing	G ₁	41	41	41	23	23	24	24	24
Width to outside of Gas Train	G ₂	54	54	54	58	58	60	60	60
HEIGHTS Inches									
Base to Stack Flange	H	86	86	86	90	90	95	95	95
Base to Steam Nozzle	H ₁	87	87	87	91	91	95	95	95
Base to Top of Casing	J	85	85	85	89	89	93	93	93
Base to Lifting Lug	J ₁	86	86	86	90	90	95	95	95
Base to Upper Drum Centerline	K	69	69	69	73	73	77	77	77
Base to Lower Drum Centerline	L	9	9	9	9	9	10	10	10
Base to Feedwater Connection	M	39	39	39	43	43	47	47	47
Base to Chemical Feed	N	44	44	44	48	48	52	52	52
LOCATIONS Inches									
Front Casing to Steam Nozzle	O	34	34	34	37	37	47	47	47
Flue Outlet Centerline	P	55	55	55	61	61	80	80	80
Front Casing to Upper Drum Rear	Q	81	81	81	87	87	108	108	108
Safety Valves 15 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 15 PSIG Setpoint	S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Safety Valves 150 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 150 PSIG Setpoint	S	N/A	N/A	N/A	N/A	N/A	9-1/2	9-1/2	9-1/2
Bottom Drain/Blowdown	T	20	20	20	21	21	23	23	23
PIPING CONNECTIONS Inches									
Flue Gas ID	U	10	10	10	12	12	16	16	16
Flue Gas Outlet Flange	V	15	15	15	17	17	21	21	21
Flange Bolt Circle Diameter	W	12-1/2	12-1/2	12-1/2	14-1/2	14-1/2	18-1/2	18-1/2	18-1/2
Number of Bolt Holes	X	4	4	4	4	4	6	6	6
Steam Nozzle 15 PSIG Design Boiler	Y	4 flg.	4 flg.	4 flg.	6 flg.	6 flg.	6 flg.	6 flg.	6 flg.
Steam Nozzle 150 PSIG Design Boiler	Y	2 mpt	2 mpt	2 mpt	2 1/2 mpt	2 1/2 mpt	3 flg.	3 flg.	3 flg.
Feedwater Makeup	Z	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
Chemical Feed	Z ₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Surface Blowff	BB	1	1	1	1	1	1	1	1
Bottom Drain/Blowdown 15 PSIG Design	CC	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	2	2	2
Bottom Drain/Blowdown 150 PSIG Design	CC	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
Safety Valves, 15 psig [Note 4]	ZZ	1 @ 2	1 @ 2	1 @ 2	1 @ 2 1/2	1 @ 2 1/2	1 @ 3	1 @ 3	1 @ 3
Safety Valves, 150 psig [Note 4]	ZZ	1 @ 1 1/4	1 @ 1 1/4	1 @ 1 1/4	1 @ 1 1/2	1 @ 1 1/2	2 @ 1 1/4	2 @ 1 1/4	2 @ 1 1/4
GENERAL DATA									
Handhole Upper Drum	AA	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6
Handhole Lower Drum	AA ₁	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5
Downcomer OD	DD	4	4	4	4	4	5	5	5
Upper Drum OD	EE	20	20	20	20	20	20	20	20
Lower Drum OD	FF	8-5/8	8-5/8	8-5/8	8-5/8	8-5/8	10-3/4	10-3/4	10-3/4
MINIMUM SERVICE CLEARANCES									
Tube removal each side	GG	28	28	28	32	32	34	34	34
Rear service area	HJ	24	24	24	24	24	24	24	24
Front service area -	HH	36	36	36	36	36	36	36	40

Dimension letters E and I are not used.

NOTES:

1. Multiply Size by 10,000 to obtain BTU/hr input of the boiler.
2. Add 4 inches to each side of the base frame dimension to account for optional seismic anchor pads on each side.
3. For unit sizes below 700, the ALWCO [auxiliary low water cutoff] is a probe device in lieu of the column.
4. Connections shown are for valve outlet connection at the standard set point, do not reduce outlet pipe size.



Table B 1-3FLX Steam Dimensions Sizes 550-1200

		BOILER SIZE - NOTE 1							
	Dim.	550	600	700	800	900	1000	1100	1200
LENGTHS Inches									
Overall	A	139	145	168	168	168	200	200	205
Boiler Base Frame	B	94	94	116	116	116	140	140	140
Front Extension Lower Drum	C	17	17	17	17	17	19	19	19
Rear Extension Lower Drum	D	13	13	15	15	15	23	23	23
Burner Extension	F	31	37	37	37	37	37	37	43
WIDTHS Inches									
Boiler Base Frame [See Note 2]	G	48	48	54	54	54	54	54	54
Centerline to Casing	G ₁	24	24	27	27	27	27	27	27
Width to outside of Gas Train	G ₂	60	60	66	66	66	66	66	66
HEIGHTS Inches									
Base to Stack Flange	H	95	95	109	109	109	108.5	108.5	108.5
Base to Steam Nozzle	H ₁	95	95	109	109	109	109	109	109
Base to Top of Casing	J	93	93	107	107	107	107	107	107
Base to Lifting Lug	J ₁	95	95	109	109	109	109	109	109
Base to Upper Drum Centerline	K	77	77	89	89	89	89	89	89
Base to Lower Drum Centerline	L	10	10	12	12	12	12	12	12
Base to Feedwater Connection	M	47	47	59	59	59	59	59	59
Base to Chemical Feed	N	52	52	64	64	64	64	64	64
LOCATIONS Inches									
Front Casing to Steam Nozzle	O	47	47	58	58	58	58	58	58
Flue Outlet Centerline	P	80	80	100	100	100	124	124	124
Front Casing to Upper Drum Rear	Q	108	108	131	131	131	163	163	163
Safety Valves 15 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 15 PSIG Setpoint	S	N/A	N/A	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2
Safety Valves 150 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 150 PSIG Setpoint	S	9-1/2	9-1/2	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2
Bottom Drain/Blowdown	T	23	23	22	22	22	22	22	22
PIPING CONNECTIONS Inches									
Flue Gas ID	U	16	16	18	18	18	24	24	24
Flue Gas Outlet Flange	V	21	21	23	23	23	29	29	29
Flange Bolt Circle Diameter	W	18-1/2	18-1/2	20-1/2	20-1/2	20-1/2	26-1/2	26-1/2	26-1/2
Number of Bolt Holes	X	6	6	8	8	8	8	8	8
Steam Nozzle 15 PSIG Design Boiler	Y	6 flg.	6 flg.	8 flg.	8 flg.	8 flg.	10 flg.	10 flg.	10 flg.
Steam Nozzle 150 PSIG Design Boiler	Y	3 flg.	3 flg.	4 flg.	4 flg.	4 flg.	6 flg.	6 flg.	6 flg.
Feedwater Makeup	Z	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	2	2	2
Chemical Feed	Z ₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Surface Blowff	BB	1	1	1	1	1	1	1	1
Bottom Drain/Blowdown 15 PSIG Design	CC	2	2	2	2	2	2	2	2
Bottom Drain/Blowdown 150 PSIG	CC	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
Safety Valves, 15 psig [Note 4]	ZZ	1 @ 3	1 @ 3	2 @ 2 1/2	2 @ 2 1/2	2 @ 2 1/2	2 @ 3	2 @ 3	2 @ 3
Safety Valves, 150 psig [Note 4]	ZZ	2 @ 1 1/4	2 @ 1 1/4	2 @ 1 1/2	2 @ 1 1/2	2 @ 1 1/2	2 @ 2	2 @ 2	2 @ 2
GENERAL DATA									
Handhole Upper Drum	AA	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6
Handhole Lower Drum	AA ₁	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5
Downcomer OD	DD	5	5	6	6	6	6	6	6
Upper Drum OD	EE	20	20	24	24	24	24	24	24
Lower Drum OD	FF	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4
MINIMUM SERVICE CLEARANCES									
Tube removal each side	GG	34	34	40	40	40	40	40	40
Rear service area	HJ	24	24	24	24	24	24	24	24
Front service area -	HH	40	40	40	40	40	45	45	45

Dimension letters E and I are not used.

NOTES:

1. Multiply Size by 10,000 to obtain BTU/hr input of the boiler.
2. Add 4 inches to each side of the base frame dimension to account for optional seismic anchor pads on each side.
3. For unit sizes below 700, the ALWCO [auxiliary low water cutoff] is a probe device in lieu of the column.
4. Connections shown are for valve outlet connection at the standard set point, do not reduce outlet pipe size.



Table B 1-4. FLX Steam Ratings Sizes 150-500

Boiler SIZE	150	200	250	300	350	400	450	500
Ratings [Notes A and B]								
Nominal Steam Capacity (lbs. steam/hr from & at 212°)	1,237	1,649	2,062	2,474	2,887	3,299	3,711	4,124
Rated Steam Capacity [kg/hr from and at 100 C]	561	748	935	1,122	1,310	1,496	1,683	1,871
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000
Output Kcal/Hr [1,000 Kcal/h]	303	403	504	605	706	806	907	1,008
Output KW	348	464	580	696	812	928	1,044	1,160
Approximate Boiler Horsepower	36	48	60	72	84	96	108	119
Approximate Fuel Consumption [Input - Note C]								
Natural Gas [ft³/hr] - 15# Steam [1.03 Bar]	1,448	1,929	2,438	2,900	3,408	3,872	4,319	4,776
Natural Gas Therms/Hour - 15# Steam [1.03 Bar]	14.5	19.3	24.4	29.0	34.1	38.7	43.2	47.8
Natural Gas [m³/hr] - 15# Steam [1.03 Bar]	41.0	54.6	69.0	82.0	96.5	109.6	122.3	135.0
Natural Gas [ft³/hr] - 150# Steam [10.34 Bar]	1,487	2,021	2,558	3,043	3,559	4,017	4,519	4,979
Natural Gas Therms/Hour - 150# Steam [10.34 Bar]	14.9	20.2	25.6	30.4	35.6	40.2	45.2	49.8
Natural Gas [m³/hr] - 150# Steam [10.34 Bar]	42.1	57.2	72.4	86.0	100.8	113.7	128.0	141.0
Propane Gas [ft³/hr] - 15# Steam [1.03 Bar]	579	772	975	1,160	1,363	1,549	1,728	1,910
Propane Gas [ft³/hr] - 150# Steam [10.34 Bar]	595	808	1,023	1,217	1,424	1,607	1,808	1,992
Propane Gas [m³/hr] - 15# Steam [1.03 Bar]	16.4	21.8	27.6	32.8	38.6	43.9	48.9	54.0
Propane Gas [m³/hr] - 150# Steam [10.34 Bar]	16.8	22.9	28.9	34.5	40.3	45.5	51.2	56.4
No.2 Oil Fuel - gph, 15# Steam [1.03 Bar]	10.0	13.5	17.1	20.4	24.1	26.8	30.2	33.6
No.2 Oil Fuel - gph, 150# Steam [10.34 Bar]	10.3	14.0	17.6	20.9	24.3	27.7	31.7	34.5
No.2 Oil Fuel - liters/hour, 15# Steam [1.03 Bar]	37.8	51.1	64.6	77.2	91.1	101.4	114.3	127.2
No.2 Oil Fuel - liters/hour, 150# Steam [10.34 Bar]	39.1	53.0	66.7	79.0	92.1	104.8	120.0	130.6
Power Requirements - Standard [Note A and D]								
Blower Motor HP - Gas Firing	1/2	3/4	3/4	3/4	1	1	2	2
Blower Motor HP - Oil or Combination	3/4	1	1	1	1-1/2	1-1/2	2	3
Oil Pump for Oil or Combination	Direct Drive from the Blower Motor							
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60	[9.8] 4.9	[13.8] 6.9	[13.8] 6.9	[13.8] 6.9	[16] 8	[16] 8	[24] 12	
Blower Motor - Oil or Combination, [115]230/1/60	[13.8] 6.9	[16] 8	[16] 8	[16] 8	[20] 10	[20] 10	[24] 12	
Blower Motor - Gas, Oil or Combination, 230/3/60								6.8
Blower Motor - Gas, Oil or Combination, 460/3/60								3.4
Blower Motor - Gas, Oil or Combination, 575/3/60								2.7
Remote Oil Pump, [230]460/3/60								
Control Circuit @115/1/60	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4
Weights								
Operating Weight, lbs.	6,600	6,600	6,600	7,200	7,200	9,200	9,200	9,200
Operating Weight, kg	2,994	2,994	2,994	3,266	3,266	4,173	4,173	4,173
Water Content Normal, gallons	108	108	108	121	121	157	157	157
Water Content Normal, liters	409	409	409	458	458	594	594	594
Water Content Flooded, gallons	194	194	194	215	215	293	293	293
Water Content Flooded, liters	734	734	734	814	814	1,109	1,109	1,109
Shipping Weight, approximate lbs.	5,700	5,700	5,700	6,200	6,200	7,900	7,900	7,900
Shipping Weight, approximate kg	2,585	2,585	2,585	2,812	2,812	3,583	3,583	3,583

Notes:

- A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.
 B. Steam ratings are listed for 0 psig and feedwater at 212 F and nominal 80% efficiency. Refer to Section B1 of the Boiler Book for ratings at operating
 C. Input calculated with Nat. Gas @ 1000 Btu/ft³. Propane @ 2500 Btu/ft³. and Oil @ 140,000Btu/gal.
 D. Standard Motors meet the requirements of UL & NEMA and include the following:

Open drip proof design
 1.15 Service Factor
 Class "B" Insulation

NEMA Design "B"
 Ball Bearing
 Continuous Duty, 40° C ambient



Table B 1-5. FLX Steam Ratings Res 550-1200

Boiler SIZE	550	600	700	800	900	1000	1100	1200
Ratings [Notes A and B]								
Nominal Steam Capacity (lbs. steam/hr from & at 212°)	4,536	4,949	5,773	6,598	7,422	8,248	9,072	9,897
Rated Steam Capacity [kg/hr from and at 100 C]	2,057	2,245	2,619	2,993	3,367	3,741	4,115	4,489
Output Btu/hr [1,000 Btu/h]	4,400	4,800	5,600	6,400	7,200	8,000	8,800	9,600
Output Kcal/Hr [1,000 Kcal/h]	1,109	1,210	1,411	1,613	1,814	2,016	2,218	2,419
Output KW	1,276	1,392	1,624	1,856	2,088	2,320	2,552	2,784
Approximate Boiler Horsepower	131	143	167	191	215	239	263	287
Approximate Fuel Consumption [Input - Note C]								
Natural Gas [ft ³ /hr] - 15# Steam [1.03 Bar]	5,311	5,774	6,885	7,807	8,853	9,877	11,040	12,009
Natural Gas Therms/Hour - 15# Steam [1.03 Bar]	53.1	57.7	68.8	78.1	88.5	98.8	110.4	121.0
Natural Gas [m ³ /hr] - 15# Steam [1.03 Bar]	150.4	163.5	195.0	221.0	250.7	279.7	312.6	340.0
Natural Gas [ft ³ /hr] - 150# Steam [10.34 Bar]	5,481	6,059	7,032	8,165	9,286	10,230	11,287	12,444
Natural Gas Therms/Hour - 150# Steam [10.34 Bar]	54.8	60.6	70.3	81.6	92.9	102.3	113.0	124.4
Natural Gas [m ³ /hr] - 150# Steam [10.34 Bar]	155.2	171.6	199.1	231.2	263.0	289.7	319.6	352.3
Propane Gas [ft ³ /hr] - 15# Steam [1.03 Bar]	2,124	2,310	2,754	3,123	3,541	3,951	4,416	4,804
Propane Gas [ft ³ /hr] - 150# Steam [10.34 Bar]	2,192	2,424	2,813	3,266	3,714	4,092	4,515	4,978
Propane Gas [m ³ /hr] - 15# Steam [1.03 Bar]	60.1	65.4	78.0	88.4	100.3	111.9	125.0	136.0
Propane Gas [m ³ /hr] - 150# Steam [10.34 Bar]	62.0	68.6	79.6	92.5	105.2	115.9	127.8	141.0
No.2 Oil Fuel - gph, 15# Steam [1.03 Bar]	37.5	40.9	47.8	55.0	61.9	69.3	77.4	83.1
No.2 Oil Fuel - gph, 150# Steam [10.34 Bar]	38.3	41.7	49.3	57.1	64.3	71.0	79.3	86.5
No.2 Oil Fuel - liters/hour, 15# Steam [1.03 Bar]	141.9	154.8	180.9	208.2	234.3	262.3	293.0	314.6
No.2 Oil Fuel - liters/hour, 150# Steam [10.34 Bar]	145.0	157.8	186.6	216.1	243.4	268.7	300.0	327.4
Power Requirements - Standard [Note A and D]								
Blower Motor HP - Gas Firing	3	5	5	5	7-1/2	10	10	15
Blower Motor HP - Oil or Combination	3	5	5	5	7-1/2	10	10	15
Oil Pump for Oil or Combination	direct drive	3/4	3/4	3/4	1	1-1/2	1-1/2	1-1/2
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60								
Blower Motor - Oil or Combination, [115]230/1/60								
Blower Motor - Gas, Oil or Combination, 230/3/60	9.6	15.2	15.2	15.2	22	22	28	28
Blower Motor - Gas, Oil or Combination, 460/3/60	4.8	7.6	7.6	7.5	11	11	14	14
Blower Motor - Gas, Oil or Combination, 575/3/60	3.9	6.1	6.1	6.1	9	9	11	11
Remote Oil Pump, [230]460/3/60	[2.8] 1.4		[2.8] 1.4	[2.8] 1.4	[3.4] 1.7	[4.2] 2.1	[4.2] 2.1	[4.2] 2.1
Control Circuit @115/1/60	2.4	2.4	1.9	1.9	1.9	2.4	2.4	2.4
Weights								
Operating Weight, lbs.	9,200	9,200	12,500	12,500	12,500	14,100	14,100	14,100
Operating Weight, kg	4,173	4,173	5,670	5,670	5,670	6,396	6,396	6,396
Water Content Normal, gallons	157	157	277	277	277	289	289	289
Water Content Normal, liters	594	594	1,049	1,049	1,049	1,094	1,094	1,094
Water Content Flooded, gallons	293	293	464	464	464	562	562	562
Water Content Flooded, liters	1,109	1,109	1,756	1,756	1,756	2,127	2,127	2,127
Shipping Weight, approximate lbs.	7,900	7,900	10,200	10,200	10,200	11,700	11,700	11,700
Shipping Weight, approximate kg	3,583	3,583	4,627	4,627	4,627	5,307	5,307	5,307

Notes:

- A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.
 B. Steam ratings are listed for 0 psig and feedwater at 212 F and nominal 80% efficiency. Refer to Section B1 of the Boiler Book for ratings at operating
 C. Input calculated with Nat. Gas @ 1000 Btu/ft³. Propane @ 2500 Btu/ft³ and Oil @ 140,000Btu/gal.
 D. Standard Motors meet the requirements of UL & NEMA and include the following:

Open drip proof design	NEMA Design "B"
1.15 Service Factor	Ball Bearing
Class "B" Insulation	Continuous Duty, 40° C ambient



Figure B 1-2FLX HW Dimension Drawing

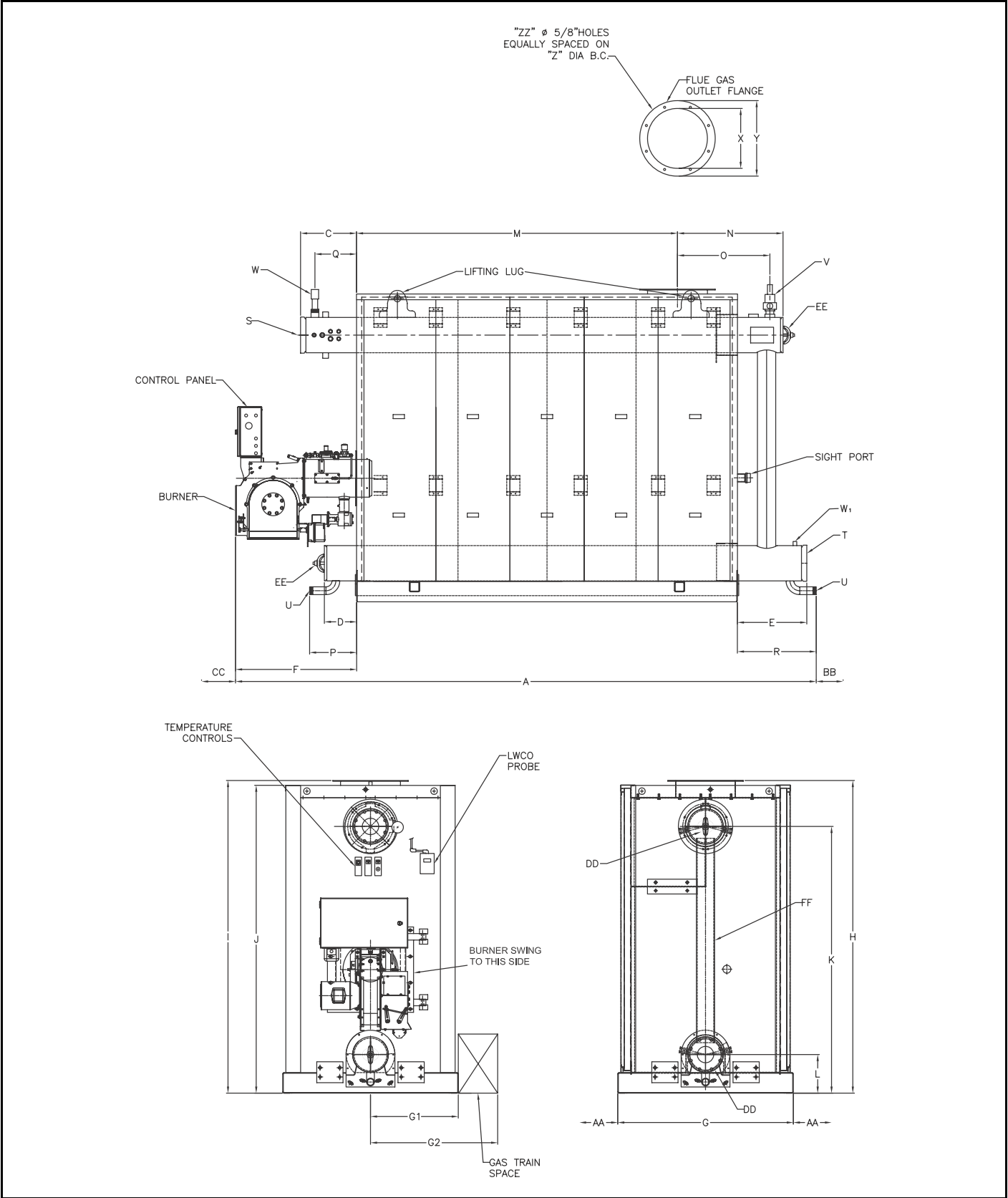


Table B 1-6FLX HW Dimensions Sizes 150-500

		BOILER SIZE [SEE NOTE 1]							
		150	200	250	300	350	400	450	500
LENGTHS Inches									
Overall Length of Boiler	A	115	115	115	120	120	146	146	146
Boiler Base Frame	B	68	68	68	74	74	95	95	95
Front Extension Upper	C	17	17	17	17	17	17	17	17
Front Extension Lower	D	11	11	11	11	11	11	11	11
Rear Extension Lower	E	20	20	20	20	20	21	21	21
Burner Extension	F	27	27	27	27	27	31	31	31
WIDTHS Inches									
Boiler Base Frame [Note	G	42	42	42	46	46	48	48	48
Centerline to Casing	G₁	21	21	21	23	23	24	24	24
Centerline to outside Gas	G₂	33	33	33	35	35	36	36	36
HEIGHTS Inches									
Base to Stack Flange	H	78	78	78	82	82	86	86	86
Base to Lifting Lug	I	78	78	78	82	82	86	86	86
Base to Top of Casing	J	76	76	76	80	80	85	85	85
Base to Supply Nozzle	K	65	65	65	69	69	73	73	73
Base to Return Nozzle	L	9	9	9	9	9	10	10	10
LOCATIONS Inches									
Flue Outlet Centerline	M	54	54	54	62	62	81	81	81
Rear Extension Upper	N	28	28	28	26	26	28	28	28
Safety Valves	O	24	24	24	22	22	24	24	24
Bottom Drain see Note 3	P	15	15	15	15	15	15	15	15
Boiler Air Vent	Q	12	12	12	13	13	13	13	13
Bottom Drain Rear see	R	N/A	N/A	N/A	N/A	N/A	24	24	24
PIPING CONNECTIONS									
Supply Nozzle [Note 4]	S	3 FLG	3 FLG	3 FLG	4 FLG	4 FLG	6 FLG	6 FLG	6 FLG
Return Nozzle [Note 4]	T	3 FLG	3 FLG	3 FLG	4 FLG	4 FLG	6 FLG	6 FLG	6 FLG
Bottom Drain see Note 2	U	1½	1½	1½	1½	1½	2 @ 2	2 @ 2	2 @ 2
Safety Valves, 30 psig	V	2	2	2	2	2	2½	2½	2½
Safety Valves, 60 psig	V	1½	1½	1½	1½	1½	2	2	2
Safety Valves, 125 psig	V	1	1	1	1¼	1¼	1½	1½	1½
Safety Valves, 160 psig	V	¾	¾	¾	¾	¾	1¼	1¼	1¼
Boiler Air Vent	W	1	1	1	1	1	1	1	1
Tapping for optional	W₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Flue Gas ID	X	10	10	10	12	12	16	16	16
Flue Gas Outlet Flange	Y	15	15	15	17	17	21	21	21
Flange Bolt Circle	Z	12½	12½	12½	14½	14½	18½	18½	18½
Number of holes in bolt	ZZ	4	4	4	4	4	6	6	6
MINIMUM SERVICE									
Tube removal each side	AA	28	28	28	32	32	34	34	34
Rear service area	BB	24	24	24	24	24	24	24	24
Front service area -	CC	36	36	36	36	36	36	36	40
PERIPHERAL DATA									
Upper/Lower Drum OD	DD	8-5/8"	8-5/8"	8-5/8"	8-5/8"	8-5/8"	10-3/4"	10-3/4"	10-3/4"
Handhole Inspection	EE	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"
Rear Downcomer (NPS)	FF	4	4	4	4	4	5	5	5

NOTES:

1. For Btu/hr input rating, multiply model designation by 10,000.
2. Add 4" to each side of the base frame dimension to account for optional seismic anchor pads.
3. For Models 150 to 350 a single drain connection is provided at the front bottom drum; for Models 400 and greater, an additional drain
4. Supply and return nozzle flanges are 150# Flat Face.
5. Standard safety valve setting is 160 psig and options for reduced settings are noted.

Table B 1 - 7FLX HW Dimensions Sizes 550-1200

		BOILER SIZE [SEE NOTE 1]							
		550	600	700	800	900	1000	1100	1200
LENGTHS Inches									
Overall Length of Boiler	A	146	153	174	174	174	206	206	206
Boiler Base Frame	B	95	95	116	116	116	140	140	140
Front Extension Upper	C	17	17	17	17	17	17	17	17
Front Extension Lower	D	11	11	11	11	11	12	12	12
Rear Extension Lower	E	21	21	21	21	21	22	22	22
Burner Extension	F	31	37	37	37	37	44	44	44
WIDTHS Inches									
Boiler Base Frame [Note]	G	48	48	54	54	54	54	54	54
Centerline to Casing	G₁	24	24	27	27	27	27	27	27
Centerline to outside Gas	G₂	36	36	39	39	39	39	39	39
HEIGHTS Inches									
Base to Stack Flange	H	86	86	95	95	95	95	95	95
Base to Lifting Lug	I	86	86	95	95	95	95	95	95
Base to Top of Casing	J	85	85	94	94	94	94	94	94
Base to Supply Nozzle	K	73	73	81	81	81	81	81	81
Base to Return Nozzle	L	10	10	10	10	10	12	12	12
LOCATIONS Inches									
Flue Outlet Centerline	M	81	81	102	102	102	122	122	122
Rear Extension Upper	N	28	28	28	28	28	33	33	33
Safety Valves	O	24	24	24	24	24	29	29	29
Bottom Drain see Note 3	P	15	15	15	15	15	15	15	15
Boiler Air Vent	Q	13	13	13	13	13	7	7	7
Bottom Drain Rear see	R	24	24	24	24	24	19	19	19
PIPING CONNECTIONS									
Supply Nozzle [Note 4]	S	6 FLG	6 FLG	6 FLG	6 FLG	6 FLG	8 FLG	8 FLG	8 FLG
Return Nozzle [Note 4]	T	6 FLG	6 FLG	6 FLG	6 FLG	6 FLG	8 FLG	8 FLG	8 FLG
Bottom Drain see Note 2	U	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2
Safety Valves, 30 psig	V	2½	2½	2 @ 2½	2 @ 2½	2 @ 2½	2 @ 2½	2 @ 2½	2 @ 2½
Safety Valves, 60 psig	V	2	2	2½	2½	2½	2½	2½	2½
Safety Valves, 125 psig	V	1½	1½	1½	1½	1½	1½	1½	1½
Safety Valves, 160 psig	V	1¼	1¼	1½	1½	1½	1½	1½	1½
Boiler Air Vent	W	1	1	1	1	1	1	1	1
Tapping for optional	W₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Flue Gas ID	X	16	16	18	18	18	24	24	24
Flue Gas Outlet Flange	Y	21	21	23	23	23	29	29	29
Flange Bolt Circle	Z	18½	18½	20½	20½	20½	26½	26½	26½
Number of holes in bolt	ZZ	6	6	8	8	8	8	8	8
MINIMUM SERVICE									
Tube removal each side	AA	34	34	40	40	40	40	40	40
Rear service area	BB	24	24	24	24	24	24	24	24
Front service area -	CC	40	40	40	40	45	45	45	45
PERIPHERAL DATA									
Upper/Lower Drum OD	DD	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"
Handhole Inspection	EE	4" x 5"	4" x 5"	4"x 5"	4" x 5"	4" x 5"	4"x 5"	4" x 5"	4" x 5"
Rear Downcomer (NPS)	FF	5	5	5	5	5	5	5	5

- NOTES:**
1. For Btu/hr input rating, multiply model designation by 10,000.
 2. Add 4" to each side of the base frame dimension to account for optional seismic anchor pads.
 3. For Models 150 to 350 a single drain connection is provided at the front bottom drum; for Models 400 and greater, an additional drain
 4. Supply and return nozzle flanges are 150# Flat Face.
 5. Standard safety valve setting is 160 psig and options for reduced settings are noted.

Table B 1 - 8 FLX HW Ratings Sizes 150-500

Boiler SIZE	150	200	250	300	350	400	450	500
Ratings [Note A]								
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000
Output Kcal/Hr [1,000 Kcal/h]	303	403	504	605	706	806	907	1,008
Output KW	348	464	580	696	812	928	1,044	1,160
Approximate Boiler Horsepower	36	48	60	72	84	96	108	119
Approximate Fuel Consumption [Input - Note B]								
Natural Gas [ft³/hr]	1,423	1,917	2,423	2,883	3,388	3,803	4,289	4,748
Natural Gas [m³/hr]	40.3	54.3	68.6	81.6	95.9	107.7	121.4	134.4
Natural Gas Therms/Hour	14.2	19.2	24.2	28.8	33.9	38.0	42.9	47.5
Propane Gas [ft³/hr]	569	764	969	1,153	1,355	1,521	1,716	1,899
Propane Gas [m³/hr]	16.1	21.6	27.4	32.6	38.4	43.1	48.6	53.8
No.2 Oil Fuel - gph	10.1	13.5	16.9	20.2	23.6	27.0	31.5	33.5
No.2 Oil Fuel - liters/hour	38.2	51.1	64.0	76.5	89.3	102.2	119.2	126.8
Power Requirements - Standard [Note A & C]								
Blower Motor HP - Gas Firing	1/2	3/4	3/4	3/4	1	1	2	2
Blower Motor HP - Oil or Combination	3/4	1	1	1	1-1/2	1-1/2	2	3
Oil Pump for Oil or Combination	Direct Drive from the Blower Motor							
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60	[9.8] 4.9	[13.8] 6.9	[13.8] 6.9	[13.8] 6.9	[16] 8	[16] 8	[24] 12	
Blower Motor - Oil or Combination, [115]230/1/60	[13.8] 6.9	[16] 8	[16] 8	[16] 8	[20] 10	[20] 10	[24] 12	
Blower Motor - Gas, Oil or Combination, 230/3/60								6.8
Blower Motor - Gas, Oil or Combination, 460/3/60								3.4
Blower Motor - Gas, Oil or Combination, 575/3/60								2.7
Remote Oil Pump, [230]460/3/60								
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4
Weights								
Operating Weight, lbs.	4,700	4,700	4,700	5,900	5,900	7,600	7,600	7,600
Operating Weight, kg	2,111	2,111	2,111	2,667	2,667	3,422	3,422	3,422
Water Content Normal, gallons	96	96	96	108	108	180	180	180
Water Content Normal, liters	344.5	344.5	344.5	401.3	401.3	658.7	658.7	658.7
Shipping Weight, approximate lbs.	3,900	3,900	3,900	5,000	5,000	6,100	6,100	6,100
Shipping Weight, approximate kg	1,769	1,769	1,769	2,268	2,268	2,767	2,767	2,767

Notes:

A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.

B. Input calculated with Nat. Gas @ 1000 Btu/ft³. Propane @ 2500 Btu/ft³. and Oil @ 140,000Btu/gal.

C. Standard Motors meet the requirements of UL & NEMA and include the following:

Open drip proof design

1.15 Service Factor

Class "B" Insulation

NEMA Design "B"

Ball Bearing

Continuous Duty, 40⁰ C ambient

Table B 1- 9 . *FLX* Ratings Sizes 550-1200

Boiler SIZE	550	600	700	800	900	1000	1100	1200
Ratings [Note A]								
Output Btu/hr [1,000 Btu/h]	4,400	4,800	5,600	6,400	7,200	8,000	8,800	9,600
Output Kcal/Hr [1,000 Kcal/h]	1,109	1,210	1,411	1,613	1,814	2,016	2,218	2,419
Output KW	1,276	1,392	1,624	1,856	2,088	2,320	2,552	2,784
Approximate Boiler Horsepower	131	143	167	191	215	239	263	287
Approximate Fuel Consumption [Input - Note B]								
Natural Gas [ft ³ /hr]	5,239	5,740	6,760	7,667	8,798	9,698	10,775	11,788
Natural Gas [m ³ /hr]	148.3	162.5	191.4	217.1	249.1	274.6	305.1	333.8
Natural Gas Therms/Hour	52.4	57.4	67.6	76.7	88.0	97.0	108.0	118.0
Propane Gas [ft ³ /hr]	2,096	2,296	2,704	3,067	3,519	3,879	4,310	4,715
Propane Gas [m ³ /hr]	59.3	65.0	76.6	86.8	99.6	109.8	122.0	133.5
No.2 Oil Fuel - gph	36.8	40.2	47.0	53.7	60.5	68.0	74.9	81.7
No.2 Oil Fuel - liters/hour	139.3	152.1	177.9	203.3	229.0	257.4	283.5	309.3
Power Requirements - Standard [Note A & C]								
Blower Motor HP - Gas Firing	3	5	5	5	7-1/2	10	10	15
Blower Motor HP - Oil or Combination	3	5	5	5	7-1/2	10	10	15
Oil Pump for Oil or Combination	direct drive	3/4	3/4	3/4	1	1-1/2	1-1/2	1-1/2
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60								
Blower Motor - Oil or Combination, [115]230/1/60								
Blower Motor - Gas, Oil or Combination, 230/3/60	9.6	15.2	15.2	15.2	22	22	28	28
Blower Motor - Gas, Oil or Combination, 460/3/60	4.8	7.6	7.6	7.5	11	11	14	14
Blower Motor - Gas, Oil or Combination, 575/3/60	3.9	6.1	6.1	6.1	9	9	11	11
Remote Oil Pump, [230]460/3/60		[2.8] 1.4	[2.8] 1.4	[2.8] 1.4	[3.4] 1.7	[4.2] 2.1	[4.2] 2.1	[4.2] 2.1
Control Circuit	2.4	2.4	1.9	1.9	1.9	2.4	2.4	2.4
Weights								
Operating Weight, lbs.	7,600	7,600	10,500	10,500	10,500	12,300	12,300	12,300
Operating Weight, kg	3,422	3,422	4,714	4,714	4,714	5,549	5,549	5,549
Water Content Normal, gallons	180	180	240	240	240	276	276	276
Water Content Normal, liters	658.7	658.7	863.1	863.1	863	1,018.3	1,018.3	1,018.3
Shipping Weight, approximate lbs.	6,100	6,100	8,500	8,500	8,500	10,000	10,000	10,000
Shipping Weight, approximate kg	2,767	2,767	3,856	3,856	3,856	4,536	4,536	4,536

Notes:

A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.

B. Input calculated with Nat. Gas @ 1000 Btu/ft³. Propane @ 2500 Btu/ft³. and Oil @ 140,000Btu/gal.

C. Standard Motors meet the requirements of UL & NEMA and include the following:

Open drip proof design

NEMA Design "B"

1.15 Service Factor

Ball Bearing

Class "B" Insulation

Continuous Duty, 40⁰ C ambient

PERFORMANCE DATA

Efficiency Fuel-to-steam (fuel-to-water) efficiency is based on specific operating conditions (fuel, pressure, temperature). Nominal efficiency on all FLX hot water and low pressure steam boilers is 81% firing natural gas, and 84% firing No. 2 oil. For high pressure steam applications, contact your local Cleaver-Brooks representative for expected efficiencies.

Emissions Expected emissions for natural gas fired FLX boilers are shown in Table B1-4.

Table B1-10. Expected Emissions (ppm, corrected to 3% O₂), Natural Gas Fired Boiler

FLUE GAS COMPONENT	HIGH-FIRE LEVEL ^A PPM _v	LOW-FIRE LEVEL ^B PPM _v
CO	<100	<100
NOx	P70	P70

NOTE: NOx levels based on standard product offering.

A. Based on 12% excess air.

B. Based on 15% excess air.

Table B1-11. Model FLX Hot Water Boiler Flow Rates and Pressure Drops

MODEL NO.	T = 20°F		T = 40°F		T = 60°F		T = 80°F		T = 100°F	
	P (PSIG)	GPM	P (PSIG)	GPM	P (PSIG)	GPM	P (PSIG)	GPM	P (PSIG)	GPM
FLX-150	1.14	122.0	0.30	61.1	0.13	41.1	0.08	30.8	0.05	24.4
FLX-200	1.14	162.3	0.30	81.1	0.13	54.1	0.08	40.6	0.05	32.5
FLX-250	1.77	202.8	0.46	101.4	0.21	67.6	0.12	50.7	0.08	40.6
FLX-300	1.85	243.4	0.48	121.7	0.22	81.1	0.12	60.9	0.08	48.7
FLX-350	2.49	284.0	0.65	142.0	0.29	94.7	0.17	71.0	0.11	56.8
FLX-400	1.35	324.5	0.35	162.3	0.16	108.2	0.09	81.1	0.06	64.9
FLX-450	1.71	365.1	0.44	182.6	0.20	121.7	0.11	91.2	0.08	73.0
FLX-500	2.03	405.7	0.54	202.8	0.25	135.2	0.14	101.4	0.09	81.1
FLX-550	2.50	446.3	0.67	223.1	0.31	148.7	0.17	111.5	0.11	89.2
FLX-600	2.99	486.8	0.77	243.4	0.35	162.3	0.20	121.7	0.13	97.4
FLX-700	1.75	567.9	0.45	284.0	0.21	189.3	0.12	142.0	0.08	113.6
FLX-800	2.27	649.1	0.59	324.5	0.27	216.4	0.15	162.3	0.10	129.8
FLX-900	2.85	730.2	0.74	365.1	0.33	243.4	0.19	182.6	0.12	146.0
FLX-1000	4.08	811.4	1.02	405.6	0.42	270.4	0.25	202.8	0.15	163.6
FLX-1100	4.42	892.6	1.15	446.2	0.48	297.4	0.28	223.0	0.18	178.4
FLX-1200	6.20	973.6	1.60	486.8	0.59	324.6	0.31	243.4	0.22	194.8

ENGINEERING DATA

Boiler Information

Flow Rates and Pressure Drops

Flow rates and pressure drops for the FLX hot water boilers are shown in Table B1-5. This table can be used to determine the boiler pressure drop in relation to full boiler output and system temperature drop.

Table B1-6 can be used to determine the maximum gpm circulating rate in relation to full boiler output and system temperature drop. The maximum gpm can be determined by knowing the boiler size and expected system temperature drop.

System Operating Parameters (Hot Water)

System over pressure requirements are shown in Table B1-7.

Minimum return water temperature is 140°F; minimum supply (boiler outlet) water temperature is 150 °F in order to prevent fireside corrosion.

System Operating Parameters (Steam Boilers)

The following operating limitations must be observed for optimum operation of the boiler:

1. Minimum make-up temperature 60 °F.
2. Maximum make-up rate (for on/off make-up control) 2.0 times the evaporation rate.
3. Minimum operating pressure 6 psig. on low pressure steam and 40 psig. on high pressure steam.
4. Maximum operating pressure 12 psig. on low pressure steam.
5. Maximum load tracking rate 0 - 100% load or 100% - 0 load, 30 seconds on low pressure steam and 20% per minute on high pressure steam.

Maximum boiler water chemistry parameters: Silica: 150 ppm; specific conductance: 3500 µmho/cm un-neutralized; total alkalinity: 300 ppm as CaCO₃; hardness: 0; oxygen: 7 ppb; pH: 7 - 10; total iron: 0.05 ppm; oil matter: 1 ppm.

Boiler Heat Release Information

Boiler heat release information is shown in Table B1-8.

Tube Attachment

Construction of the Flexible Watertube Boiler includes a special tube-to-drum attachment that requires no welding or rolling (see Figure B1-3). The tube is fitted with a tapered ferrule, which is press-fit into the tube hole in the drum. The ferrule is welded to the tube at the factory for both new and replacement tubes, so no field welding is required. The tube is held in place with a keeper plate.

This tube attachment design reduces repair and maintenance costs, and also reduces the cost of field erection of new units.

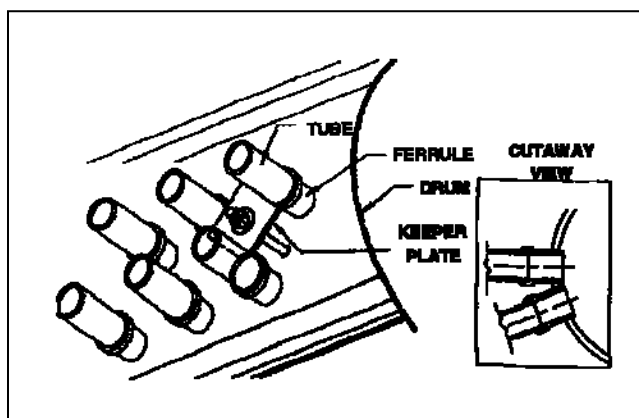


Figure B1-3. Model FLX Tube Attachment

Table B1-12. Model FLX Circulating Rates, Hot Water Boiler

MODEL NO. (HP)	SYSTEM TEMPERATURE DROP °F									
	10	20	30	40	50	60	70	80	90	100
	MAXIMUM CIRCULATING RATE - GPM									
FLX-150 (36)	243	122	81	61	49	41	35	31	27	24
FLX-200 (48)	324	162	108	81	65	54	46	41	36	32
FLX-250 (60)	404	202	135	101	81	68	58	51	45	41
FLX-300(72)	488	244	162	122	97	81	70	61	54	49
FLX-350 (84)	568	284	189	142	114	95	81	71	63	57
FLX-400 (96)	648	324	216	162	130	108	93	81	72	65
FLX-450 (108)	729	365	243	182	146	122	105	91	81	73
FLX-500 (119)	812	406	270	203	162	135	116	101	90	81
FLX-550 (131)	893	447	297	223	178	149	128	111	99	89
FLX-600 (143)	972	486	325	243	195	162	139	122	108	97
FLX-700 (167)	1136	568	379	284	227	189	162	142	126	114
FLX-800 (191)	1300	650	433	325	260	216	185	162	144	130
FLX-900 (215)	1460	730	487	365	292	243	209	183	162	146
FLX-1000 (239)	1622	811	541	406	324	270	232	203	180	164
FLX-1100 (263)	1784	893	595	446	357	297	255	223	198	178
FLX-1200 (287)	1947	974	649	487	389	325	279	243	216	195

Table B1-13. Model FLX Minimum Over Pressure Requirements

MAXIMUM OUTLET TEMPERATURE (°F)	MINIMUM SYSTEM PRESSURE (PSIG)
180	12
190	15
200	18
210	21
220	24
230	27
240	30

Table B1-15. Model FLX Burner Characteristics

MODEL NO.	BURNER MAXIMUM INPUT MBH	BURNER MODEL	FAN MOTOR (3450 RPM) VOLTAGE
FLX-150	1500	PFVLG-15	115/230/1/60
FLX-200	2000	PFVLG-20	115/230/1/60
FLX-250	2500	PFVLG-25	115/230/1/60
FLX-300	3000	PFVLG-30	115/230/1/60
FLX-350	3500	PFVLG-35	208/230/1/60
FLX-400	4000	PFVLG-40	208/230/1/60
FLX-450	4500	PFVLG-45	208-230/460/3/60
FLX-500	5000	PFVLG-50	230/460/3/60
FLX-550	5500	PFVLG-55	230/460/3/60
FLX-600	6000	PFVLG-60	460/3/60
FLX-700	7000	PFVLG-70	460/3/60
FLX-800	8000	PFVLG-80	460/3/60
FLX-900	9000	PFVLG-90	460/3/60
FLX-1000	10000	PFVLG-100	460/3/60
FLX-1100	11000	PFVLG-110	460/3/60
FLX-1200	12000	PFVLG-120	460/3/60

Notes:

- 1 Burner model selection shown is subject to changed and is based on actual application (altitude, gas pressure, reduced NOx, etc.)
- 2 Standard voltage for Canadian applications is 575/3/60.
- 3 Burner operation is Full Modulation on Elite Series and for the Econo series
- Low High Low for units 150 - 600 and modulated firing on 700 and greater.
- 4 Burner models shown are for combination gas/oil firing. For straight gas, delete the letter L, and for straight oil, delete the letter G.

Table B1-14. Model FLX Boiler Heat Release Information

MODEL NO.	FURNACE PROJECTED AREA (FT ²)	FURNACE VOLUME (FT ³)	FURNACE HEAT RELEASE BTU/HR (FT ³)	FURNACE HEAT RELEASE BTU/HR (FT ²)
FLX-150	38.4	24.2	61,983	39,063
FLX-200	38.4	24.2	82,645	52,083
FLX-250	38.4	24.2	103,306	65,104
FLX-300	48.7	34.9	85,960	61,602
FLX-350	48.7	34.9	100,287	71,869
FLX-400	70.6	54.7	73,126	56,657
FLX-450	70.6	54.7	82,267	63,739
FLX-500	70.6	54.7	91,408	70,822
FLX-550	70.6	54.7	100,548	77,904
FLX-600	70.6	54.7	109,689	84,986
FLX-700	104.6	94.6	73,996	66,922
FLX-800	104.6	94.6	84,567	76,482
FLX-900	104.6	94.6	95,137	86,042
FLX-1000	128.9	116.5	85,837	77,580
FLX-1100	128.9	116.5	94,421	85,337
FLX-1200	128.9	116.5	103,004	93,095

Table B1-16. Model FLX Minimum Required Gas Pressure

MODEL NO.	STD GAS TRAIN SIZE (IN.) Note 3	MIN. GAS PRESSURE (IN.W.C.) Note 4	MIN. GAS PRESSURE (IN.W.C.) Note 5	BURNER MODEL
FLX-150	1	11.2	12.5	PFVG-15
FLX-200	1	19.4	21.7	PFVG-20
FLX-250	1.5	12.4	15.7	PFVG-25
FLX-300	1.5	15.9	20.7	PFVG-30
FLX-350	1.5	15.5	22.0	PFVG-35
FLX-400	1.5	18.7	27.2	PFVG-40
FLX-450	2	16.0	26.7	PFVG-45
FLX-500	2	17.6	21.0	PFVG-50
FLX-550	2	22.9	27.1	PFVG-55
FLX-600	2	20.0	24.9	PFVG-60
FLX-700	2	25.2	31.9	PFVG-70
FLX-800	2.5	19.9	22.2	PFVG-80
FLX-900	2.5	24.7	27.7	PFVG-90
FLX-1000	2.5	31.6	31.6	PFVG-100
FLX-1100	2.5	37.3	37.3	PFVG-110
FLX-1200	2.5	38.2	38.2	PFVG-120

Notes:

1. Table is based on 1,000 Btu/cu.ft natural gas and elevation to 1000 feet.
2. Minimum gas pressure also applies to 200 fuel series.
3. As an option, the standard gas train can be replaced with an oversized design to reduce inlet gas pressure requirements.
4. Use this column for all U.S. Installations.
5. Use this column for all Canadian Installations.

**Burner/Control
Information****Burner Characteristics**

Burner information is shown in Table B1-9. Note that the model selection may vary for actual application factors (altitude, gas pressure, etc.).

Minimum Required Gas Pressures

Approximate gas pressure required at rated input is shown in Table B1-10. For oversized gas trains or altitudes above 1,000 feet, contact your local Cleaver-Brooks authorized representative.

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization 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 should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Figure B1-4 shows a typical fuel oil supply arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

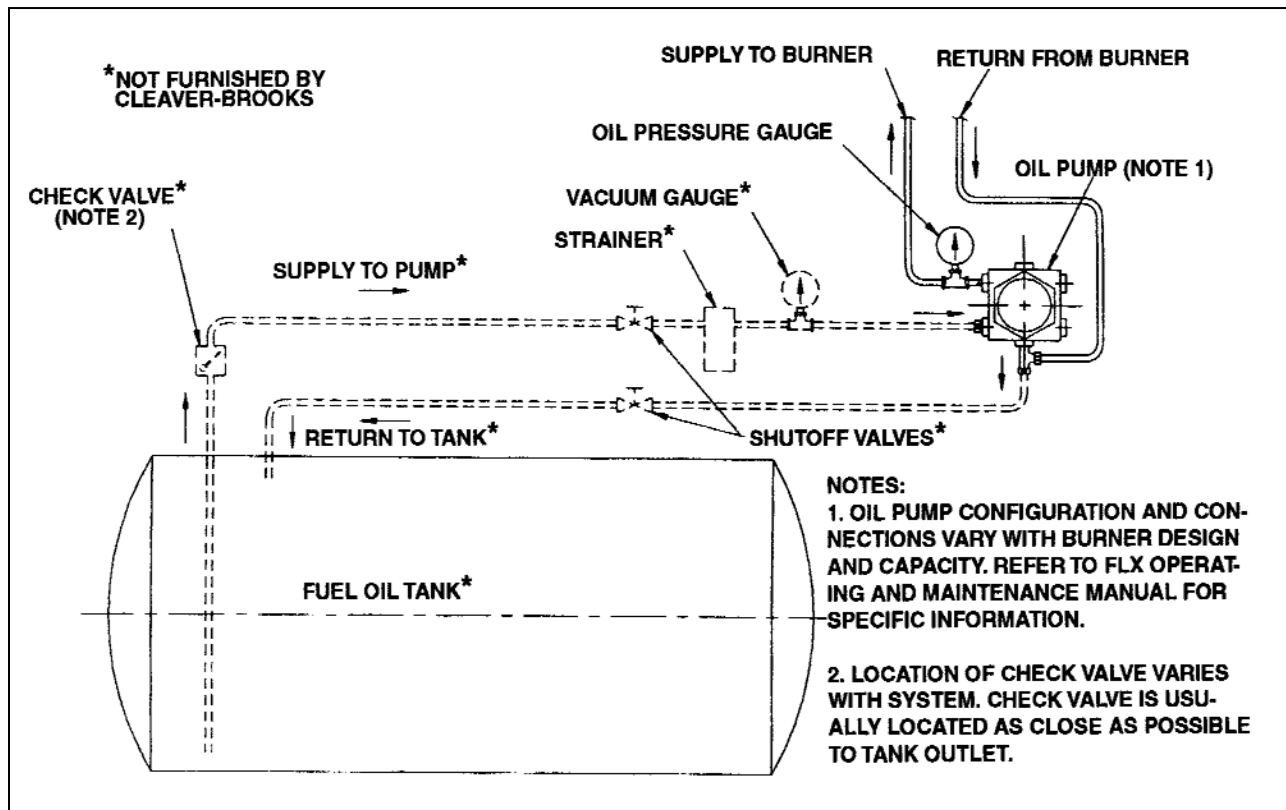


Figure B1-4. Model FLX Oil Burner Supply Pump Installation

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Table B1-17. Model FLX Sound Levels

SOUND LEVEL FIRING RATE	MODEL NO.															
	150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1200
Low Fire (dBA)	75	75	76	75	75	77	78	79	79	79	81	81	83	79	82	85
High Fire (dBA)	76	76	77	76	76	78	79	80	80	80	82	82	83	81	83	86

Measurement: Three feet from front center of boiler, and 3-1/2 feet above boiler base. Measurements are decibel ratings on the A-weighted scale, registered without addition of sound attenuators, mufflers, or silencers. Sound pressure data taken on combination fuel burners firing oil. Sound pressure levels firing natural gas will be 0.5 dBA lower.

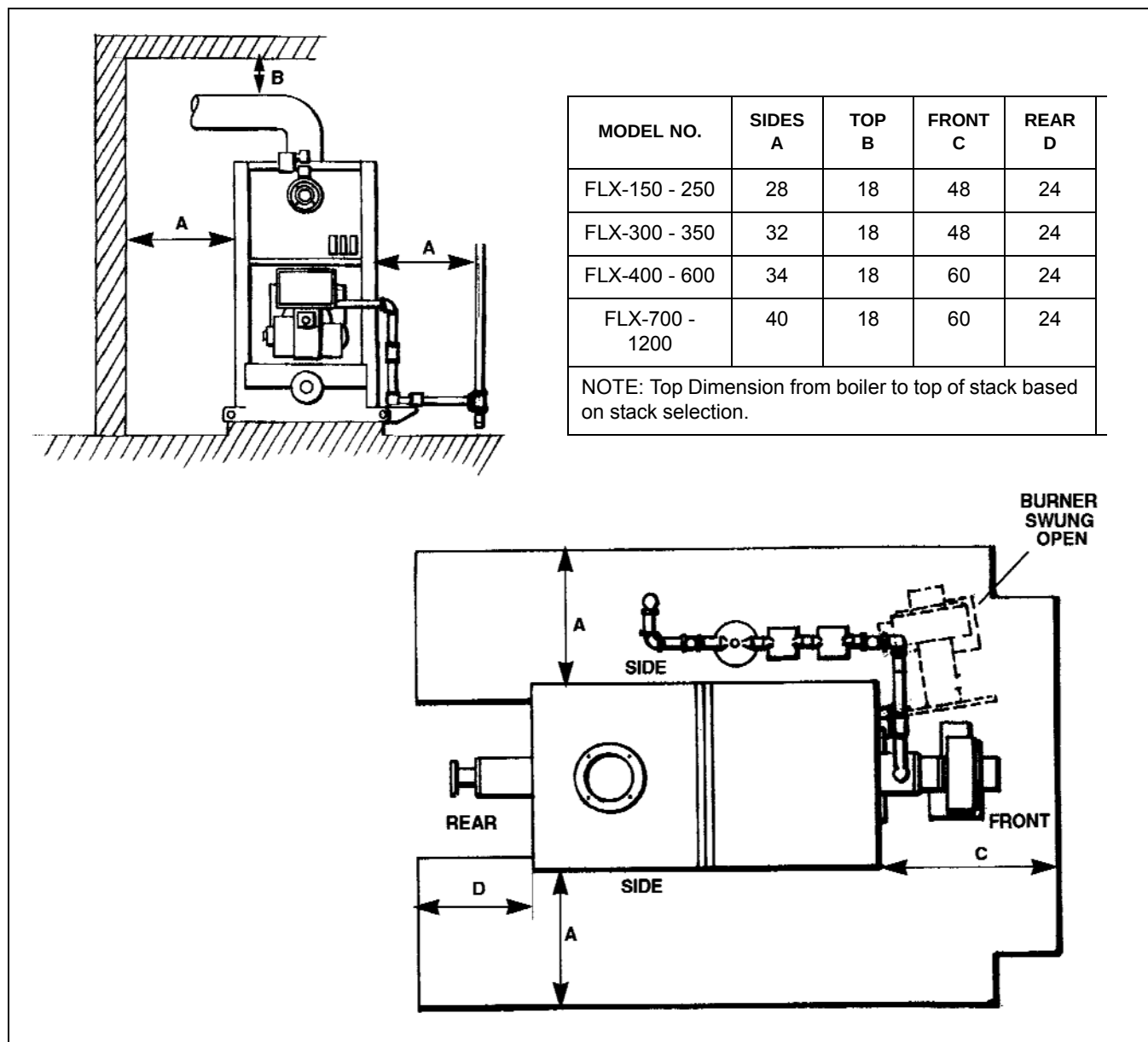


Figure B1-5. Model FLX Clearance Requirements

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

Sound Levels (dBA)

Refer to Table B1-11 for sound level information.

Outdoor Reset Control

Cleaver-Brooks does not recommend the use of outdoor controls which reset the boiler water outlet temperature below 150 °F, or the utilization of the boiler as a system thermostat.

Boiler Room Information

The boiler must be installed on a non-combustible floor. If the floor is not level, piers, or a raised pad, slightly larger in length and width than the boiler base dimensions, will make boiler installations and leveling easier. Installation on a raised pad or piers will make boiler drain connections more accessible. The floor, 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 for Model FLX series steam and hot water boilers are shown in Dimensions and Ratings.

After the boiler is in place it must be leveled. Both side-to-side and front-to-back level can be verified using the vertical connection between the upper and lower drums at the back of the boiler. If shims are required to level the boiler, the weight of the boiler must be evenly distributed at all points of support.

The boiler must be installed so that all components remain accessible for inspection, cleaning, or maintenance. Field-installed piping and electrical connections to the burner and boiler must be arranged to allow removal of the casing panels, and swinging of the burner.

Minimum clearances to walls or other obstructions and combustible materials are shown in Figure B1-5. The top view shaded sections in Figure B1-5 show areas that must be kept clear of field installed connections to the boiler for access or maintenance purposes.

A positive means of supplying a volume of outside air for complete fuel combustion is required. Proper ventilation of the boiler room must be provided. The amount of air required, and the required duct and air supply opening areas, are determined by the maximum fuel input rating of the burner and the altitude of the installation. Refer to Table B1-12. Air inlets must be sized in accordance with applicable engineering guidelines and regulatory code.

Breechings

For single boiler installations, use breeching of the same diameter as the vent outlet on the boiler. For multiple boiler installations, and when a number of boilers of the same size (input) are to be connected to a common breeching, use the table on Figure B1-6 to size the breeching diameter. For more information on breechings and stacks, refer to "Stacks," Section F.

Stack Support Capabilities

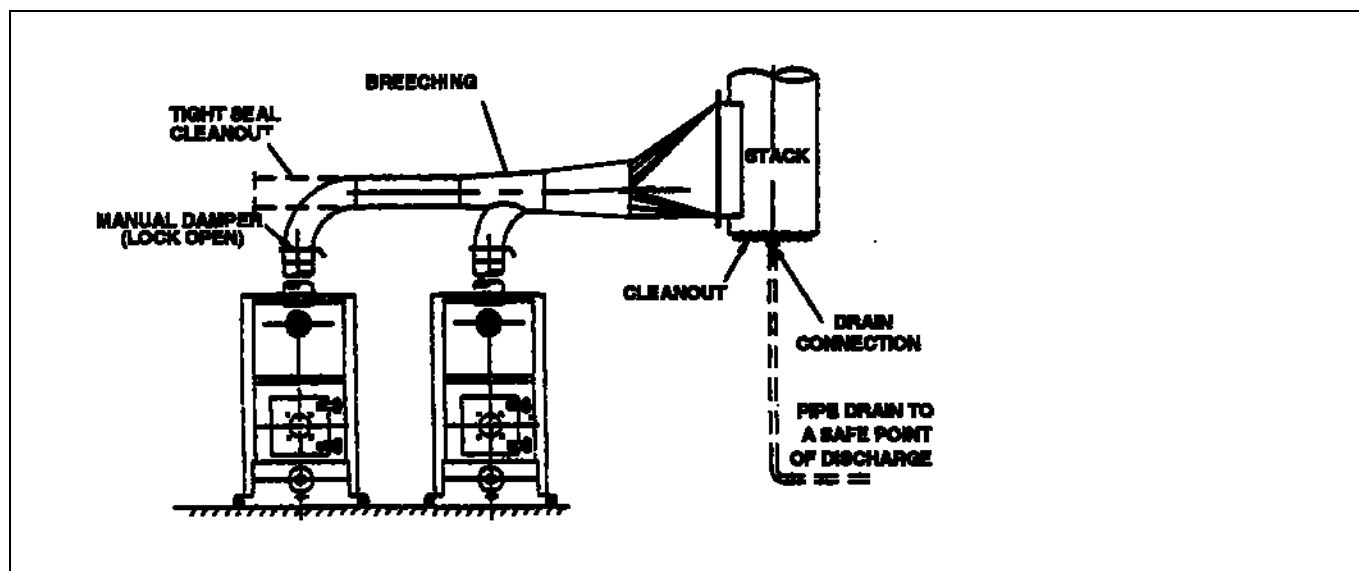
Flextube boilers can support up to 200 lbs without additional support.

Table B1-18. Model FLX Combustion Air Requirements

MODEL NO.		150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1200
Comb Air (Dry)	Gas (scfh)	15480	20640	25800	30960	36120	41280	46440	51600	56760	61920	72240	82560	92280	103200	113520	123840
	(lb/hr)	1207	1609	2012	2414	2817	3219	3621	4024	4426	4828	5633	6438	7243	8048	8853	9657
	Oil (scfh)	17050	22733	28414	34098	39782	45463	51146	56831	62514	68196	79562	90928	102294	113662	125028	136394
	(lb/hr)	1269	1692	2115	2538	2961	3384	3807	4231	4654	5077	5923	6769	7640	8462	9308	10154
Flue Gas (Dry)	Gas (scfh)	17520	23360	29200	35040	40880	46720	52560	58400	64240	70080	81760	93440	105120	116800	128480	140160
	(lb/hr)	1278	1704	2130	2556	2983	3409	3835	4261	4687	5113	5965	6817	7669	8521	9373	10225
	Oil (scfh)	17915	23886	29855	35827	41799	47769	53740	59713	65684	71655	83598	95541	107484	119427	131370	143312
	(lb/hr)	1357	1809	2261	2714	3166	3618	4070	4523	4975	5427	6330	7237	8142	9047	9951	10856

NOTES:

1. Natural gas @ 1000 Btu/cu-ft.
2. No. 2 oil @ 140,000 Btu/gal.

**Figure B1-6. Model FLX Breeching Arrangement - Single or Multiple Boiler Installation**

Notes

Model FLX Boilers
(Steam Boiler Specifications)

Boiler Capacity.....B1-28

General Design.....B1-28

Steam Boiler Trim.....B1-28

Burner and Controls.....B1-29

Burner Description.....B1-29

Pilot Gas Train for Each Burner (Mounted, Piped, and Wired) B1-30

Oil Burner.....B1-30

Gas Valve Train for Each Burner.....B1-30

Burner Controls.....B1-31

Warranty B1-32

Field Erectable.....B1-32

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application. A separate specification is provided for hot water boiler and steam boiler packages.



PART 1 GENERAL 1.1 BOILER CAPACITY

- A. The (low or high) pressure steam boiler shall be Cleaver- Brooks Model FLX (FLE for field erected) designed for (15 or 150) psig steam.
- B. The boiler shall have a maximum output of lbs/hr at psig when fired with No. 2 oil and/or natural gas, Btu/cu-ft. Electrical power available will be Volt, phase, Hz.

PART 2 PRODUCTS 2.1 GENERAL DESIGN

- A. The boiler shall be of a two-drum flexible watertube design with a tangent tube waterwall furnace mounted on a heavy steel frame. Top, bottom and sides of the furnace shall be water cooled.
- B. The boiler pressure vessel shall be constructed in accordance with ASME Boiler Code, and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser. The complete packaged boiler - burner unit shall be listed by Underwriters Laboratories', and shall have the UL/cUL label affixed to the front head.
1. The boiler drums shall be furnished with handholes to facilitate boiler inspection and cleaning.
 2. Boiler tubes shall be 1.5" diameter, 0.095" wall thickness, and shall be easy to remove and replace without expanding or welding the tube attachment to the drums.
 3. The boiler shall have sufficiently sized downcomers to provide positive natural internal circulation.
 4. The burner shall be mounted on a hinged backing plate for easy access to furnace.
- C. Observation ports for the inspection of flame conditions shall be provided at rear end of the boiler and in the burner assembly at the front end.
- D. The tangent wall tubes shall be covered with 1-1/2 inches of insulation under a gas-tight, 16-gauge inner casing. There shall be 2 inches of insulation between the inner and outer casing. The outer casing shall be 20 gauge. The boiler base frame and other components shall be factory-painted before shipment, using a hard enamel finish.

2.2 STEAM BOILER TRIM

- A. The following items shall be installed on the boiler:
1. Low Water Cutoff - A low water cut-off control of the float-type shall be mounted in a water column to the upper drum. It is to be wired to the burner control circuit to prevent burner operation if the boiler water falls below proper levels.
 2. Feedwater Pump Control - The boiler feedwater pump control switch shall be included. It shall provide automatic actuation of a motor-driven feedwater pump, or solenoid valve, to maintain the boiler water level within normal limits.
 3. Steam Pressure Controls - A minimum of three controls shall be provided: one auto reset type for burner on-off control, one for burner firing rate, and one manual reset type for burner cutout in excessive steam pressure conditions.
 4. Miscellaneous - A pressure gauge shall be mounted to the boiler. Pressure controls (for regulation of burner operation) shall be mounted to the boiler. Steam relief valves shall be of a type and size to comply with ASME Code requirements (shipped loose).

2.3 BURNER AND CONTROLS

- A. The boiler shall be provided with a UL/cUL approved fuel burning system in full accordance with the requirements of state, provincial and local codes, the local gas utility, and other applicable regulatory bodies. The boiler shall be a Cleaver-Brooks Profire burner.
- B. (Option as required)
- C. The complete fuel burning system shall further be in full accordance with Factory Mutual (FM) requirements.
- D. The complete fuel burning system shall further be in full accordance with Industrial Risk Insurers (IRI) requirements.

2.4 BURNER DESCRIPTION

- A. Option (specify 1, 2, or 3)
 - 1. The burner shall include a gas burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/cu-ft of _____ gas at a pressure of _____ (lbs/sq-inch) (inches of water column) at the inlet of the burner gas control train.
 - 2. The burner shall include an oil burner having rated capacity to burn _____ gph of No. 2 fuel oil.
 - 3. The burner shall include a combination gas-oil burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/cu-ft gas at a pressure of _____ lbs/sq-inch (inches of water column) at the inlet to the burner gas control train (or _____ gph of No. 2 fuel).
- B. The burner shall be forced draft type with full firing rate modulation.
All combustion air shall be furnished by the burner fan, which shall be an integral part of the burner. Each burner motor shall not be larger than _____ hp, _____ phase.
- C. Option (specify 1, 2, or 3)
 - 1. The gas burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
 - 2. The light oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and a maximum of No. 1 smoke spot, as measured on the Bacharach Scale.
 - 3. The gas-oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion on gas firing, and a maximum of No. 1 smoke, as measured on the Bacharach Scale when burning oil. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
- D. Primary-secondary air control shall be a design function of the combustion head.
Combustion heads requiring an internal adjustment shall not be acceptable.
- E. The burner shall be equipped with an aluminum reverse curve fan for lower fan motor hp requirements and self-cleaning characteristics.

F. A permanent observation port shall be provided in the burner to allow observation of both the pilot and main flame. Both the pilot and the flame scanner shall be easily accessible without opening or disassembling the burner.

G. Supply voltage available shall be Volts, phase, 60 Hz. All motors shall be suitable for use on this voltage. All burner controls are to be for use on 120 volts, 1 phase, 60 hz.

H. The burner shall be factory fire-tested to ensure proper operation before shipment.

2.5 PILOT GAS TRAIN FOR EACH BURNER (MOUNTED, PIPED, AND WIRED)

A separate pilot gas cock, gas pressure regulator, and pilot safety shutoff gas valve shall be provided for the ignition gas supply.

2.6 OIL BURNER

A. The oil burner shall be of the mechanical pressure atomizing type. B. A two-stage oil pump shall be provided for each burner as an integral part of the burner.

C. Two approved automatically operated safety shutoff valve(s) shall be provided in the oil supply line to the burner valves to be piped in series but wired parallel.

D. Supply an oil pressure gauge to indicate the discharge oil pump pressure.

E. Install a manual valve, fuel oil filter, or strainer and vacuum gauge on the suction side of the oil pump (optional).

F. Install a fusible-link-actuated oil safety shutoff valve in the oil supply line between the oil tank and the manual gate valve at the oil pump (optional).

G. Oil pressure monitoring shall be provided by an approved pressure switch interlocked to accomplish a non-recycling safety shutdown in the event of low oil pressure (optional).

2.7 GAS VALVE TRAIN FOR EACH BURNER

A. Provide a pressure gauge to indicate the gas burner manifold pressure (optional).

B. Furnish and install one manually operated, inch, ball valve upstream of all valves.

C. Provide one inch, main gas pressure regulator (of tight shutoff type) with vent to outside atmosphere, in accordance with local codes.
Specify a tight shutoff type gas pressure regulator when the inlet gas pressure exceeds 1-1/2 psig.

D. Provide one inch, automatically operated motorized safety gas valve.

E. One safety shutoff valve shall be proven closed during pre- ignition by proof of valve closure interlock switch on valve.

F. Provide a second inch, automatically operated gas safety shutoff valve to operate simultaneously with the above gas valve.

G. A manually operated gas valve shall be located downstream of both automatic gas valves to permit leakage testing of the valves.

- H. Gas pressure monitoring shall be provided by approved pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of either high or low gas pressure (optional on sizes 150-250).

2.8 BURNER CONTROLS

- A. The full modulation of the burner shall be controlled by steam pressure by means of a pressure control.
- B. An additional high limit safety pressure control of the manual reset type shall be provided to control the burner.
- C. Pre-purge and post-purge operation of the burner fan shall be provided per current UL/cUL requirements.
- D. The burner shall utilize a CB12E type flame safeguard programmer incorporating LED indicator lights to annunciate the current operating status of the burner.
- E. A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.
- F. All three-phase motors shall be controlled and protected by an automatic starter with thermal overload protection. The starter shall be inter-locked to prevent burner operation when over-load relays are tripped out.
- G. Supply a burner-mounted diaphragm air flow switch to prevent the energization of the main fuel valves in the event of insufficient combustion air, or to provide safety shutdown in the event of combustion air interruption.
- H. A factory-wired control cabinet shall be supplied and mounted on the burner. The control cabinet shall house the flame safeguard control, programming timer, burner motor starter, fuses, control circuit transformer, control switches, indicating lamps and relays as required.
- I. Provide four individual lights with nameplates on the control cabinet to indicate "call for heat," "main fuel valve on," "low water," and "main flame failure."
- J. Option (specify A or B)
1. The changing from one fuel to the other shall be manual by means of a fuel selector switch. No burner adjustments shall be required to switch from one fuel to the other.
 2. Changing from one fuel to the other shall be automatically controlled by the outdoor temperature switch, or other external device. No burner adjustment shall be required to switch from one fuel to the other.
- K. The burner shall be equipped with suitable fuel and air controls to assure smooth main flame ignition. The burner shall utilize a proportional air flow damper design, including independent low-fire and high-fire air flow shutter assemblies for ease of adjustment and consistent excess air performance throughout the firing range.
- L. Fuel-air control shall be synchronized. The fuel air drive unit shall be provided with a position indicating switch interlocked with the flame safeguard system to assure starting at the low fire position. The flame safeguard system shall further program this drive unit to provide a full open louver of sufficient time to provide a four air change pre-ignition of the combustion chamber, heat exchanger, and flue passages.

- M. Pre-ignition pure air flow rate shall not be less than 60% maximum firing rate air flow. Interlocks shall be provided to monitor and prove 60% air flow purge when air inlet louvers are automatically opened to obtain this rate.
- N. Full modulation of fuel input shall be provided. A modulating pressure control shall be supplied to modulate a burner mounted damper motor controlling both fuel and air supply by means of direct mechanical linkage.
- O. Electronic safety combustion controls shall be supplied, complete with ultra-violet flame scanner to monitor the pilot and main flame. It shall be so utilized as to provide intermittent type gas-electric ignition and pre-ignition timer. Flame rod will not be permitted for proving pilot or main flame.

PART 3 EXECUTION 3.1 WARRANTY

All equipment is to be guaranteed against defects in material and/or workmanship for a period of 12 months from the date of start-up or 18 months from the date of shipment, whichever ever comes first. In addition the boiler pressure vessel shall be warranted against damage resulting from thermal stress for a period of 20 years from date of shipment provided the boiler is operated and maintained in accordance with the conditions specified in the owner's Operator and Maintenance Manual. Refer to the FLX Boiler warranty.

3.2 FIELD ERECTABLE

The specified boiler/burner package shall be shipped disassembled for field assembly. All pieces and components must fit through a standard doorway. Assembly shall be accomplished with ordinary hand tools, with no welding or rolling required. Major casing components are to be shipped with insulation and refractory installed for ease of assembly.

Model FLX Boilers
(FLX Hot Water Boiler Specifications)

Boiler Capacity.....B1-34

General Boiler Design B1-34

Hot Water Boiler Trim B1-34

Burner and Controls.....B1-35

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SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application. A separate specification is provided for hot water boiler and steam boiler packages.



PART 1 GENERAL 1.1 BOILER CAPACITY

- A. The hot water boiler shall be Cleaver-Brooks Model FLX (FLE for field erected), designed for 160 psig (hot water). Maximum water temperature shall be °F, and maximum system temperature drop shall be °F.
- B. The boiler shall have a maximum output of Btu/hr when fired with No. 2 oil, and/or Btu/cu- ft when fired with natural gas. Available electrical power will be Volt, phase, Hz.

PART 2 PRODUCTS 2.1 GENERAL BOILER DESIGN

- A. The boiler shall be a two-drum, flexible watertube design with a tangent-tube waterwall furnace mounted on a heavy steel frame. Top, bottom and sides of the furnace shall be water cooled.
- B. The boiler pressure vessel must be constructed in accordance with ASME Boiler Code, and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser. The complete packaged boiler - burner unit shall be listed by Underwriters Laboratories, and shall have the UL/cUL label affixed to the front head.
1. The boiler drums shall be furnished with handholes to facilitate boiler inspection and cleaning.
 2. Boiler tubes shall be 1.5" diameter, with 0.095" wall thickness, and shall be easy to remove and replace without expanding or welding the tube attachment to the drums.
 3. The boiler shall have a sufficiently sized downcomer to provide natural internal circulation.
 4. The burner shall be mounted on a hinged backing plate for easy access to the furnace.
- C. Observation ports for the inspection of flame conditions shall be provided at the rear of the boiler, and in the burner assembly at the front.
- D. The tangent wall tubes shall be covered with 1-1/2 inches of insulation under a gas-tight, 16-gauge inner casing. There shall be 2 inches of insulation between the inner and outer casing. The outer casing shall be 20 gauge. The boiler base frame and other components shall be factory-painted before shipment, using a hard enamel finish.

2.2 HOT WATER BOILER TRIM

- A. The following items will be installed on the boiler.
1. Low Water Cut-Off: A probe-type, low water cut-off control shall be mounted in the upper drum. It is to be wired to the burner control circuit to prevent burner operation if the boiler water falls below a safe level.
 2. Miscellaneous: A combustion temperature and pressure gauge shall be mounted on the boiler. Temperature controls, for regulation of burner operation, shall be mounted on the boiler and the temperature sensing element shall be located adjacent to the boiler outlet. Water relief valves (shipped loose) shall be of a type and size to comply with ASME Code requirements.

2.3 BURNER AND CONTROLS

- A. The boiler shall be provided with a UL/cUL approved fuel burning system in full accordance with the requirements of state, provincial and local codes, the local gas utility, and other applicable regulatory bodies. The burner shall be a Cleaver-Brooks ProFire burner or approved equal.
- B. Option (specify 1.) or 2.), as required)
1. The complete fuel burning system shall be in full accordance with Factory Mutual (FM) requirements.
 2. The complete fuel burning system shall be in full accordance with Industrial Risk Insurers (IRI) requirements.
- C. Burner Description
1. Option (specify a, b, or c)
 - a. The boiler shall include a gas burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/cu-ft of _____ gas at a pressure of _____ (lbs/sq-in.) _____ (inches of water column) at the inlet of the burner gas control train.
 - b. The boiler shall include an oil burner having rated capacity to burn _____ gph of No. 2 fuel oil.
 - c. The boiler shall include a combination gas-oil burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/ cu-ft gas at a pressure of _____ (lbs/sq-in.) _____ (inches of water column) at the inlet to the burner gas control train or _____ gph of No. 2 fuel.
 2. The burner shall be forced draft type with full firing rate modulation. All combustion air shall be furnished by the burner fan, which shall be an integral part of the burner. Each burner motor shall not be larger than _____ hp, _____ phase.
- D. Option (specify 1.), 2.), or 3.))
1. The gas burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than _____ 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
 2. B. The light oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and a maximum of No. 1 smoke spot, as measured on the Bacharach Scale.
 3. C. The gas-oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion on gas firing, and a maximum of No. 1 smoke spot, as measured on the Bacharach Scale when burning oil. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
- E. Primary-secondary air control shall be a design function of the combustion head. Combustion heads requiring an internal adjustment shall not be acceptable.
- F. The burner shall be equipped with an aluminium reverse curve fan for lower fan motor hp requirements and self-cleaning characteristics.
- G. A permanent observation port shall be provided in the burner to allow observation of both the pilot and main flame. Both the pilot and the flame scanner shall be easily accessible without opening or disassembling the burner.

H. Supply voltage available shall be Volts, phase, 60 Hz. All motors shall be suitable for use on this voltage. All burner controls are to be for use on 120 volts, 1 phase, 60 Hz.

I. The burner shall be factory fire-tested to ensure proper operation before shipment.

2.4 PILOT GAS TRAIN FOR EACH BURNER (MOUNTED, PIPED, AND WIRED)

A separate pilot gas cock, gas pressure regulator, and pilot safety shutoff gas valve, shall be provided for the ignition gas supply.

2.5 OIL BURNER

A. The oil burner shall be of the mechanical pressure atomizing type. B. A two-stage oil pump shall be provided for each burner as an integral part of the burner.

C. Two approved automatically operated safety shutoff valve(s) shall be provided in the oil supply line to the burner valves to be piped in series but wired parallel.

D. Supply an oil pressure gauge to indicate the discharge oil pump pressure.

E. Install a manual valve, fuel oil filter, or strainer and vacuum gauge on the suction side of the oil pump (optional).

F. Install a fusible-link-actuated oil safety shutoff valve in the oil supply line between the oil tank and the manual gate valve at the oil pump (optional).

G. Oil pressure monitoring shall be provided by an approved pressure switch interlocked to accomplish a non-recycling safety shutdown in the event of low oil pressure (optional).

2.6 GAS VALVE TRAIN FOR EACH BURNER

A. Provide a pressure gauge to indicate the gas burner manifold pressure (optional).

B. Furnish and install one manually operated, inch, ball valve upstream of all valves.

C. Provide one inch, main gas pressure regulator (of tight shutoff type) with vent to outside atmosphere, in accordance with local codes.

Notice

Specify a tight shutoff type gas pressure regulator when the inlet gas pressure exceeds 1-1/2 psig.

D. Provide one inch, automatically operated motorized safety gas valve. One safety shutoff valve shall be proven closed during pre- ignition by proof of valve closure interlock switch on valve.

E. Provide a second inch, automatically operated gas safety shutoff valve to operate simultaneously with the above gas valve.

F. A manually operated gas valve shall be located downstream of both automatic gas valves to permit leakage testing of the valves.

G. Gas pressure monitoring shall be provided by approved pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of either high or low gas pressure (optional on sizes 150-250).

2.7 BURNER CONTROLS

- A. The full modulation of the burner shall be controlled by water temperature by means of a temperature control.
- B. An additional high limit safety temperature control of the manual reset type shall be provided to control the burner.
- C. Pre- and post- operation of the burner fan shall be provided per current UL/cUL requirements.
- D. The burner shall utilize a Fireye™ CB120E type flame safeguard programmer, incorporating LED indicator lights to annunciate the current operating status of the burner.
- E. A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.
- F. All three-phase motors shall be controlled and protected by an automatic starter with thermal overload protection. The starter shall be inter-locked to prevent burner operation when over-load relays are tripped out.
- G. Supply a burner-mounted diaphragm air flow switch to prevent energizing the main fuel valves in the event of insufficient combustion air, or to provide safety shutdown in the event of combustion air interruption.
- H. A factory-wired control cabinet shall be supplied and mounted on the burner. The control cabinet shall house the flame safeguard control, programming timer, burner motor starter, fuses, control circuit transformer, control switches, indicating lamps, and relays as required.
- I. Provide four individual lights with nameplates on the control cabinet to indicate “call for heat,” “main fuel valve on,” “low water,” and “main flame failure.”
- J. Option (specify 1.) or 2.))
 - 1. The changing from one fuel to the other shall be manual by means of a fuel selector switch. No burner adjustments shall be required to switch from one fuel to the other.
 - 2. Changing from one fuel to the other shall be automatically controlled by an outdoor temperature switch, or other external device. No burner adjustment shall be required to switch from one fuel to the other.
- K. The burner shall be equipped with suitable fuel and air controls to assure smooth main flame ignition. The burner shall utilize a proportional air flow damper design, including independent low-fire and high-fire air flow shutter assemblies for ease of adjustment and consistent excess air performance throughout the firing range.
- L. Fuel-air control shall be synchronized. The fuel air drive unit shall be provided with a position indicating switch interlocked with the flame safeguard system to assure starting at the low fire position. The flame safeguard system shall further program this drive unit to provide a full open louver of sufficient time to provide a four air change pre-ignition of the combustion chamber, heat exchanger, and flue passages.

- M. Pre-ignition pure air flow rate shall not be less than 60% maximum firing rate air flow. Interlocks shall be provided to monitor and prove 60% air flow purge when air inlet louvers are automatically opened to obtain this rate.
- N. Full modulation of fuel input shall be provided. A modulating temperature control shall be supplied to modulate a burner mounted damper motor, controlling both fuel and air supply by means of direct mechanical linkage.
- O. Electronic safety combustion controls shall be supplied, complete with ultra-violet flame scanner to monitor the pilot and main flame. It shall be so utilized as to provide intermittent type gas-electric ignition and pre-ignition timer. Flame rod will not be permitted for proving pilot or main flame.

PART 3 EXECUTION 3.1 WARRANTY

All equipment is to be guaranteed against defects in material and/or workmanship for a period of 12 months from the date of start-up or 18 months from the date of shipment, whichever ever comes first. The boiler pressure vessel shall be warranted against damage resulting from thermal stress for a period of 20 years from date of shipment, provided the boiler is operated and maintained in accordance with the conditions specified in the owner's Operating and Maintenance Manual.

3.2 FIELD ERECTABLE

The specified boiler/burner package shall be shipped disassembled for field assembly. All pieces and components must fit through a standard doorway. Assembly shall be accomplished with ordinary hand tools, with no welding or rolling required. Major casing components are to be shipped with insulation and refractory installed for ease of assembly.

MODEL 4 BOILER

1,500 - 6,000 MBTU &
Watertube Boiler



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This section contains information on the Model 4 Commercial Watertube Boiler product line for low and high pressure steam applications. Sizes range from 1.5 to 6 MMBtu/hr. The Model 4 Boiler is an excellent choice where high outputs are needed but space limitations exist. The model number designation is 1500 through 6000, representing MBtu/hr input (1,500,000 to 6,000,000 Btu/hr).

Fuel series designation is as follows:

- Series 100: No. 2 oil firing.
- Series 700: Natural gas firing.
- Series 200: No. 2 oil/natural gas firing.

Design pressure designation is stated as 15 psig, 150 psig, and 250 psig for steam. For example, an M4P-700-2500-150ST boiler designates a gas-fired, 2,500,000 Btu/hr, 150 psig, steam boiler.

FEATURES AND BENEFITS

The following features and benefits apply to the Model 4 Boiler product line.

33" Cased Width:

- Boiler fits through most standard doorways.
- Reduced installation costs.

Direct Driven, Vibration-Free Centrifugal Impeller:

- Quiet operation.
- Sound levels below 79 dBA.
- Ideal for noise critical areas such as hospitals, churches, etc.

Minimum Refractory:

- Membrane waterwalls reduce the need for refractory by 95%.
- Reduced maintenance costs and refractory repair requirements.

Membrane Waterwalls:

- Enhanced heat transfer area in compact design.
- Full water wall furnace improves heat transfer for high efficiency.

Small Boiler Footprint:

- Savings of up to 50% in floor space.

Weighs up to 40% less than Comparable Boilers:

- Lower freight and rigging costs.
- Reduced structural requirements.

Standard Built-in Soot Washers:

- Boiler fireside cleaning without shutdown.
- Maintains peak boiler performance.

Packaged Forced Draft Burner:

- High pressure drop design.
- Optimum fuel and air mixing.
- Improved combustion efficiency.

Burner/Windbox Davit:

- Easy access to furnace with swing-open windbox.
- Reduced maintenance costs.

Steam Design Pressures to 500 psig (optional):

- High performance in a compact design.
- Proven vessel design for high design pressure applications.

PRODUCT OFFERING

The Model 4 (M4) Boiler is a compact carbon steel, extended fin, watertube boiler. Heat transfer design is configured in a "3-pass" gas travel across the watertube surfaces. The pressure vessel is constructed to conform to the A.S.M.E. Code, either Section IV for low pressure steam @ 15 PSIG MAWP (maximum allowable working pressure) or Section I for MAWP greater than 15 PSIG.

The vessel (boiler) consists of two rows on each side of the vessel, of formed seamless tubes with extended fin surfaces and downcomers connected to the steam drum and lower drum. To reduce standby losses, the vessel is insulated with a fiberglass blanket and removable steel jacket.

Complete with an integral burner for either No.2 fuel oil or Natural Gas, the complete burner/boiler package is UL Approved, listed, and labeled.

Standard Equipment

The standard boiler/burner package is described below. Optional controls, trim, and devices may be added to meet project requirements. Some of those options are noted following this standards list.

1. Boiler

A. Designed, constructed, and hydrostatically tested in accordance with the A.S.M.E. Boiler and Pressure Vessel Code. The complete vessel is mounted on a structural steel frame.

B. Steam drum includes a hand hole in the rear head for drum water side inspection. Connections are included for the following:

- Feedwater Makeup w/internal dispersion tube.
- Surface Blowoff.
- Steam Supply.
- Safety Relief Valve.

C. Lower Drum includes hand holes at each end for waterside inspection. A drain/blowoff tapping is provided at the front, bottom centerline.

D. Soot washer lances are provided on each side of the vessel between the two rows of tubes for fireside cleaning. Soot washer drains are located at the bottom of the boiler, with connections to drain located on each side of the lower drum at the rear.

E. Refractory is limited to the furnace floor, lower drum, and burner throat tile. High temperature insulation is installed on the front water wall and furnace access door.

F. Two lifting eyes are provided on the top centerline of the upper drum for ease of installation.

G. Furnace inspection/access door is provided in the furnace front wall.

H. The exhaust gas vent is located at the top rear centerline of the boiler. A stack thermometer is shipped loose for field installation by the installing contractor into the stack.

I. The complete vessel is fully insulated (2" fiberglass blanket) under a preformed, sectional steel jacket.

Table B2-1. Model 4 Boiler Sizes

MODEL NO.	INPUT MBH	HEAT OUTPUT MBH	EQUIV HP	STEAM OUTPUT LB/HR	SHIPPING WEIGHT LBS
1500	1500	1200	35	1237	3100
2000	2000	1600	47	1649	3100
2500	2500	2000	59	2062	3700
3000	3000	2400	71	2474	3700
3500	3500	2800	83	2887	4100
4000	4000	3200	95	3299	4100
4500	4500	3600	107	3711	4700
5000	5000	4000	119	4124	4700
6000	6000	4800	143	4949	5400

NOTE: Steam output from and at 212 °F.

J. Factory painted using hard-finish enamel.

2. Forced Draft Burner

A. The burner is a high radiant multi-port type approved for operation on natural gas and a pressure atomizing type approved for operation with commercial grade No. 2 fuel oil.

B. Consisting of the fan which is direct connected to the fan motor, wind box, air damper that is linkage connected to a damper drive motor, the complete assembly is factory mounted and tested.

C. To ensure proper air for pre purge and combustion is provided by the fan, a combustion air proving switch is provided.

D. The complete burner/wind box swings open via a davit arm attached to the upper drum. This permits fireside inspection of the furnace and burner internals.

E. Responding to steam demand from the drum mounted pressure control, the burner operates in the low-high-low-off firing mode. Ultra-violet (UV) flame scanner is provided for flame presence during firing.

F. An Ignition transformer is provided.

G. Ignition is direct spark on straight oil fired burners, and gas pilot on straight gas or combination gas/oil burners.

H. Oil Train consists of the following:

- 4 Solenoid Shutoff Valves providing low fire, intermediate transitional firing from low to high and high fire.
- An oil pump is mounted (belt driven from the fan motor) for pressure atomization of the fuel oil.
- Oil Pressure Gauge.
- Suction and return tubing connected to an oil connection block.

Gas Train consists of the following:

- Primary gas shutoff valve with integral proof of closure switch.
- A manual shutoff valve located ahead of the primary gas valve.
- A plugged leakage test connection and a second manual shutoff valve for tightness checking of the primary shutoff valve.
- Separate Gas Pressure Regulators for the pilot train and main gas train.
- Low Gas Pressure and High Gas Pressure Switches for units at 3000 and greater.
- A second motorized gas valve is provided in addition to the primary valve on size 6000 units.
- The pilot gas train includes a manual shutoff valve and solenoid shutoff valve.

3. Boiler Trim and Controls

- A. 15 psig or 150 psig set A.S.M.E. safety relief valves.
- B. Steam pressure gauge with inspectors test cock and connection.
- C. Primary Water Column complete with gauge glass and column drain valve.
- D. Low Water cutoff switch and pump control switch, integrally mounted in the primary water column.
- E. Auxiliary Low Water Cutoff, manual reset type.
- F. Steam Pressure Controls:
 - Operating Limit.
 - Excess Steam Pressure (High Limit), manual reset.
 - Burner firing rate, low high low.

4. Burner Control Panel and Controls

- A. The control panel is enclosed within a NEMA 1A Rated enclosure, mounted on the burner wind box at approximately eye level height.
- B. Mounted within or on the control panel box are the following controls. Panel wiring is factory tested.
 - Combustion Flame Safeguard Control, Model CB120 that provides pre purge, post purge, trial for ignition, main flame/burner operation, and safety shutdown.
 - Fan Motor Starter wired into the non recycling circuit of the flame safeguard control.
 - Indicating Lights for low water, flame failure, load demand, and fuel valve on.
 - Burner On/Off Switch.
 - Damper Positioning Switch.
 - Fuel Selector Switch for combination fuel fired burners.
 - Control Circuit Step-down Transformer with primary fuse protection.
 - Terminals for interface wiring connection of controls.
 - Oil, heat, and moisture resistant wire used. Each wire is number coded relative to the wiring diagram.

5. Electric Service Panel

An electric service panel (entrance box) is provided on the side of the boiler for all external wiring connections to remote control devices and the main power for the boiler. Wiring to this panel eliminates the need to disconnect wiring when the front burner wind box is opened for burner or boiler servicing.

Optional Equipment

For more detailed information on optional equipment, contact your local Cleaver-Brooks authorized representative. In summary, options include the following:

1. Boiler

- Larger pressure gauges or specific manufacturer type.
- Bottom Drain Valves for low pressure applications.
- Bottom Blowoff Valves for high pressure applications.
- Surface Blowoff Valve with internal collector pipe.
- Feedwater Stop and Check Valves.
- Steam Stop Valve.
- ASME Hydro Test of Valves and Valve Piping.
- Design pressures above 150 PSIG.

2. Burner/Control Options

- Full Modulation Firing on Gas.
- Lead/Lag Control.
- Day-Night Controls.
- Low Fire Hold Control.
- Elapsed Time Meter.
- Alarm with silence switch.
- Additional Indicator Lights.
- Main Power Disconnect.
- Remote Oil Pump.
- Optional NEMA Enclosures.
- Special Fan Motor requirements (TEFC).

3. Fuel Options

- Automatic Fuel Changeover (combination burner).
- Propane Fuel Firing.
- Special Gas Pressure Regulators.
- Special fuel shut-off valves.
- Dual Pilots (gas and oil).
- Gas strainer.

Insurance/Codes

The boiler package can be equipped to meet various insurance or code requirements. Some of these insurance/code requirements are:

- Factory Mutual (FM)
- XL GAP (Formerly GE GAP/IRI).
- A.S.M.E. CSD-1.

A. Factory Mutual (FM Global) - Recommended guidelines as described by FM pertain to boilers rated at greater than 2.5 MMBtu/hr input on gas and 2.8 MMBtu/hr input on oil. Boilers that are labeled and tested in accordance with an independent testing lab such as UL or CSA and are below these inputs are exempt from these recommendations.

The Model 4 boiler is UL listed and labeled. In addition to the standard UL requirements the following are needed to comply with FM when required.

- Alarm Bell with silence switch for low water and safety shutdowns.
- Low Oil Pressure Switch if the oil pump is not direct driven from the fan motor.

B. XL GAP (Formerly GE GAP/IRI) Recommended guidelines as described by XL GAP pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBtu/hr input. For

these boilers, the requirements are the same as for A.S.M.E CSD-1 requirements. Above 12.0 MMBtu/hr input, the requirements defer to the NFPA 85 standards for single burner boilers.

C. A.S.M.E. CSD-1 - Recommended guidelines as described by this Code pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBtu/hr input. Above 12.0 MMBtu/hr input, the requirements defer to the NFPA 85 standards for single burner boilers. For the sizes this Code covers, the requirements are as follows, in addition to the standard UL package:

- Low Oil Pressure Switch for oil firing
- 3/4" Pressure Control Piping
- If gas supply is > 5 psig, a relief valve is required after the gas pressure regulator in the main and pilot gas trains.
- Lever Handled shutoff cock for the pilot gas train.
- Non-fused disconnect to remove boiler from all sources of power.

DIMENSIONS AND RATINGS

For layout purposes, the nominal dimensions and connections for the Model 4 Standard Package Boiler are shown in Figure B2-1 and Table B2-2. Ratings of each boiler size are noted in Table B2-3. Additional information is shown in the following figures, tables, and illustrations.

Table B2-4: Recommended steam nozzle sizes for high pressure boilers operating at lower and higher pressures.

Figure B2-2: Standard gas train dimensions and components.

Table B2-5: Natural Gas Pressure Requirements, standard gas train size.

Table B2-6: Natural Gas Pressure Requirements, oversized gas train.

Table B2-7: Propane Gas Pressure Requirements, standard gas train size.

Table B2-8: Propane Gas Pressure Requirements, oversized gas train.

Table B2-9: Safety Valve Outlet Sizes.

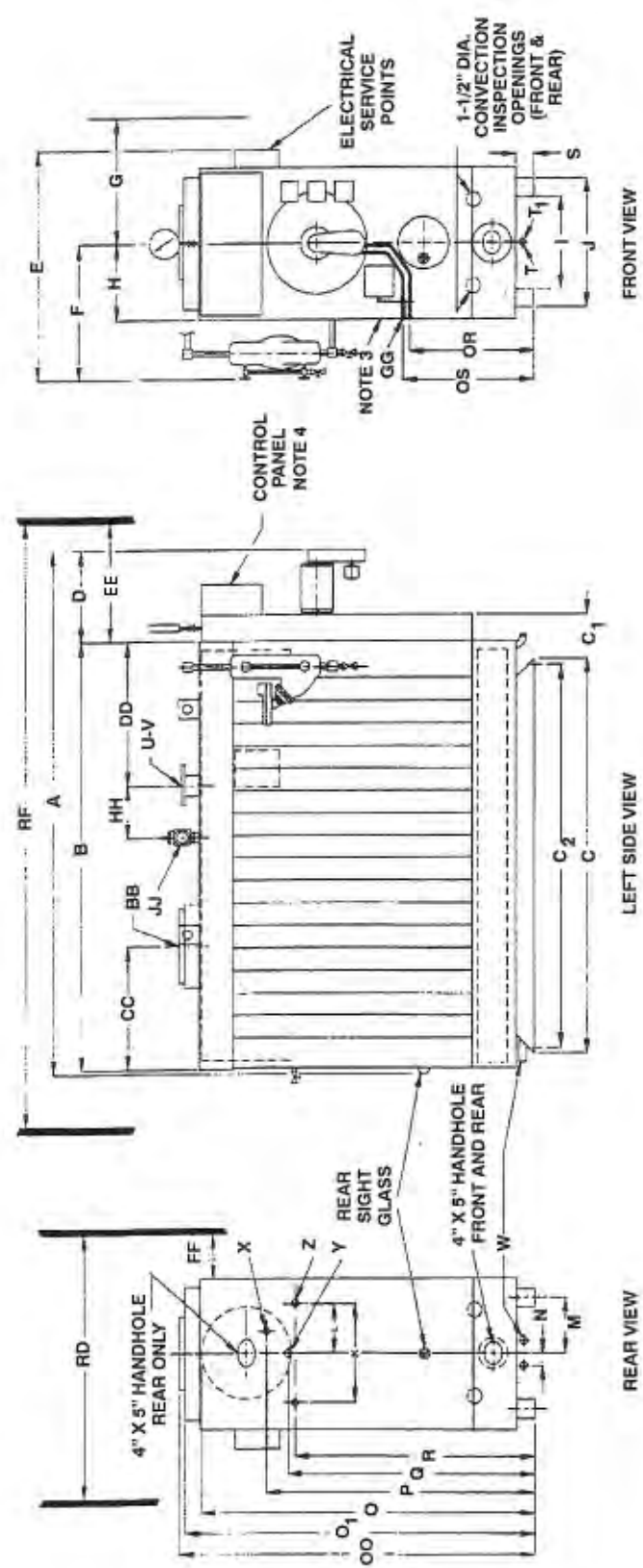


Table B2-2. Model 4 Dimensions

		Boiler Size								
Note 1		1500	2000	2500	3000	3500	4000	4500	5000	6000
<u>Lengths</u>		All Dimensions are in inches								
A	Overall	84.25	84.25	100.25	100.25	117.375	117.375	136.75	136.75	152.375
B	Pressure Vessel w/casing	61	61	77	77	92.375	92.375	109	109	124.625
C	Base Frame	54	54	69.625	69.625	85.25	85.25	101	101	116.5
C ₁	Base to Burner/W indbox	9.625	9.625	9.625	9.625	9.625	9.625	10	10	10
C ₂	Base Frame Anchor Holes	51.5	51.5	67.125	67.125	82.75	82.75	98.375	98.375	114
CC	Rear Casing to Stack Connection	25.8	25.8	26.25	26.25	26.25	26.25	30.375	30.375	30.375
D	Burner/W indbox Extension	20.1	20.1	20.1	20.1	21.9	21.9	24.6	24.6	24.6
DD	Front Casing to Steam Nozzle	17.25	17.25	25.25	25.25	30.75	30.75	37.375	37.375	45.25
HH	Steam Nozzle to Safety Valve 15#	8	8	12	12	11.5	11.5	13	13	17
	Steam Nozzle to Safety Valve 150#	8	8	12	12	17	17	17	17	17
<u>Widths</u>										
E	Overall	53.25	53.25	53.25	53.25	53.25	53.25	53.25	53.25	53.25
F	Center to Water Column	32.4	32.4	32.4	32.4	32.4	32.4	32.4	32.4	32.4
G	Center to Opt. Aux. Water Column	26.6	26.6	26.5	26.6	26.6	26.6	26.6	26.6	26.6
H	Center to Outside Casing	16.375	16.375	17.375	16.375	16.375	16.375	16.375	16.375	16.375
I	Base Frame Inside	20	20	20	20	20	20	20	20	20
J	Base Frame Outside	28	28	28	28	28	28	28	28	28
K	Soot Washers, Center to Center	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
L	Boiler Centerline to Soot Washer	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7
M	Boiler Centerline to Base Centerline	12	12	12	12	12	12	12	12	12
N	Boiler Centerline to Soot Drain	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.25
<u>Heights</u>										
OO	Overall [Base to Stack Connection]	78.75	78.75	78.75	78.75	78.75	78.75	78.75	78.75	78.75
O	Base to Steam Nozzle 150#	74.75	75.75	74.75	74.75	74.75	74.75	78	78	78
O ₁	Base to Steam Nozzle 15#	75	75	75	75	78.25	78.25	78.25	78.25	78.25
O ₂	Base to Stack Box	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8
O ₂	Base to Top of Control Panel	83.25	83.25	83.25	83.25	83.25	83.25	83.25	83.25	83.25
P	Base to Surface Blowoff	59.25	59.25	59.25	59.25	59.25	59.25	59.25	59.25	59.25
Q	Base to Feedwater Inlet	57.25	57.25	57.25	57.25	57.25	57.25	57.25	57.25	57.25
R	Base to Soot Washer Lance	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5
S	Height of Base	4	4	4	4	4	4	4	4	4
OS	Base to Oil Supply Connection	27.75	27.75	27.75	27.75	27.75	27.75	27.75	27.75	27.75
OR	Base to Oil Return Connection	25.75	25.75	25.75	25.75	25.75	25.75	25.75	25.75	25.75
<u>Connections</u>										
BB.	OD Stack - Sleeve Connection	12	12	12	12	12	12	16	16	16
T	Bottom Drum Blow Down, 15# [one]	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5
T ₁	Bottom Drum Blow Down, 150# [one]	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
U	Steam Nozzle, 15#	4 ^A	4 ^A	4 ^A	4 ^A	6 ^B	6 ^B	6 ^B	6 ^B	6 ^B
V	Steam Nozzle, 150#	2.5 ^A	2.5 ^A	3 ^A	3 ^A	3 ^A	3 ^A	4 ^B	4 ^B	4 ^B
W	Soot Washer Drains [Two]	2	2	2	2	2	2	2	2	2
X	Surface Blow off [One]	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Y	Feedwater Inlet [One]	1	1	1	1	1	1	1	1	1
Z	Soot Washer [Two]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
GG	Oil Supply and Return	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
JJ	Relief Valve, 15#	2	2	2	2	2	2.5	2.5	2.5	3
	Relief Valve, 150#	1	1.25	1.25	1.25	1.5	1.5	1.5	1.5	2
<u>Clearances</u>										
EE	Burner/W indbox Swing	33	33	33	33	33	33	33	33	33
FF	Tube removal each side	30	30	30	30	30	30	30	30	30
RF	Allowance for Burner/Windbox Swing and 30" Rear Aisle Space.	124	124	140	140	155	155	172	172	187
RD	Allowance for Tube Removal Each Side and Burner/Windbox Swing.	93	93	93	93	93	93	93	93	93

- NOTES:
- The above dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
 - Allow sufficient space at rear of boiler for removal of soot washer lance.
 - For access to the furnace, a 13" x 21" access door is provided behind the front door.
 - Control Panel may be larger (up to 4" in height) if certain control options are provided.
- A. Connection is a Female Pipe Thread.
B. Connection is a 150# Flange, Flat Face.

Table B2-3. Model 4 Steam Ratings

Boiler SIZE	1500	2000	2500	3000	3500	4000	4500	5000	6000
Ratings [Note A]									
Rated Capacity - Steam (lbs. steam/hr from & at 212° F.)	1,237	1,649	2,062	2,474	2,887	3,299	3,711	4,124	4,949
Rated Steam Capacity [kg/hr from and at 100 C]	461.7	615.5	769.6	923.4	1,077.5	1,231.3	1,385.0	1,539.2	1,847.2
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,800
Output Kcal/Hr [1,000 Kcal/h]	302	403	504	605	706	806	907	1,007	1,210
Output KW	348	464	580	696	812	928	1,044	1,160	1,392
Approximate Fuel Consumption At Rated Capacity [Input - Note B]									
Natural Gas [ft³/hr] - 15# Steam	1,511	1,538	2,500	3,038	3,487	4,025	4,494	5,050	6,052
Natural Gas [ft³/hr] - 150# Steam	1,572	2,133	2,597	3,117	3,590	4,155	4,657	5,194	6,233
Natural Gas [m³/hr] - 15# Steam	42.8	43.5	70.8	86	98.7	114.0	127.0	143.0	171.4
Natural Gas [m³/hr] - 150# Steam	44.5	60.4	73.5	88.3	101.6	117.6	131.8	147.0	176.5
Propane Gas [ft³/hr] - 15# Steam	604	615	1,000	1,215	1,395	1,610	1,798	2,020	2,421
Propane Gas [ft³/hr] - 150# Steam	629	853	1,039	1,247	1,436	1,662	1,863	2,078	2,493
Propane Gas [m³/hr] - 15# Steam	17	17.4	28.3	34.4	39.5	45.6	51	57.2	68.5
Propane Gas [m³/hr] - 150# Steam	17.8	24.1	29.4	35.3	40.7	47	52.7	58.8	70.6
No.2 Oil Fuel - 15# Steam, gph	10	14	17	21	24	28	31	35	42
No.2 Oil Fuel - 150# Steam, gph	11	15	18	22	25	28.9	32	36	43
No.2 Oil Fuel - 15# Steam, liters/hour	38	53	64	79	91	106	117	132	159
No.2 Oil Fuel - 150# Steam, liters/hour	41	56	68	82	95	109	121	136	163
Power Requirements - 3 Phase 60 Hz Standard [Note C]									
Blower Motor HP - Gas Firing	3/4	1	1-1/2	2	2	3	3	3	5
Blower Motor HP - Oil or Combination	1-1/2	1-1/2	2	2	3	5	3	3	5
Oil Pump for Oil or Combination	←————— Belt Driven from the Blower Motor —————→								
Minimum Ampacity									
Blower Motor - Gas Firing Only, 230V	1.53	3.3	4.7	6	6	9	9	9	15
Blower Motor - Gas Firing Only, 460V	0.77	1.7	2.4	3	3	4.5	4.5	4.5	7.5
Blower Motor - Oil or Combination, 230V	4.7	4.7	6	6	9	15	9	9	15
Blower Motor - Oil or Combination, 460V	2.4	2.4	3	3	4.5	7.5	4.5	4.5	7.5
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4	2.4
Weights									
Operating Weight, lbs.	3,758	3,758	4,566	4,566	5,175	5,175	5,991	5,991	6,900
Operating Weight, kg	1,399	1,399	1,704	1,704	1,932	1,932	2,236	2,236	2,575
Water Content Normal, gallons	79	79	104	104	130	130	156	156	181
Water Content Normal, liters	299	299	394	394	492	492	591	591	685
Water Content Flooded, gallons	109	109	145	145	177	177	213	213	245
Water Content Flooded, liters	413	413	549	549	670	670	806	806	927
Shipping Weight, approximate lbs.	3,100	3,100	3,700	3,700	4,100	4,100	4,700	4,700	5,400
Shipping Weight, approximate kg	1,157	1,157	1,381	1,381	1,530	1,530	1,754	1,754	2,015

Notes:

A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.

B. Input calculated with Nat. Gas @ 1000 Btu/ft³ Propane @ 2500 Btu/ft³ and Oil @ 140,000Btu/gal.

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

Table B2-4. Recommended Steam Nozzle Size (to maintain 4000 to 5000 fpm nozzle velocity)

Operating Pressure (PSIG)	BOILER SIZE								
	1500	2000	2500	3000	3500	4000	4500	5000	6000
15	4	4	6	6	6	6	8	8	8
20	3	4	4	6	6	6	8	8	8
30	3	4	4	4	4	6	6	6	6
40	2-1/2	3	3	4	4	4	6	6	6
50	2-1/2	3	3	4	4	4	4	4	6
65	2-1/2	2-1/2	3	3	3	4	4	4	4
75	2-1/2	2-1/2	3	3	3	4	4	4	4
95 - 125 ^A	2-1/2	2-1/2	3	3	3	3	4	4	4
150	1-1/2	2	2	2-1/2	2-1/2	2-1/2	3	3	3
200	1-1/2	1-1/2	1-1/2	2	2	2-1/2	2-1/2	2-1/2	3
250 - 400	1-1/2	1-1/2	1-1/2	1-1/2	2	2	2	2	2-1/2

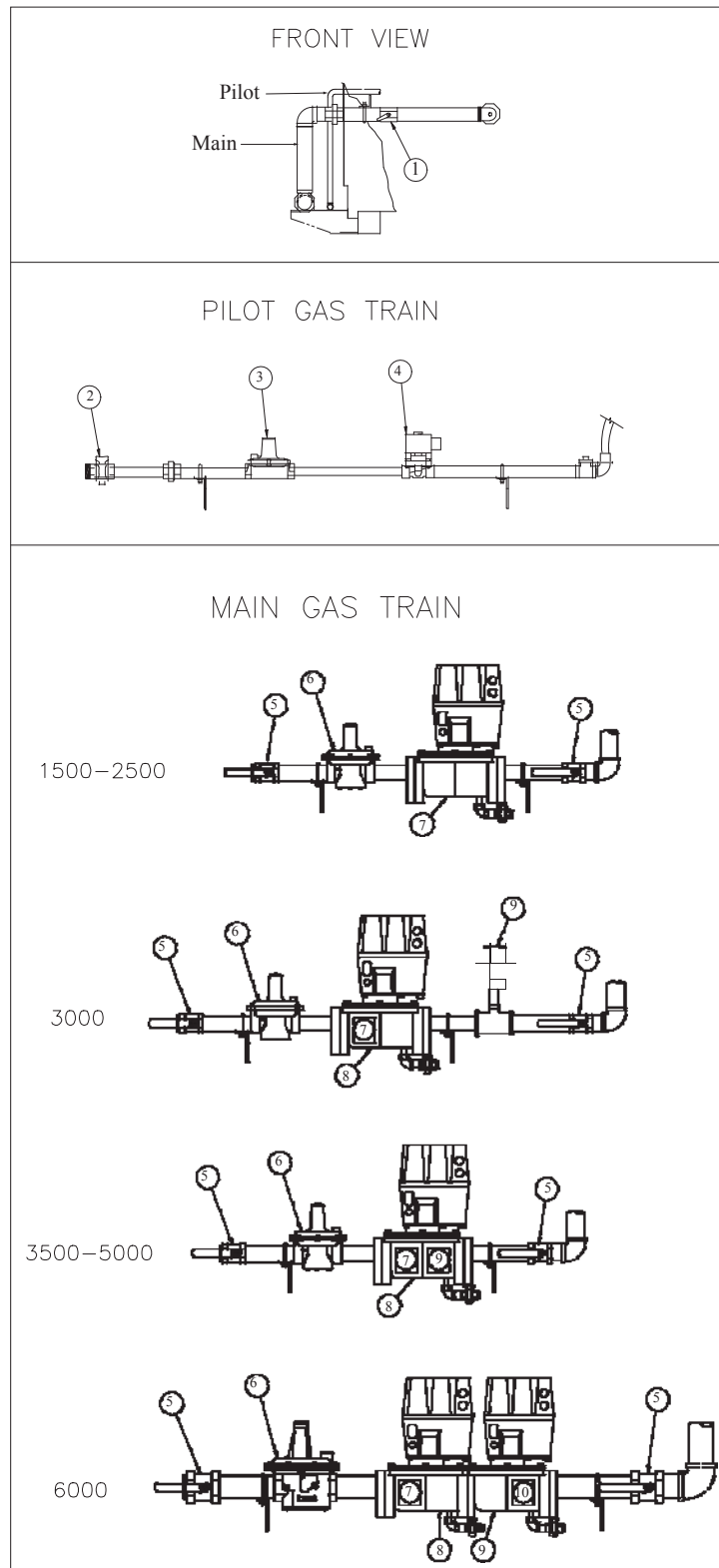
A. Standard nozzle size for 150 PSIG MAWP Boiler Design

Example 1: Size 3500, 150# boiler to operate @ 30 PSIG requires 4" steam nozzle in lieu of standard 3" nozzle.

Example 2: Size 3500, 150# boiler to operate @ 200 PSIG requires 2" steam nozzle in lieu of standard 3" nozzle.



Figure B2-2. Model 4 Standard Pilot and Main Gas Trains



ITEM	PART DESCRIPTION	SIZES INCHES
Sizes 1500 TO 2500		
1	Butterfly Valve	1-1/2
2	Pilot Shutoff Cock	1/2
3	Pilot Gas Regulator	1/2
4	Pilot Solenoid Valve	1/2
5	Manual Shutoff Valve	1-1/2
6	Main Gas Regulator	1-1/2
7	Motorized Valve with P.O.C.	1-1/2
Size 3000		
1	Butterfly Valve	1-1/2
2	Pilot Shutoff Cock	1/2
3	Pilot Gas Regulator	1/2
4	Pilot Solenoid Valve	1/2
5	Manual Shutoff Valve	1-1/2
6	Main Gas Regulator	1-1/2
7	Low Gas Pressure Switch	1/4
8	Motorized Valve with P.O.C.	1-1/2
9	High Gas Pressure Switch	1/4
Sizes 3500 to 5000		
1	Butterfly Valve	2
2	Pilot Shutoff Cock	1/2
3	Pilot Gas Regulator	1/2
4	Pilot Solenoid Valve	1/2
5	Manual Shutoff Valve	2
6	Main Gas Regulator	2
7	Low Gas Pressure Switch	1/4
8	Motorized Valve with P.O.C.	2
9	High Gas Pressure Switch	1/4
Size 6000		
1	Butterfly Valve	2
2	Pilot Shutoff Cock	1/2
3	Pilot Gas Regulator	1/2
4	Pilot Solenoid Valve	1/2
5	Manual Shutoff Valve	2
6	Main Gas Regulator	2-1/2
7	Low Gas Pressure Switch	1/4
8	Motorized Valve (std)	2
9	Motorized Valve with P.O.C.	2
10	High Gas Pressure Switch	1/4

Table B2-5. Minimum required NATURAL GAS pressure at entrance to STANDARD UL, FM, & XL GAP gas trains (upstream of gas pressure regulator)

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	1.5	1.5	4.4	28.0	1500
2000	1.5	1.5	8.4	28.0	2000
2500	1.5	1.5	12.9	28.0	2500
3000	1.5	1.5	17.1	28.0	3000
3500	2.0	2.0	11.3	28.0	3500
4000	2.0	2.0	13.6	28.0	4000
4500	2.0	2.0	12.2	28.0	4500
5000	2.0	2.0	16.8	28.0	5000
6000	2.0	2.0	21.5	28.0	6000

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
Natural Gas @ 1000 Btu/cu-ft, specific gravity @ 0.65

Table B2-6. Minimum required NATURAL GAS pressure at entrance to OVERSIZED UL, FM, & XL GAP gas trains (upstream of gas pressure regulator)

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	2.0	2.0	2.3	28.0	1500
2000	2.0	2.0	4.8	28.0	2000
2500	2.0	2.0	6.5	28.0	2500
	2.5	2.5	5.7		
3000	2.0	2.0	9.0	28.0	3000
	2.5	2.5	6.8		
	3.0	3.0	6.0		
3500	2.5	2.5	9.7		3500
	3.0	3.0	7.1		
4000	2.5	2.5	11.8		4000
	3.0	3.0	8.5		
4500	2.5	2.5	9.8		4500
	3.0	3.0	5.6		
5000	2.5	2.5	12.9	28.0	5000
	3.0	3.0	7.1		
	4.0	4.0	5.6		
6000	2.5	2.5	17.5	28.0	6000
	3.0	3.0	10.0		
	4.0	4.0	7.9		

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
Natural Gas @ 1000 Btu/cu-ft, specific gravity @ 0.65

Table B2-7. Minimum required PROPANE GAS pressure at entrance to STANDARD UL, FM, & XL GAP gas trains (upstream of gas pressure regulator)

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	1.5	1.5	6.7	28.0	600
2000	1.5	1.5	10.5	28.0	800
2500	1.5	1.5	13.3	28.0	1000
3000	1.5	1.5	17.0	28.0	1200
3500	2.0	2.0	14.3	28.0	1400
4000	2.0	2.0	16.5	28.0	1600
4500	2.0	2.0	14.8	28.0	1800
5000	2.0	2.0	16.4	28.0	2000
6000	2.0	2.0	19.6	28.0	2400

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
Propane @ 2500 Btu/cu-ft, specific gravity @ 1.6

Table B2-8. Minimum required PROPANE GAS pressure at entrance to OVERSIZED UL, FM, & XL GAP gas trains (upstream of gas pressure regulator)

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	2.0	2.0	5.9	28.0	600
2000	2.0	2.0	9.0	28.0	800
2500	2.0	2.0	10.8	28.0	1000
	2.5	2.5	10.5		
3000	2.0	2.0	13.8	28.0	1200
	2.5	2.5	12.9		
	3.0	3.0	12.6		
3500	2.5	2.5	13.6		1400
	3.0	3.0	12.6		
4000	2.5	2.5	15.8		1600
	3.0	3.0	14.5		
4500	2.5	2.5	13.8		1800
	3.0	3.0	12.1		
5000	2.5	2.5	14.8	28.0	2000
	3.0	3.0	12.5		
	4.0	4.0	12.0		
6000	2.5	2.5	18.0	28.0	2400
	3.0	3.0	15.0		
	4.0	4.0	14.1		

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
Propane @ 2500 Btu/cu-ft, specific gravity @ 1.6

Table B2-9. Safety valve outlet size

Boiler Size	SAFETY VALVE SETTING					
	15 PSIG STEAM			150 PSIG STEAM		
	VALVES REQ'D	OUTLET SIZE (IN.)**	VALVE CAPACITY	VALVES REQ'D	OUTLET SIZE (IN.)**	VALVE CAPACITY
1500	1	2	3161 lbs/hr	1	1	1651 lbs/hr
2000	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
2500	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
3000	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
3500	1	2	3161 lbs/hr	1	1-1/2	4240 lbs/hr
4000	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
4500	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
5000	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
6000	1	3	6942 lbs/hr	1	2	6596 lbs/hr

** Female Pipe Thread Connection [FPT]

PERFORMANCE DATA

Efficiency

Efficiency data provided in Table B2-10 is based on low pressure steam operation. For high pressure steam operation contact your local Cleaver-Brooks authorized representative for expected efficiency data.

Table B2-10. Predicted efficiency, 10 psig operating (includes radiation and convection losses)

Boiler Size	Gas Fuel		Oil Fuel	
	Firing Rate		Firing Rate	
	Low Fire	High Fire	Low Fire	High Fire
1500	81.6	81.9	84.1	84.4
2000	81.1	80.0	83.6	82.5
2500	81.6	81.5	84.1	84.0
3000	81.3	80.3	83.8	82.8
3500	81.6	81.5	84.1	84.0
4000	81.3	80.7	83.8	83.0
4500	81.1	80.9	83.6	83.4
5000	81.3	80.0	83.8	82.5
6000	81.6	79.8	84.1	82.4

Emissions

The following tables give typical emission levels for Nature Gas and No. 2 Oil. Please contact your local Cleaver-Brooks authorized representative if an emission guarantee is required.

Table B2-11. Model 4 emission data - Natural Gas

POLLUTANT		UNCONTROLLED
CO	ppm	xx200
	lb/MMBtu	0.15
NO _x	ppm	100
	lb/MMBtu	0.12
SO _x	ppm	1
	lb/MMBtu	0.001
HC/ VOCs	ppm	40
	lb/MMBtu	0.016
PM	ppm	–
	lb/MMBtu	0.01

Table B2-12. Model 4 emission data - No. 2 Oil

POLLUTANT		UNCONTROLLED
CO	ppm	90
	lb/MMBtu	0.07
NO _x	ppm	187
	lb/MMBtu	0.248
SO _x	ppm	270
	lb/MMBtu	0.515
HC/ VOCs	ppm	50
	lb/MMBtu	0.025
PM	ppm	–
	lb/MMBtu	0.025

NOTES:

Based on fuel oil constituent levels:

Fuel bound nitrogen = 0.05% (max) by weight.

Sulfur = 0.5% (max) by weight.

Ash = 0.01% (max) by weight.

ENGINEERING DATA

The following engineering information is provided for the Model 4 steam boiler. Additional information may be obtained from your local Cleaver-Brooks authorized representative.

Feedwater

Steam boilers require make-up water for steam production. This make-up can be a combination of condensate return and raw make-up, 100% condensate return or 100% raw make-up. Proper treatment of make-up water and boiler water is essential to the longevity and performance of the boiler. Table B2-13 shows the rate of make-up required and Table B2-14 shows the recommended water quality guidelines.

As a minimum, raw make-up should be piped into a water softener and then to a feed tank, which also can be the container that receives the system condensate returns. Chemical feed is recommended to be fed via a quill into the water make-up line feeding the boiler.

Table B2-13. Feedwater makeup rates

Boiler Size	Gallons/Minute
1500	2.5
2000	3.3
2500	4.1
3000	5
3500	5.8
4000	6.6
4500	7.5
5000	8.3
6000	9.9

Table B2-14. Water quality parameters

Parameter	Boiler Water Limit
pH	8.3 - 10.5
Iron	0.1 ppm
Oxygen	0.1 mg/liter
Specific Conductivity	2000 μ mho/cm
Suspended Solids	300 ppm
Total Hardness	0 ppm as CaCO ₃

Blowdown

As steam is produced, unwanted solids are left behind in the boiler water and become concentrated within the vessel. If these constituents are allowed to adhere to the heat transfer surfaces, they will impede the flow of energy into the water. Their removal requires proper blowdown that will include bottom and possibly surface blowoff. For proper TDS control, surface blowoff with a TDS monitoring device is recommended. Local codes will dictate the manner of treating the blowdown affluent.

Boiler Stacks

General - The Model 4 boiler operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore, the stack must be a positive pressure design.

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

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

When two or more Model 4 boilers are connected to a common breeching/stack, one should evaluate the affects of pressure variations that may occur during boiler sequencing while boilers are firing. It may be determined that some type of mechanical draft system be employed to ensure proper draft at each boiler is maintained.

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

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler

room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA 54 (National Fuel Gas Code - NFPA) for U.S. installations and CAN/CSA B149/1 and B149.2 for Canadian installations.

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

A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler. Refer to Figure B2-3.

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

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

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

E. Size the openings by using the formula ($\text{Area in ft}^2 = \text{cfm}_a / \text{fpm}_a$), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.

F. Amount of air required (cfm):

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

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

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

Example of required air openings (Engineered Method):

Determine the area of the boiler room air supply openings for [2] size 4500 Model 4 boilers at 750 feet elevation; each have a rating of 107 boiler horsepower. The air openings will be 5 feet above the floor level.

The total boiler horsepower (bhp): $107 \times 2 = 214$ bhp.

From F.3 above, total air required = $214 \text{ bhp} \times 10 = 2140$ cfm.

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

Area required: From the formula in E above, $2140 \text{ cfm} / 250 \text{ fpm} = 8.56$ square feet total.

Area opening: 8.56 divided by $2 = 4.28 \text{ ft}^2$ per opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

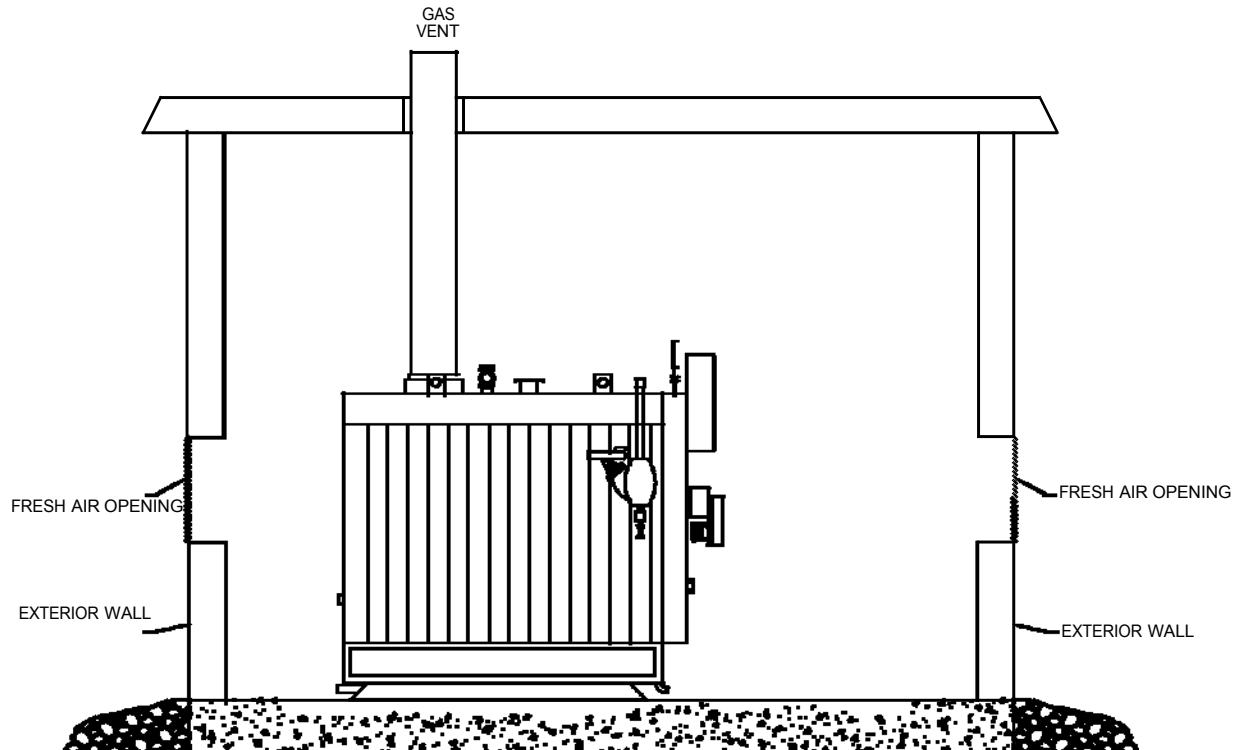
See Table B2-15 for combustion air and flue gas flow.

Table B2-15. Model 4 fuel, combustion air, and flue gas flow rates

			Boiler Size								
			1500	2000	2500	3000	3500	4000	4500	5000	6000
Fuel Consumpi on	Gas	cfh	1500	1500	2500	3000	3500	4000	4500	5000	6000
	Oil	gph	10.72	14.29	17.86	21.43	25.00	28.57	32.14	35.71	42.85
Combustion Air	Gas	scfh	15,480	20,640	25,800	30,960	36,120	41,280	46,440	51,600	61,920
		lb/hr	1207	1609	2012	2414	2817	3219	3621	4024	4828
	Oil	scfh	17,049	22,733	28,414	34,098	39,782	45,463	51,147	56,831	68,196
		lb/hr	1269	1692	2115	2538	2961	3384	3808	4231	5077
Flue Gas	Gas	scfh	17,520	23,360	29,200	35,040	40,880	46,720	52,560	58,400	70,080
		lb/hr	1,278	1,704	2,130	2,556	2,983	3,409	3,835	4,261	5,113
	Oil	scfh	17,914	23,886	29,855	35,827	41,799	47,769	53,741	59,713	71,655
		lb/hr	1,357	1,809	2,261	2,714	3,166	3,618	4,070	4,523	5,427

Notes:

- A. Gas consumption, expressed in cubic feet per hour, is based on 1,000 Btu/cu.ft gas value.
 B. Oil consumption, expressed in pounds per hour, is based on 140,000 Btu/gal oil value.
 C. Oil supply lines must be sized for 125 gph pumping rate. Oil pump suction pressure to be -10" Hg to 3 psig.

Figure B2-3. Boiler room air supply - "Engineered Design"

Oil Piping

General - Oil operation of the Model 4 boiler requires proper oil to the standard burner mounted oil pump. As the combustion of oil utilizes mechanical pressure atomization, line sizing to the pump must be sufficient to provide 125 gph of oil to the suction side of the pump.

Oil Train Components - Oil flow to the burner is controlled by four solenoid valves. The oil flows through a primary or safety shutoff valve into a manifold block. This valve and the low fire valve are energized simultaneously by the flame safeguard control and when opened, allow flow of oil to the low fire nozzle.

As the damper motor moves to high fire position, the damper motor end switches close to energize in sequence, the intermediate and then high fire oil valve. The purpose of the intermediate valve is to smooth the transition from low to high fire by balancing the oil input with increasing flow of air.

High fire rating of the burner is obtained when all three nozzles are firing, assuming proper oil pressure and normally sized nozzles.

Gas Piping

General - The Model 4 boiler requires appropriate gas supply pressure and volume for proper operation and long burner life. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation must follow these guidelines and of the local authorities that have installation jurisdiction.

Gas Train Components - Model 4 boilers are equipped with a gas train that meets the requirements of UL as standard. These components also comply with the recommendations of FM, XL GAP (formerly IRI/GE GAP) and ASME CSD-1. The gas train and its components have been designed and tested to operate for the highest combustion efficiency.

Gas Pressure Requirements - For proper and safe operation, each Model 4 boiler requires a stable gas pressure supply. The pressure requirements are listed in previous sections for standard gas train size, and oversized trains for reduced available pressure.

Gas Piping - Model 4 units are standardly equipped with a gas pressure regulator. If upstream pressure to the standard regulator will be greater than 1 psig, an additional upstream regulator should be provided with a pressure relief valve.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c., a "full lockup" type regulator is recommended along with proper overpressure protection. In addition to the regulator, a plug type or "butterball" type gas shutoff cock should be provided upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the boiler gas train during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Gas Supply Pipe Sizing - For proper operation of a single unit or multiple units, we recommend that the gas pipe be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. The gas supplier (utility) should be consulted to confirm that sufficient volume and normal pressure are provided to the building at the discharge side of the gas meter or supply pipe (for installations of new boilers into an existing building, gas pressure should be measured with a manometer to ensure sufficient pressure is available).

A survey of all connected gas using devices should be made. If appliances other than the boiler are connected to the gas supply line, then a determination should be made of how much flow volume (cfh = cubic feet per hour) will be demanded at one time and the pressure drop requirements when all appliances are operating.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final connection. As a minimum guideline, gas piping Tables B2 - 16 through B2 - 20 should be used. The data in these tables is from the NFPA source book, 2006 edition.

Table B2-16. Gas line capacity - Schedule 40 metallic pipe

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

Table B2-17. Gas line capacity - Schedule 40 metallic pipe

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

Table B2-18. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	57,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	954	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
1000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
**Fuel: Natural Gas									
**Inlet Pressure: 2.0 psi									
**Pressure Drop: 1.0 psi									
**Specific Gravity: 0.60									

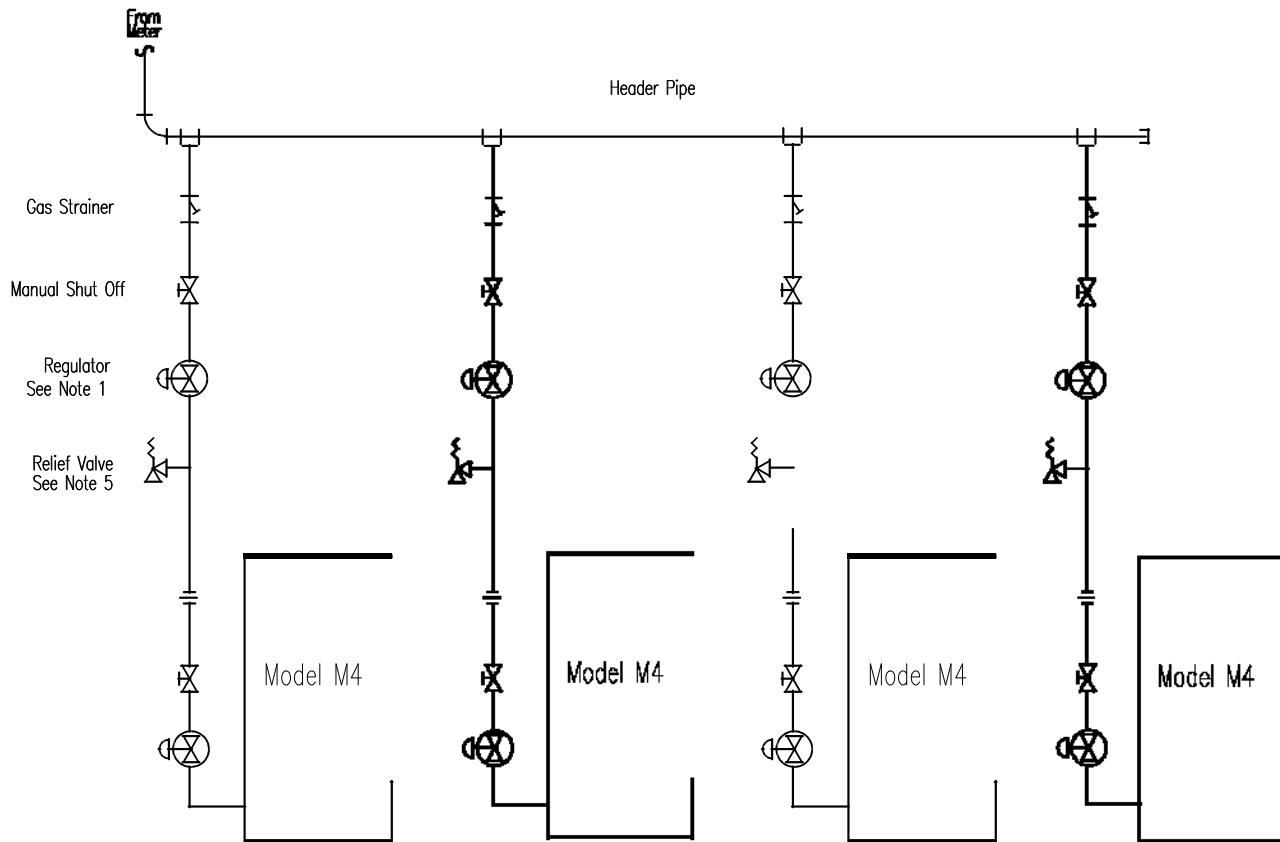
Table B2-19. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	75,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,300	20,300	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,300
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
500	283	593	1,120	2,290	3,430	6,610	10,300	18,600	38,000
1000	195	407	897	1,380	2,360	4,550	7,240	12,000	26,100
1500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
**Fuel: Natural Gas									
**Inlet Pressure: 3.0 psi									
**Pressure Drop: 2.0 psi									
**Specific Gravity: 0.60									

Table B2-20. Gas line capacity - Schedule 40 metallic pipe

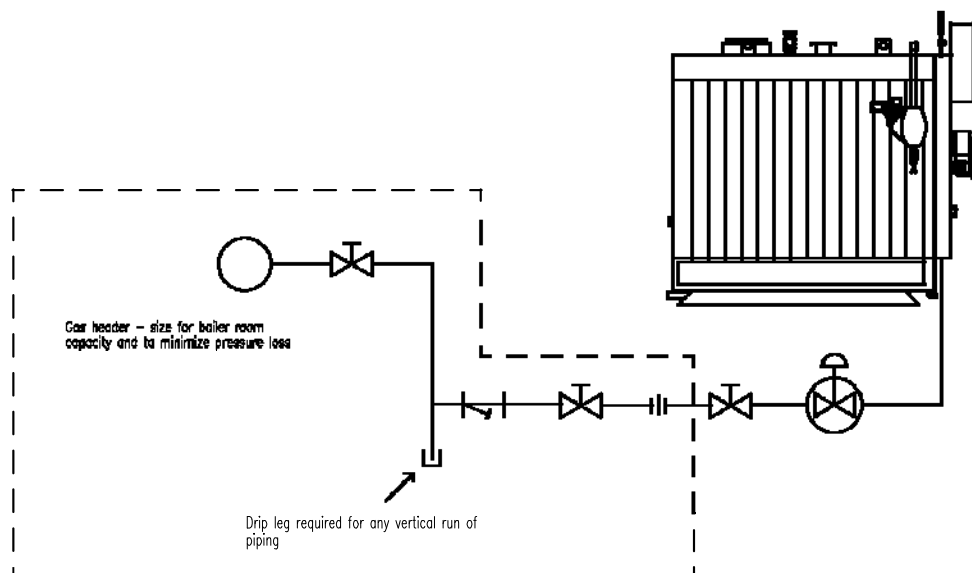
Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
1000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400
**Fuel: Natural Gas									
**Inlet Pressure: 5.0 psi									
**Pressure Drop: 3.5 psi									
**Specific Gravity: 0.60									

Figure B2-4. Typical gas header piping



NOTES:

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



Model 4 Boiler Steam Specifications

Submittals B2-28

Codes B2-28

Guarantees B2-28

Type B2-28

Design Criteria B2-28

Product Design B2-29

Burner Management System B2-33

Shop Tests B2-34

Shipment B2-34

Installation B2-34

Start-Up B2-34

Operation and Maintenance Manuals B2-35

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer’s specific needs and application.



PART 1 GENERAL

1.1

SUBMITTALS

- A. The manufacturer shall supply ____copies of a dimensional drawing indicating all relevant unit dimensions, layout and required clearances.
- B. The manufacturer shall supply ____copies of a ladder type wiring diagram to include all internal unit wiring, external connections, and power supply requirements.
- C. The manufacturer shall supply a copy of the authorized inspection report, to the purchaser, upon completion and shipment of the unit.

1.2

CODES

- A. The boiler shall be designed, constructed, and hydrostatically tested in accordance with the ASME Boiler and Pressure Vessel Code.
- B. The boiler shall be wired in accordance with the rules of the National Electric Code.
- C. All electrical equipment shall be in conformity with the Underwriters Laboratories requirements.
- D. The complete boiler–burner package shall be approved by Underwriters Laboratories and shall bear a UL label.
- E. The boiler shall be built to comply with the following insurances _____. (Factory Mutual, XL-GAP, ASME CSD–1)

1.3

GUARANTEES

- A. The complete boiler package shall be warranted from defects in materials and/or workmanship for a period of not less than 18 months from shipment or 12 months from unit start–up.

PART 2 PRODUCTS

2.1

TYPE

- A. The boiler shall be a watertube type steam boiler with all steel membrane walls.
- B. The boiler shall be a three gas pass type boiler mounted on a heavy duty steel frame.
- C. The boiler shall have an integral forced draft burner and burner controls.
- D. The boiler shall be a Cleaver Brooks Model 4, series _____(100 = No. 2 oil, 200 = No. 2 oil and gas, 700 = gas) steam boiler.

2.2

DESIGN CRITERIA

- A. The boiler shall be designed in accordance with the ASME Boiler and Pressure Code Section _____(IV for low pressure, I for high pressure).
- B. The boiler shall be designed for _____psig (15, 150, 250, 350, or 500). The maximum operating pressure will be _____psig.
- C. The boiler shall be designed for a maximum output of _____lbs/hr of steam, or _____bhp. The boiler shall develop _____ lbs/hr of steam when operating at _____psig with a feedwater temperature of _____°F.
- D. Electrical power available will be _____volts, _____phase, _____Hz.



- E. The maximum sound level shall not exceed 80 dBA measured 3 feet in front of the boiler.

2.3 PRODUCT DESIGN

A. Pressure Vessel

1. The upper drum shall have a 20" OD, manufactured from SA-53 Gr. B seamless pipe, with a minimum wall thickness of 0.375".
2. The lower drum shall have an 8-5/8" OD, manufactured from SA-53 Gr. B seamless pipe, with a minimum wall thickness of 0.322".
3. The generating tubes shall be 2" OD, manufactured from SA-178 Gr. A tubing, with a minimum wall thickness of 0.095".
4. The boiler shall have two downcomers, located at the rear of the boiler, and be totally insulated from the generating tubes. These shall be a minimum of 2-1/2" OD, manufactured from SA-178 Gr. A tubing, with a minimum wall thickness of .105".
5. The upper drum shall have an inspection opening, located at the rear of the unit, to allow internal inspection, and shall be a minimum of 4"x6".
6. The lower drum shall have inspection openings, located at the front and rear of the unit, to allow internal inspection, and shall be a minimum of 4-7/8" x 5-7/8".
7. The boiler shall have inspection openings in the convection area.
8. A feedwater tapping and integral feedwater distribution pipe shall be located in the upper drum. The distribution pipe shall blend the feedwater with the boiler water.
9. A 3/4" surface blowoff connection shall be located in the rear head of the upper drum.
10. A _____" bottom blowoff connection shall be located in the lower drum.

B. Refractory

1. Refractory shall be limited to the furnace floor to insulate the lower drum, and to the burner throat tile.
2. High temperature insulation shall be installed on the front wall of the furnace.

C. Insulation and Casing

1. The boiler insulation shall be a minimum of 2" fiberglass, and shall cover the entire pressure vessel.
2. The insulation shall be covered with a corrugated metal lagging.
3. The metal lagging and insulation shall be arranged for easy removal and installation if required.
4. The front head (windbox) shall be attached with a davit arm, gasket sealed, and bolted. The front head shall swing open to provide full access to the furnace chamber and burner throat tile.

5. Observation ports shall be provided at each end of the boiler for visual inspection of the pilot and main flame conditions.
6. Two lifting eyes shall be located on top of the boiler.
7. The exhaust gases shall vent at the rear of the boiler, on the top centerline.

D. Trim

1. The water column shall be located on the left side of the boiler. It shall be piped with unions for easy removal.
2. A gauge glass set, gauge glass blowdown valve, and water column blowdown valve shall be provided.
3. The boiler feedwater control switch shall be included as an integral item of the water column. It shall provide automatic actuation of a motor driven feedwater pump or valve to maintain the boiler water level within normal limits.
4. The primary low water cutoff switch shall be an integral part of the water column. It shall be wired into the burner control circuit preventing burner operation if the boiler water level falls below the designated safe level.
5. A steam pressure gauge shall be located at the front end of the boiler and shall include a cock and test connection.
6. A safety relief valve shall be provided of a size and type to comply with ASME Code requirements. The safety relief valve set pressure shall be _____psig.
7. A high limit pressure control shall be provided. It shall be a manual reset type and shall be wired to prevent burner operation and lockout if excessive steam pressure occurs.
8. An operating limit control shall be provided. It shall be wired to provide on-off control of the burner at operating set points.
9. A firing rate control shall be provided. It shall control the firing rate of the burner based on the boiler load.
10. An auxiliary low water cutoff shall be provided (manual reset type). It shall be wired into the burner control circuit preventing burner operation if the boiler water level falls below the designated safe level.
11. A stack thermometer shall be shipped loose for field installation.

E. Soot Cleaning

1. Soot washer lances shall be provided in the convection area of the boiler measuring the full length of the pressure vessel.
2. Each lance shall be provided with a shutoff valve and the assembly shall be capable of rotating 360 degrees. This shall ensure complete washing of the convection zone while the boiler is operating in the low fire mode.
3. Soot washer troughs shall be provided at the bottom of the boiler. These shall be furnished for each convection side and shall The soot washer troughs shall be provided with 2" drain connections at the rear of the boiler, and shall have inspection/cleanout openings at the front of the boiler.

F. Burner Design – General

1. The burner shall be integral to the windbox.
2. All air for combustion shall be supplied by a forced draft blower mounted in the windbox, above the burner, to minimize noise and vibration level.
3. The blower motor shall be an open drip proof type with a minimum service factor of 1.15.
4. The impeller shall be an enclosed centrifugal fan type, properly balanced, and directly connected to the blower motor shaft.
5. The combustion air damper shall be integral to the windbox and shall be operated by a single damper motor.
6. The burner shall remain in the low fire position during ignition and until main flame has been established.
7. A combustion air proving switch shall be provided to ensure adequate air for pre-purge and combustion.

G. Burner Design – Gas

1. The burner shall be the high radiant multi-port type approved for operation with natural gas.
2. The burner shall operate on the _____(low-high-low or full modulation) principle and must return to the low fire position prior to ignition.
3. Automatic electric ignition of the premix gas pilot shall be furnished. An electric scanner, of the UV principle, shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established.
4. The single combustion air damper motor shall operate the gas butterfly valve. The damper motor shall regulate the fire according to system demand in response to the firing rate control.

H. Burner Design – No. 2 Oil

1. The burner shall be the pressure atomizing type approved for operation with commercial grade No. 2 oil.
2. The burner shall operate on the low-high-low principle, and must return to the low fire position prior to ignition.
3. The burner shall remain in the low fire position during ignition and until main flame has been proven. The ignition period shall be monitored with an electric scanner, of the UV principle, to confirm the presence of the low fire oil flame.
4. Automatic electric ignition of the low fire oil supply shall be provided with a minimum 10,000 volt transformer and heavy duty electrodes.

Notice

Optional insurance compliance may require a premix gas pilot in lieu of direct spark ignition.

5. [Optional] Automatic electric ignition of the premix gas pilot shall be furnished. An electric scanner, of the UV principle, shall confirm the pilot prior to the delivery of the low fire oil supply.
 6. The single combustion air damper motor shall operate the low and high fire oil valves. The damper motor shall regulate the fire according to system demand in response to the firing rate control.
- I. Burner Design – Gas and No. 2 Oil
1. The burner shall be the high radiant multi-port type for gas and shall be the pressure atomizing for oil. The burner must be approved for operation with either natural gas or commercial grade No. 2 oil.
 2. The burner shall operate on the low-high-low principle, and must return to the low fire position prior to ignition.
 3. The burner shall remain in the low fire position during ignition and until main flame has been proven.
 4. Automatic electric ignition of the premix gas pilot shall be furnished. An electric scanner, of the UV principle, shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established.
 5. The single combustion air damper motor shall operate the low and high fire oil valves and the gas butterfly valve. The damper motor shall regulate the fire according to system demand in response to the firing rate control.
- J. Main Gas Train
1. The gas burner piping shall include a primary gas shutoff valve. It shall be controlled by the programming relay to start or stop the burner and to close automatically in the event of power failure, flame failure, or a low water condition.
 2. A manual shutoff valve shall be located ahead of the primary gas valve.
 3. A plugged leakage test connection and a second manual shutoff valve shall be provided as a means for a tightness check of the primary shutoff valve.
 4. A gas pressure regulator shall be factory mounted and piped for pressure regulation to the burner.
 5. Gas Train Components
 - a. [Sizes 1500–2500] The primary gas shutoff valve shall be motorized with a proof of closure switch.
 - b. [Sizes 3000–5000] The primary gas shutoff valve shall be motorized with a proof of closure switch. High and low gas pressure switches shall be provided.
 - c. [Size 6000] The primary gas shutoff valve shall be motorized with a proof of closure switch. A second gas safety shutoff valve and an additional plugged leakage test cock shall be provided. High and low gas pressure switches shall be provided.

K. Natural Gas Pilot Train

1. A pilot gas pressure regulator shall be factory mounted and piped for pressure regulation of the pilot gas to the burner.
2. The pilot gas train shall include a safety shutoff valve. It shall be controlled by the programming relay to start the burner.
3. A manual shutoff valve shall be located ahead of the pilot gas pressure regulator.

L. 2.3.12 Oil System

1. An oil pump shall be provided. The oil pump, integral with the burner, shall include a built-in relief valve and self-cleaning strainer.
2. The oil pump shall be belt driven from the blower motor.
3. The fuel oil system shall include supply and return tubing to a terminal block, an oil pressure gauge, shutoff cock, and four solenoid oil shutoff valves. These items shall be factory mounted and piped on the front head (windbox).

2.4 BURNER MANAGEMENT SYSTEM

A. Control Panels

1. The control panel shall be a NEMA 1 rated panel and have a key lock.
2. The control panel shall be mounted on the front head of the boiler and shall be conveniently located for the boiler operator.
3. The panel shall contain the blower motor starter, control circuit fuses, control circuit transformer, and control switches. A damper selector switch shall be provided to permit selection of automatic or manual selection of low or high firing.
4. A terminal board shall be provided to which all wires entering or leaving the panel shall be connected.
5. The panel shall include four indicating lights to show operating conditions of: red = low water; red = flame failure; white = load demand; and white = fuel valve open. The lights and switches shall be located on the panel switch ledge.
6. All electrical service connections shall be made to an electrical entrance box to be mounted on the right hand side of the boiler.
7. All electrical wiring shall be oil, heat, and moisture resistant and shall be number coded.

B. Combustion Safeguard Control

1. A combustion safeguard control (program relay) shall be provided to control ignition, starting, and stopping of the burner. It shall provide precombustion and postcombustion purge periods and shall stop burner operation in the event of ignition, pilot, or main flame failure. Trial for ignition shall be limited to 10 seconds.
2. The boiler shall be provided with a combustion safeguard controller that provides technology and functions equal to the Cleaver Brooks Model CB120E.

3. The combustion safeguard control shall be microprocessor based, with self-diagnostics, non-volatile memory, and a message center with a vocabulary of 42 different messages. Messages shall scroll across an alpha-numeric display and provide sequence status and flame failure mode information.
4. The combustion safeguard control shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run, and post-purge cycles.
5. The controller shall be the non-recycle type for maximum safety that will shut down the burner and indicate as a minimum the following trip functions: pilot failure, main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal, and fuel valve open.
6. The controller shall have a test/run switch. It will allow interruptions to sequence just after pre-purge, during pilot ignition trial, and during run cycles, for adjustments to firing rate motor, damper linkages, and pilot flame for turndown tests.
7. The controller shall also have the following functions: display history of operating hours and totals of completed on-off cycles; provide a constant flame signal strength read-out; and have provisions for remote display capability and Modbus communication.

PART 3 EXECUTION**3.1****SHOP TESTS**

- A. The pressure vessel shall be hydrostatically tested in accordance with ASME requirements.
- B. The boiler will be test fired by the manufacturer, prior to shipment, to verify proper and safe operation.

3.2**SHIPMENT****A. Painting**

1. The entire boiler, base frame, and other components shall be factory painted, before shipment, using a hard finish enamel.
2. The boiler surface shall be cleaned/prepared for painting using manufacturer's specifications and standard industrial painting practices.

B. Preparation

1. All boiler openings shall be plugged/covered prior to shipment.
2. The boiler shall be skid mounted and protected with a weather resistant covering.
3. All shipped loose components shall be wrapped in protective material and packaged in a separate container(s).

3.3**INSTALLATION****3.4****START-UP**

- A. The boiler start-up shall be performed by a factory trained representative and will be done in accordance with the manufacturer's recommended procedures.

- B. The boiler start-up shall include boiler operator training and shall cover boiler operation, water treatment, and maintenance of the unit.

3.5 OPERATION AND MAINTENANCE MANUALS

Manufacturer shall supply _____copies of the Operating & Maintenance Manual.

MODEL 5 BOILER

1,500 - 6,000 MBTU &
7,500-8,000 Low Water Volume
Watertube Boiler



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The Model 5 Commercial Watertube Boiler product line is used for low and high pressure steam applications. Sizes range from 1.5 to 8 MMBtu/hr. The Model 5 Boiler is an excellent choice where high outputs are required but space limitations exist. The model number designation is 1500 through 8000, representing MBtu/hr input (1,500,000 to 8,000,000 Btu/hr).

Fuel series designation is as follows:

- Series 100: No. 2 oil firing.
- Series 700: Natural gas firing.
- Series 200: No. 2 oil/natural gas firing.

Design pressure designation is stated as 15 psig, 150 psig, and 250 psig for steam, and 140 psig for hot water. For example, a Model M5P-700-2500-150 boiler designates a gas-fired, 2,500,000 Btu/hr, 150 psig, steam boiler.

FEATURES AND BENEFITS

33" Cased Width:

- Boiler fits through most standard doorways.
- Reduced installation costs.

Direct Driven, Vibration-Free Centrifugal Impeller:

- Quiet operation.
- Sound levels below 80 dbA.
- Ideal for noise critical areas such as hospitals, churches, etc.

Minimum Refractory:

- Membrane waterwalls reduce the need for refractory by 95%.
- Reduced maintenance costs and refractory repair requirements.

Membrane Waterwalls:

- Enhanced heat transfer area in compact design.
- Sealed combustion chamber improves heat transfer for high efficiency.

Small Boiler Footprint:

- Savings of up to 50% in floor space.

Weights up to 40% less than Comparable Boilers:

- Lower freight and rigging costs.
- Reduced structural requirements.

Standard Built-in Soot Washers:

- Boiler cleaning without shutdown.
- Maintains peak boiler performance.

Packaged Forced Draft Burner:

- High pressure drop design.
- Optimum fuel and air mixing.
- Improved combustion efficiency.

Low Water Volume Design (optional):

- Meets various provincial operating engineer codes and regulations.
- Reduced operating costs.
- High and low pressure steam.

Steam Design Pressures to 500 psig:

- High performance in a compact design.
- Proven vessel design for high design pressure applications.

PRODUCT OFFERING

The Model 5 (M5) Boiler is a compact carbon steel, extended fin, watertube boiler. Heat transfer design is configured in a "3-pass" gas travel across the watertube surfaces. The pressure vessel is constructed to conform to the A.S.M.E. Code, either Section IV for low pressure steam @ 15 PSIG MAWP (maximum allowable working pressure) or Section I for MAWP greater than 15 PSIG.

The vessel (boiler) consists of two rows on each side of the vessel, of formed seamless tubes with extended fin surfaces and downcomers connected to the steam drum and lower drum. To reduce standby losses, the vessel is insulated with a fiberglass blanket and removable steel jacket.

Complete with an integral burner for either No.2 fuel oil or Natural Gas, the complete burner/boiler package is CSA International Approved, listed, and labeled.

Standard Equipment

The standard boiler/burner package is described below. Optional controls, trim, and devices may be added to meet project requirements, and some of those options are noted, following this standards list.

1. Boiler

A. Designed, constructed, and hydrostatically tested in accordance with the A.S.M.E. Boiler and Pressure Vessel Code. The complete vessel is mounted on a structural steel frame.

B. Steam drum includes a hand hole in the rear head for drum water side inspection. Connections are included for the following:

Feedwater Makeup w/internal dispersion tube.

Table B3-1. Model 5 Boiler Sizes

MODEL NO.	INPUT MBH	HEAT OUTPUT MBH	EQUIV HP	STEAM OUTPUT LB/HR	SHIPPING WEIGHT LBS
1500	1500	1200	35	1237	3100
2000	2000	1600	47	1649	3100
2500	2500	2000	59	2062	3700
3000	3000	2400	71	2474	3700
3500	3500	2800	83	2887	4100
4000	4000	3200	95	3299	4100
4500	4500	3600	107	3711	4700
5000	5000	4000	119	4124	4700
6000	6000	4800	143	4949	5400
8000 LWV	8000	6320	194	6516	6200

NOTE: Steam output from and at 212 °F.

LWV = Low Water Volume.

Surface Blowoff.

Steam Supply.

Safety Relief Valve.

C.Lower Drum includes hand holes at each end for waterside inspection. A drain/blowoff tapping is provided at the front, bottom centerline.

D.Soot washer lances are provided on each side of the vessel between the two rows of tubes for fireside cleaning. Soot washer drains are located at the bottom of the boiler, with connections to drain located on each side of the lower drum at the rear.

E.Refractory is limited to the furnace floor, lower drum, and burner throat tile. High temperature insulation is installed on the front water wall and furnace access door.

F.Two lifting eyes are provided on the top centerline of the upper drum for ease of installation.

G.Furnace inspection/access door is provided in the furnace rear wall.

The exhaust gas vent is located at the top rear centerline of the boiler. A stack thermometer is shipped loose for field installation by the installing contractor into the stack.

I.The complete vessel is fully insulated (2" fiberglass blanket) under a preformed, sectional steel jacket.

J.Factory painted using hard-finish enamel.

1. Steam Boiler Control Standard Equipment (15 to 150 psig)

A. ASME safety relief valve(s).

B. Steam pressure gauge.

C. Pressure controls:

- High limit control-manual reset.
- Operating limit control.
- High-low fire control (full modulation for gas firing).

D. D. Low water cutoff with pump control.

E. E. Water column gauge glass set and fittings.

F. F. Auxiliary low water cut-off.

G. G. Combustion air proving switch.

2. Electrical Control Panel

A. Mounted at eye level on the front head of the boiler.

B. NEMA rating 1A with gasket dust seal.

C. Contains electronic program relay and switches.

3. Miscellaneous

A. The boiler is Canadian Standards Association (CSA) approved and bears the CSA label.

Optional Equipment

Optional Equipment

For more detailed information on optional equipment, contact the local Cleaver-Brooks authorized representative. In summary, options include the following:

1. Boiler



Larger pressure gauges or specific manufacturer type.
Bottom Drain Valves for low pressure applications.
Bottom Blowoff Valves for high pressure applications.
Surface Blowoff Valve with internal collector pipe.
Feedwater Stop and Check Valves.
Steam Stop Valve.
ASME Hydro Test of Valves and Valve Piping.
Design pressures above 150 PSIG.

2. Burner/Control Options

Full Modulation Firing on Gas.
Lead/Lag Control.
Day-Night Controls.
Low Fire Hold Control.
Elapsed Time Meter.
Alarm with silence switch.
Additional Indicator Lights.
Main Power Disconnect.
Remote Oil Pump.
Optional NEMA Enclosures.
Special Fan Motor requirements (TEFC).

3. Fuel Options

Automatic Fuel Changeover (combination burner).
Propane Fuel Firing.
Special Gas Pressure Regulators.
Special fuel shut-off valves.
Dual Pilots (gas and oil).
Gas strainer.

"Guarded Plant" status equipment.

4. Low Water Volume Design Options (LWV)

5. Guarded Plant Requirements

Notice

****Not required for low pressure steam applications.***

Special Insurance Requirements

The boiler package can be equipped to meet various insurance or code requirements. Some of these insurance/code requirements are:

Factory Mutual (FM)

XL GAP (Formerly GE GAP/IRI).
A.S.M.E. CSD-1.

Factory Mutual (FM Global) - Recommended guidelines as described by FM pertain to boilers rated at greater than 2.5 MMBtu/hr input on gas and 2.8 MMBtu/hr input on oil. Boilers that are labeled and tested in accordance with an independent testing lab such as UL or CSA and are below these inputs are exempt from these recommendations.

The Model 5 boiler is CSA listed and labeled. In addition to the standard CSA requirements the following are needed to comply with FM when required.

Alarm Bell with silence switch for low water and safety shutdowns.

Low Oil Pressure Switch if the oil pump is not direct driven from the fan motor.

XL GAP (Formerly GE GAP/IRI) Recommended guidelines as described by XL GAP pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBtu/hr input. For these boilers, the requirements are the same as for A.S.M.E CSD-1 requirements. Above 12.0 MMBtu/hr input, the requirements defer to the NFPA 85 standards for single burner boilers.

A.S.M.E. CSD-1 - Recommended guidelines as described by this Code pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBtu/hr input. Above 12.0 MMBtu/hr input, the requirements defer to the NFPA 85 standards for single burner boilers. . For the sizes this Code covers, the requirements are as follows, in addition to the standard CSA package:

Low Oil Pressure Switch for oil firing all sizes.

$\frac{3}{4}$ " Pressure Control Piping

If gas supply is > 5 psig, a relief valve is required after the gas pressure regulator in the main and pilot gas trains.

Lever Handled shutoff cock for the pilot gas train.

Non-fused disconnect to remove boiler from all sources of power.

DIMENSIONS AND RATINGS

For layout purposes, the nominal dimensions and connections for the Model 5 Standard Boiler Packages are shown in Figure B3-1 and Tables B3-1 and B3-2. Low Water Volume (LWV) Package Boiler Dimensions are shown on Figure B3-2 and Table B3-3 and B3-4. Ratings of each boiler size are noted in Table B3-5.

Additional information is shown in the following figures, tables, and illustrations.

Table B3-6 Recommended steam nozzle sizes for high pressure boilers operating at lower and higher pressures.

Table B3-7 Model 5 Oil Fuel Requirements.

Figure B3-3 Standard gas train.

Tables B3-8 to B3-11 Gas pressure requirements.

Table B3-12 Safety Valve Outlet Sizes.

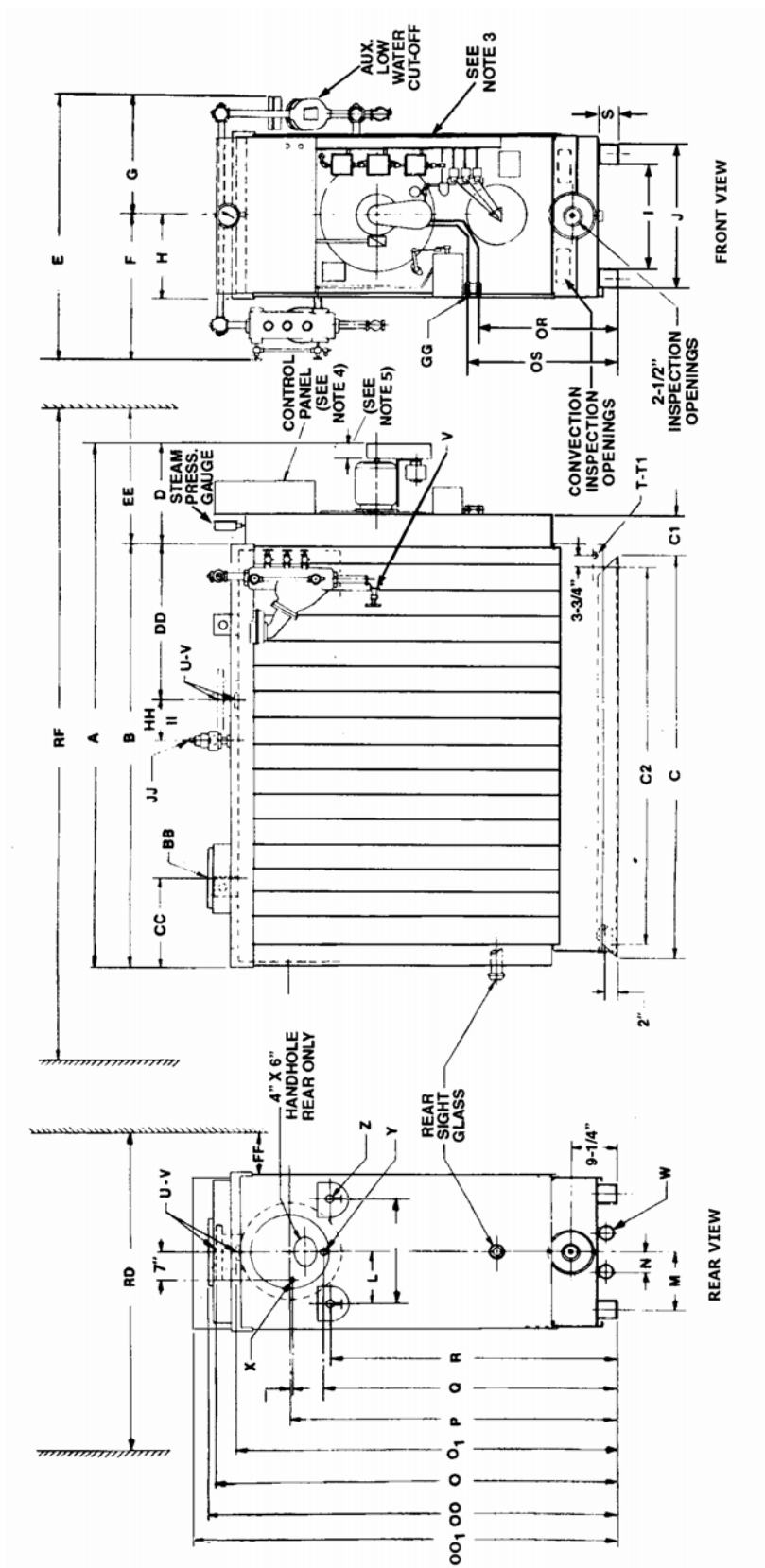


Figure B3-1. Model 5 Steam Boiler Dimension Diagram

		Boiler Size								
Note 1		1500	2000	2500	3000	3500	4000	4500	5000	6000
<u>Lengths</u>		All Dimensions are in Inches								
A	Overall	69.7	69.7	85.8	85.8	104.4	104.4	121.1	121.1	136.7
B	Pressure Vessel w/casing	51.25	51.25	67.375	67.375	83	83	99.625	99.625	115.25
C	Base Frame	45.5	45.5	61.1	61.1	76.75	76.75	92.4	92.4	108
C ₁	Base to Front Head	8	8	8	8	8	8	8	8	8
C ₂	Base Frame Anchor Holes	43	43	58.5	58.5	74.5	74.5	90	90	105.5
CC	Rear Casing to Stack Connection	17.2	17.2	17.7	17.7	17.7	17.7	21.8	21.8	21.8
D	Front Head Extension	13	13	13	13	16	16	16	16	16
DD	Front Casing to Steam Nozzle	16.4	16.4	24.4	24.4	30.1	30.1	36.75	36.75	44.6
HH	Steam Nozzle to Safety Valve 15#	7	7	12	12	11.5	11.5	13	13	17
	Steam Nozzle to Safety Valve 150#	8	8	12	12	17	17	17	17	17
<u>Widths</u>										
E	Overall	57.5	57.5	57.5	57.5	57.5	57.5	57.5	57.5	57.5
F	Center to Water Column	33	33	33	33	33	33	33	33	33
G	Center to Aux. Water Column	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
H	Center to Outside Casing	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
I	Base Frame Inside	20	20	20	20	20	20	20	20	20
J	Base Frame Outside	28	28	28	28	28	28	28	28	28
K	Soot Washers, Center to Center	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
L	Boiler Centerline to Soot Washer	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75
M	Boiler Centerline to Base Centerline	12	12	12	12	12	12	12	12	12
N	Boiler Centerline to Soot Drain	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
<u>Heights</u>										
OO	Overall [Base to Stack Connection]	78.25	78.25	78.25	78.25	78.25	78.25	78.25	78.25	78.25
OO ₁	Base to Top of Control Panel	84.5	84.5	84.5	84.5	84.5	84.5	84.5	84.5	84.5
O	Base to Steam Nozzle 15#	73.5	73.5	73.5	73.5	76.5	76.5	76.5	76.5	76.5
O ₁	Base to Steam Nozzle 150#	73.5	73.5	73.5	73.5	73.5	73.5	76.5	76.5	76.5
P	Base to Steam Drum Centerline	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25
P ₁	Drum Centerline To Surface Blowoff, Std. Design & 15# Low Water Volume. [See Note C]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
P ₁	Drum Centerline To Surface Blowoff; High Pressure Design Low Water Volume. [See Note D]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
R	Base to Sootwasher Lance	54	54	54	54	54	54	54	54	54
S	Height of Base	4	4	4	4	4	4	4	4	4
OS	Base to Oil Supply Connection	26.625	26.625	26.625	26.625	26.625	26.625	26.625	26.625	26.625
OR	Base to Oil Return Connection	24.625	24.625	24.625	24.625	24.625	24.625	24.625	24.625	24.625

Table B3-1. Model 5 Dimensions

Connections										
BB	OD Stack - Sleeve Connection	12	12	12	12	12	12	16	16	16
T	Bottom Drum Blow Down, 15# [one]	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5
T ₁	Bottom Drum Blow Down, 150# [one]	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
U	Steam Nozzle, 15#	4 ^A	4 ^A	4 ^A	4 ^A	6 ^B	6 ^B	6 ^B	6 ^B	6 ^B
V	Steam Nozzle, 150#	2.5 ^A	2.5 ^A	3 ^A	3 ^A	3 ^A	3 ^A	4 ^B	4 ^B	4 ^B
W	Soot Washer Drains [Two]	2	2	2	2	2	2	2	2	2
X	Surface Blow off [One]	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Y	Feedwater Inlet [One]	1	1	1	1	1	1	1	1	1
Z	Soot Washer [Two]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
GG	Oil Supply and Return	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
JJ	Relief Valve, 15#	1.5	2	2	2	2.5	2.5	2.5	2.5	3
	Relief Valve, 150#	0.75	1	1	1	1.25	1.25	1.25	1.25	1.5
Clearances										
EE	Front Door Swing	33	33	33	33	33	33	33	33	33
FF	Tube removal each side	30	30	30	30	30	30	30	30	30
RF	Allowance for Front Door Swing and 30" Rear Aisle Space.	133	133	149	149	167	167	184	184	200
RD	Allowance for Tube Removal Each Side and Front Door Swing.	94	94	94	94	94	94	94	94	94

NOTES:

- The above dimensions, while sufficiently accurate for layout purposes must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
 - Allow sufficient space at rear of boiler for removal of soot washer lance.
 - For access to the furnace, a 13" x 21" access door is provided behind the front door.
 - Control Panel may be larger [up to 4" in height] if certain control options are provided.
- A. Connection is a Female Pipe Thread.
 B. Connection is a 150# Flange, Flat Face.
 C. When optional internal collector pipe is requested, tapping will be 4.5" from drum centerline.
 D. When optional internal collector pipe is requested, tapping will be 6.8" from drum centerline.

Table B3-2. Model 5 connection sizes and clearances

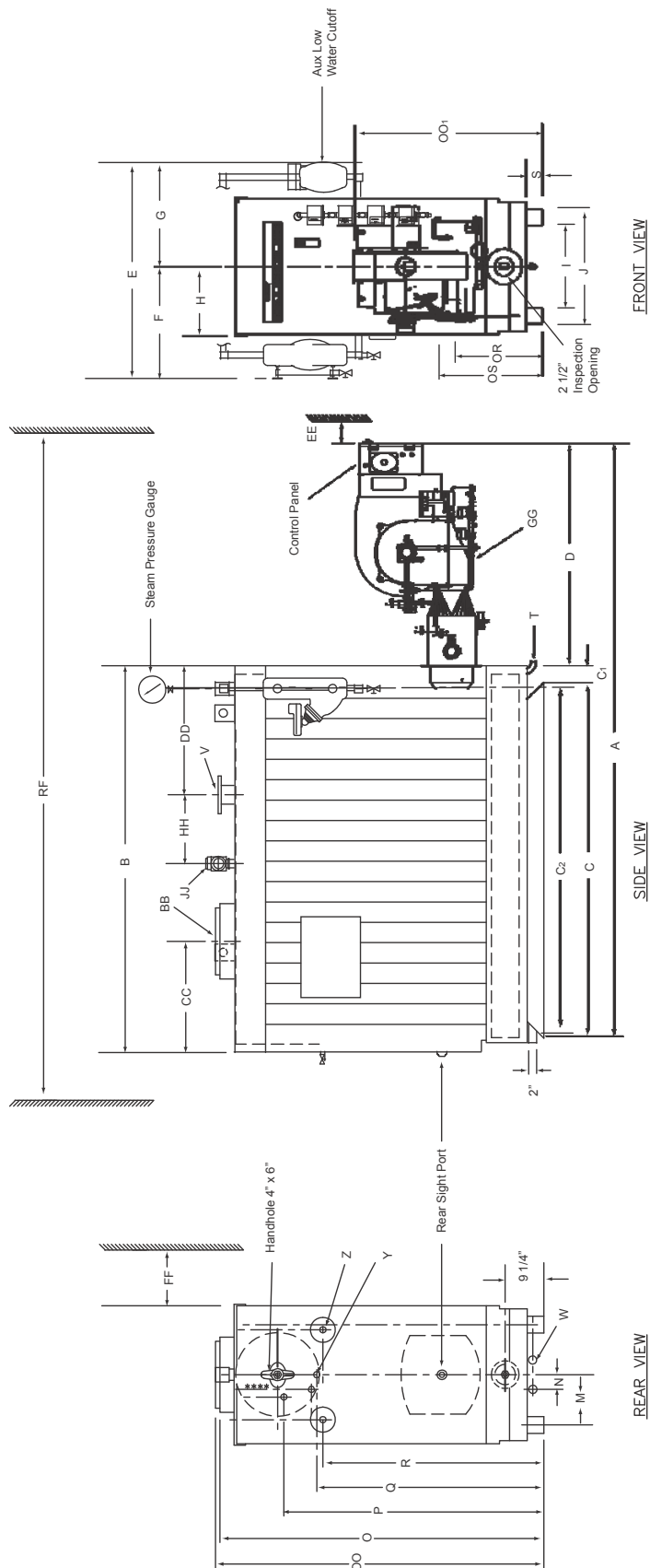


Figure B3-2. Model 5 Low Water Volume Dimension Diagram

		Boiler Size	
Note 1		7500	8000
<u>Lengths</u>		All Dimensions are in Inches	
A	Overall	190.1	190.1
B	Pressure Vessel w/casing	138.7	138.7
C	Base Frame	117.4	129.9
C ₁	Base to Front	6	6
C ₂	Base Frame Anchor Holes	112.4	127.4
CC	Rear Casing to Stack Connection	21.8	21.8
D	Burner Extension	56.5	56.5
DD	Front Casing to Steam Nozzle	63	63
II	Steam Nozzle to Safety Valve 150#	17	17
<u>Widths</u>			
E	Overall	57.5	57.5
F	Center to Water Column	33	33
G	Center to Aux. Water Column	23.5	23.5
H	Center to Outside Casing	16.5	16.5
I	Base Frame Inside	20	20
J	Base Frame Outside	28	28
K	Soot Washers, Center to Center	21.5	21.5
L	Boiler Centerline to Soot Washer	10.75	10.75
M	Boiler Centerline to Base Centerline	12	12
N	Boiler Centerline to Soot Drain	3.5	3.5
<u>Heights</u>			
OO	Overall [Base to Stack Connection]	78.25	78.25
OO ₁	Base to Top of Control Panel	84.5	84.5
O ₁	Base to Steam Nozzle 150#	73.25	73.25
P	Base to Surface Blowoff	58.5	58.5
Q	Base to Feedwater Inlet	55.75	55.75
R	Base to Sootwasher Lance	54	54
S	Height of Base	4	4
OS	Base to Oil Supply Connection	26.625	26.625
OR	Base to Oil Return Connection	24.625	24.625

NOTES:

1. The above dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
2. Allow sufficient space at rear of boiler for removal of soot washer lance.
3. For access to the furnace, a 13" x 21" access door is provided behind the front door.
4. Control Panel may be larger [up to 4" in height] if certain control options are provided.

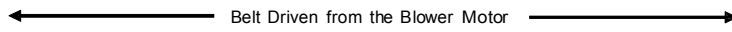
Table B3-3. Model 5 Low Water Volume dimensions

<u>Connections</u>			
BB.	OD Stack - Sleeve Connection	18	18
T ₁	Bottom Drum Blow Down, 150# [one]	1.25	1.25
V	Steam Nozzle, 150#	6	6
W	Soot Washer Drains [Two]	2	2
X	Surface Blow off [One]	0.75	0.75
Y	Feedwater Inlet [One]	1	1
Z	Soot Washer [Two]	0.25	0.25
GG	Oil Supply and Return	0.5	0.5
JJ	Relief Valve, 150#	2	2
<u>Clearances</u>			
EE	Clearance from Control Panel	36	36
FF	Tube removal each side	30	30
RF	Allowance for Front Burner Removal and 30" Rear Aisle Space.	220	220

NOTES:

1. The above dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
2. Allow sufficient space at rear of boiler for removal of soot washer lance.
3. For access to the furnace, a 13" x 21" access door is provided behind the front door.
4. Control Panel may be larger [up to 4" in height] if certain control options are provided.

Table B3-4. Model 5 Low Water Volume connection sizes and clearances

Boiler SIZE	1500	2000	2500	3000	3500	4000	4500	5000	6000	7500 LWV	8000 LWV
Ratings [Note A]											
Rated Capacity - Steam (lbs. steam/hr from & at 212° F.)	1,237	1,649	2,062	2,474	2,887	3,299	3,711	4,124	4,949	6,186	6,600
Rated Steam Capacity [kg/hr from and at 100 C]	561.0	748.0	935.0	1,122.0	1,309.0	1,496.0	1,683	1,871.0	1,847.2	2,806	2,993.7
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,800	6,000	6,400
Output Kcal/Hr [1,000 Kcal/h]	302	403	504	605	706	806	907	1,007	1,210	1,512	1,613
Output KW	348	464	580	696	812	928	1,044	1,160	1,392	1,740	1,856
Approximate Fuel Consumption At Rated Capacity [Input - Note B]											
Natural Gas [ft³/hr] - 15# Steam	1,465	2,000	2,450	2,952	3,456	3,950	4,444	4,938	5,925	NA	NA
Natural Gas [ft³/hr] - 150# Steam	1,538	2,077	2,564	3,117	3,590	4,155	4,657	5,194	6,233	7594	8205
Natural Gas [m³/hr] - 15# Steam	41.5	56.6	69.4	80.8	97.9	111.9	125.8	139.8	167.7	NA	NA
Natural Gas [m³/hr] - 150# Steam	43.5	58.8	72.6	88.3	101.6	117.6	131.8	147.0	176.5	215	232.4
Propane Gas [ft³/hr] - 15# Steam	586	800	980	1,181	1,382	1,580	1,778	1,975	2,370	NA	NA
Propane Gas [ft³/hr] - 150# Steam	615	831	1,026	1,247	1,436	1,662	1,863	2,078	2,493	3038	3282
Propane Gas [m³/hr] - 15# Steam	16.6	22.6	27.7	33.4	39.1	44.7	50.3	55.9	67.1	NA	NA
Propane Gas [m³/hr] - 150# Steam	17.4	23.5	29.1	35.3	40.7	47.1	52.7	58.8	70.6	86	92.9
No.2 Oil Fuel - 15# Steam, gph	10	14	17	21	24	28	31	35	42	NA	NA
No.2 Oil Fuel - 150# Steam, gph	11	15	18	22	25	28.9	32	36	43	54	59
No.2 Oil Fuel - 15# Steam, lph	38	53	64	79	91	106	117	132	159	NA	NA
No.2 Oil Fuel - 150# Steam, lph	41	56	68	82	95	109	121	136	163	204	223
Power Requirements - 3 Phase 60 Hz Standard [Note C]											
Blower Motor HP - Gas Firing	2	2	2	2	2	3	3	3	5	7.5	7.5
Blower Motor HP - Oil or Comb.	2	2	2	2	3	5	3	3	5	7.5	7.5
Oil Pump for Oil or Combination										Direct Drive from Fan Motor	
Minimum Ampacity											
Blower Motor - Gas, 230V	6	6	6	6	6	9	9	9	15	22	22
Blower Motor - Gas, 460 V	3	3	3	3	3	4.5	4.5	4.5	7.5	11	11
Blower Motor - Oil or Comb, 230 V	6	6	6	6	9	15	9	9	15	22	22
Blower Motor - Oil or Comb., 460V	3	3	3	3	4.5	7.5	4.5	4.5	7.5	11	11
Blower Motor - Gas, 575 V	1.6	1.6	1.6	1.6	1.6	2.4	2.4	2.4	4.1	6.1	6.1
Blower Motor - Oil or Comb., 575V	1.6	1.6	1.6	1.6	2.4	4.1	2.4	2.4	4.1	6.1	6.1
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4	2.4	2.5	2.5
Weights											
Operating Weight, lbs.	3,643	3,643	4,445	4,445	5,040	5,040	5,858	5,858	6,753	6,920	6,920
Operating Weight, kg	1,652	1,652	2,016	2,016	2,286	2,286	2,657	2,657	3,063	3,139	3,139
Water Content Normal, Imp.gals	54.4	54.4	74.9	74.9	94	94	116.1	116.1	135.7	71.1	71.1
Water Content Normal, liters	248	248	340	340	428	428	528	528	617	324.7	324.7
Water Content Flooded, Imp. gals	79.94	79.94	109.08	109.08	135.7	135.7	166.5	166.5	194.01		
Water Content Flooded, liters	363.4	363.4	459.9	459.9	616.9	616.9	756.9	756.9	881.99		
Shipping Weight, approx imate lbs.	3,100	3,100	3,700	3,700	4,100	4,100	4,700	4,700	5,400	6,200	6,200
Shipping Weight, approx imate kg	1,406	1,406	1,678	1,678	1,860	1,860	2,132	2,132	2,449	2,812	2,812

Notes:

A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.

B. Input calculated with Nat. Gas @ 1000 Btu/ft³, Propane @ 2500 Btu/ft³, and Oil @ 140,000Btu/gal.

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

Table B3-5. Model 5 Steam Boiler Ratings

Table B3-6. Recommended Steam Nozzle Size (To Maintain 4000 to 5000 fpm Nozzle Velocity)

Operating Pressure (PSIG)	BOILER SIZE								
	1500	2000	2500	3000	3500	4000	4500	5000	6000
15	4	4	6	6	6	6	8	8	8
20	3	4	4	6	6	6	8	8	8
30	3	4	4	4	4	6	6	6	6
40	2-1/2	3	3	4	4	4	6	6	6
50	2-1/2	3	3	4	4	4	4	4	6
65	2-1/2	2-1/2	3	3	3	4	4	4	4
75	2-1/2	2-1/2	3	3	3	4	4	4	4
95 - 125 ^A	2-1/2	2-1/2	3	3	3	3	4	4	4
150	1-1/2	2	2	2-1/2	2-1/2	2-1/2	3	3	3
200	1-1/2	1-1/2	1-1/2	2	2	2-1/2	2-1/2	2-1/2	3
250 - 400	1-1/2	1-1/2	1-1/2	1-1/2	2	2	2	2	2-1/2

A. Standard nozzle size for 150 PSIG MAWP Boiler Design

Example 1: Size 3500, 150# boiler to operate @ 30 PSIG requires 4" steam nozzle in lieu of standard 3" nozzle.

Example 2: Size 3500, 150# boiler to operate @ 200 PSIG requires 2" steam nozzle in lieu of standard 3" nozzle.

Table B3-7. Model 5 Oil Fuel Requirements

BOILER MODEL	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000 LWV
OIL USAGE ^A (GPH)	10.7	14.3	17.9	21.4	25.0	28.6	32.7	35.7	42.8	57.2

NOTES:

1. Oil supply lines to be sized for 125 gph pumping rates.

2. Oil pump suction pressure -10" Hg to 3 psig.

A. Usage Based on #2 Fuel @ 140,000 Btu/gal.

ITEM	PART	SIZE (IN.)
SIZE 1500 - 3000		
1	Gas Inlet	1-1/2
2	Shutoff Cock	1/2
3	Main Regulator	1-1/2
4	Pilot Regulator	1/2
5	Solenoid Valve	1/2
7	Valve (POC)	1-1/2
8	Low Gas Pressure (Switch or Sensor)	1/4
9	High Gas Pressure Switch	1/4
10	Shutoff Valve	1-1/2
11	Butterfly Valve	1-1/2
SIZES 3500 TO 5000		
1	Gas Inlet	2
2	Shutoff Cock	1/2
3	Main Regulator	2
4	Pilot Regulator	1/2
5	Solenoid Valve	1/2
7	Valve (POC)	2
8	Low Gas Pressure (Switch or Sensor)	1/4
9	High Gas Pressure Switch	1/4
10	Shutoff Valve	2
11	Butterfly Valve	2
SIZE 6000 To 8000		
1	Gas Inlet	2
2	Shutoff Cock	1/2
3	Main Regulator	2-1/2
4	Pilot Regulator	1/2
5	Solenoid Valve	1/2
6	Valve (STD)	2
7	Valve (POC)	2
8	Low Gas Pressure (Switch or Sensor)	1/4
9	High Gas Pressure Switch	1/4
10	Shutoff Valve	2
11	Butterfly Valve	2

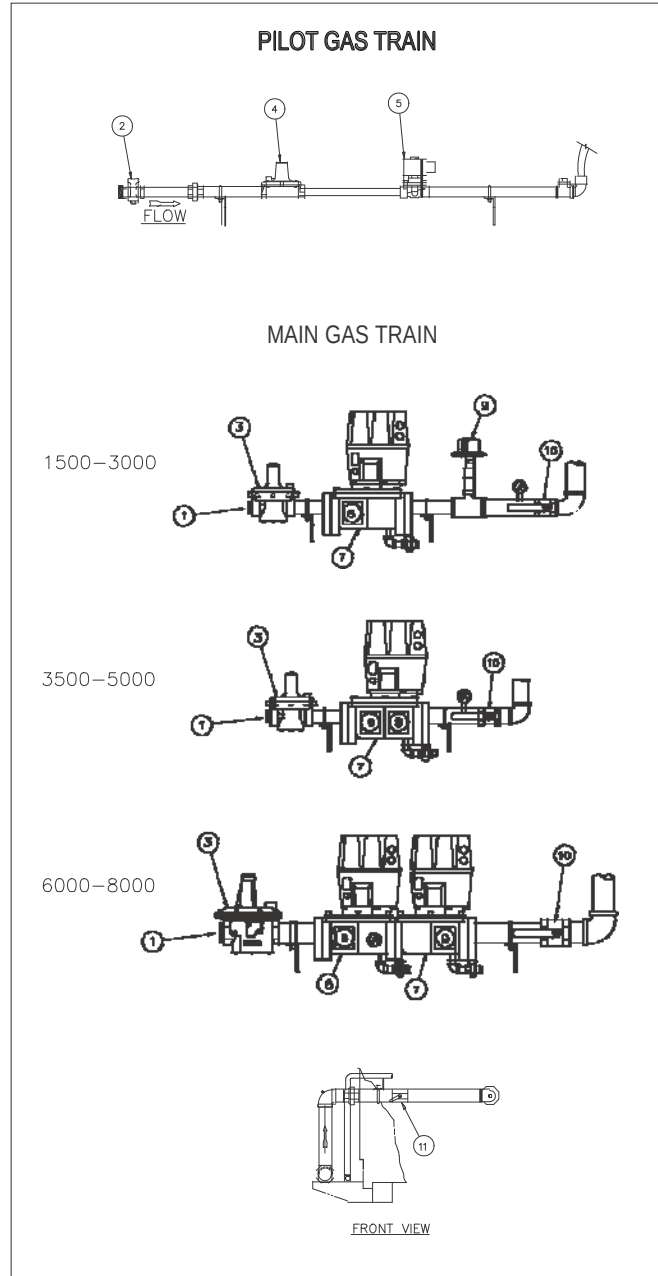


Figure B3-3. Standard Gas Train Model 5

Table B3-8. Model M5 minimum required Natural Gas pressure at entrance to the standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	1.5	1.5	4.3	28.0	1500
2000	1.5	1.5	8.4	28.0	2000
2500	1.5	1.5	11.3	28.0	2500
3000	1.5	1.5	14.9	28.0	3000
3500	2.0	2.0	10.0	28.0	3500
4000	2.0	2.0	11.9	28.0	4000
4500	2.0	2.0	11.5	28.0	4500
5000	2.0	2.0	16.0	28.0	5000
6000	2.0	2.0	20.4	28.0	6000
8000 LWV	2.5	19.9	19.9	28.0	8000

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
 Natural Gas @ 1000 Btu/cu-ft, specific gravity @ 0.65

Table B3-9. Model M5 minimum required Natural Gas pressure at entrance to the oversized standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	2.0	2.0	2.3	28.0	1500
2000	2.0	2.0	4.8	28.0	2000
2500	2.0	2.0	6.5	28.0	2500
	2.5	2.5	5.7		
3000	2.0	2.0	9.0	28.0	3000
	2.5	2.5	6.8		
	3.0	3.0	6.0		
3500	2.5	2.5	9.7	28.0	3500
	3.0	3.0	7.1		
4000	2.5	2.5	11.8	28.0	4000
	3.0	3.0	8.5		
4500	2.5	2.5	9.8	28.0	4500
	3.0	3.0	5.6		
5000	2.5	2.5	12.9	28.0	5000
	3.0	3.0	7.1		
	4.0	4.0	5.6		
6000	2.5	2.5	17.5	28.0	6000
	3.0	3.0	10.0		
	4.0	4.0	7.9		
8000 LWV	3.0	3.0	9.8	28.0	8000
	4.0	4.0	5.6		

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
 Natural Gas @ 1000 Btu/cu-ft, specific gravity @ 0.65

Table B3-10. Model M5 minimum required Propane Gas pressure at entrance to the standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	1.5	1.5	6.7	28.0	600
2000	1.5	1.5	10.5	28.0	800
2500	1.5	1.5	13.3	28.0	1000
3000	1.5	1.5	17.0	28.0	1200
3500	2.0	2.0	14.3	28.0	1400
4000	2.0	2.0	16.5	28.0	1600
4500	2.0	2.0	14.8	28.0	1800
5000	2.0	2.0	16.4	28.0	2000
6000	2.0	2.0	19.6	28.0	2400
8000 LWV	2.0	2.0	19.6	28.0	3200

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.

Propane @ 2500 Btu/cu-ft, specific gravity @ 1.6

Table B3-11. Model M5 minimum required Propane Gas pressure at entrance to the oversized standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	2.0	2.0	5.9	28.0	600
2000	2.0	2.0	9.0	28.0	800
2500	2.0	2.0	10.8	28.0	1000
	2.5	2.5	10.5		
3000	2.0	2.0	13.8	28.0	1200
	2.5	2.5	12.9		
	3.0	3.0	12.6		
3500	2.5	2.5	13.6	28.0	1400
	3.0	3.0	12.6		
4000	2.5	2.5	15.8	28.0	1600
	3.0	3.0	14.5		
4500	2.5	2.5	13.8	28.0	1800
	3.0	3.0	12.1		
5000	2.5	2.5	14.8	28.0	2000
	3.0	3.0	12.5		
	4.0	4.0	12.0		
6000	2.5	2.5	18.0	28.0	2400
	3.0	3.0	15.0		
	4.0	4.0	14.1		
8000 LWV	2.5	2.5	13.8	28.0	3200
	3.0	3.0	12.1		

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
Propane @ 2500 Btu/cu-ft, specific gravity @ 1.6

Table B3-12. Safety Valve Outlet Sizes

Boiler Size	SAFETY VALVE SETTING					
	15 PSIG STEAM			150 PSIG STEAM		
	VALVES REQ'D	OUTLET SIZE (IN.)**	VALVE CAPACITY	VALVES REQ'D	OUTLET SIZE (IN.)**	VALVE CAPACITY
1500	1	2	3161 lbs/hr	1	1	1651 lbs/hr
2000	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
2500	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
3000	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
3500	1	2	3161 lbs/hr	1	1-1/2	4240 lbs/hr
4000	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
4500	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
5000	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
6000	1	3	6942 lbs/hr	1	2	6596 lbs/hr
8000 LWV	NA	NA	NA	1	2	

** Female Pipe Thread Connection [FPT]

PERFORMANCE DATA**Efficiency**

Efficiency data provided in Table B3 - 13 is based on low pressure steam operation. For high pressure steam operation contact your local Cleaver-Brooks authorized representative for expected efficiency data.

Table B3-13. Predicted Efficiency, 10 PSIG operating (includes radiation and convection losses)

Boiler Size	Gas Fuel		Oil Fuel	
	Firing Rate		Firing Rate	
	Low Fire	High Fire	Low Fire	High Fire
1500	81.6	81.9	84.1	84.4
2000	81.1	80.0	83.6	82.5
2500	81.6	81.5	84.1	84.0
3000	81.3	80.3	83.8	82.8
3500	81.6	81.5	84.1	84.0
4000	81.3	80.7	83.8	83.0
4500	81.1	80.9	83.6	83.4
5000	81.3	80.0	83.8	82.5
6000	81.6	79.8	84.1	82.4

Emissions

The following tables denote typical emission levels for Natural Gas and No. 2 Oil. Please contact your local Cleaver-Brooks authorized representative if an emission guarantee is required.

Notice

The data in these tables represent typical emission levels only. Please contact your local Cleaver-Brooks authorized representative if an emission guarantee is required, or for emission level information not shown in these tables.

Table B3-14. Model 5 Emission Data, Natural Gas

POLLUTANT		UNCONTROLLED
CO	ppm ^A	200
	lb/MMBtu	0.15
NOx	ppm ^A	100
	lb/MMBtu	0.12
SOx	ppm ^A	1
	lb/MMBtu	0.001
HC/VOCs	ppm ^A	40
	lb/MMBtu	0.016
PM	ppm ^A	—
	lb/MMBtu	0.01

A. ppm levels corrected to 3% O₂ dry basis.

Table B3-15. Emission Data, No. 2 Oil

POLLUTANT		UNCONTROLLED ^B
CO	ppm ^A	90
	lb/MMBtu	0.07
NOx	ppm ^A	187
	lb/MMBtu	0.248
SOx	ppm ^A	278
	lb/MMBtu	0.515
HC/VOCs	ppm ^A	50
	lb/MMBtu	0.025
PM	ppm ^A	—
	lb/MMBtu	0.025

NOTES:
A. ppm levels corrected to 3% O₂ dry basis.
B. Based on the following fuel oil constituents.
Fuel-bound nitrogen = 0.05% (max) by weight.
Sulfur = 0.5% (max) by weight.
Ash = 0.01% (max) by weight.

ENGINEERING DATA

The following engineering information is provided for the Model 5 steam boiler. Additional information may be obtained from your local Cleaver-Brooks authorized representative.

Feedwater

Steam boilers require make-up water for steam production. This make-up can be a combination of condensate return and raw make-up, 100% condensate return or 100% raw make-up. Proper treatment of make-up water and boiler water is essential to the longevity and performance of the boiler. Table B3-23 depicts the rate of make-up required and Table B3-22 shows the recommended water quality guidelines.

As a minimum, raw make-up should be piped into a water softener and then to a feed tank, which also can be the container that receives the system condensate returns. Chemical feed is recommended to be fed via a quill into the water make-up line feeding the boiler.

Blowdown

As steam is produced; unwanted solids are left behind in the boiler water and become concentrated within the vessel. If these constituents are allowed to adhere to the heat transfer surfaces, they will impede the flow of energy into the water. Their removal requires proper blowdown that will include bottom and possibly surface blowoff. For proper TDS control, surface blowoff with a TDS monitoring device is recommended. Local codes will dictate the manner of treating the blowdown affluent.

Boiler Stacks

General - The Model 5 boiler operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore, the stack must be a positive pressure design.

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

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

When two or more Model 5 boilers are connected to a common breeching/stack, one should evaluate the affects of pressure variations that may occur during boiler sequencing while boilers are firing. It may be determined that some type of mechanical draft system be employed to ensure proper draft at each boiler is maintained.

Combustion Air - The burner for each boiler must be supplied with adequate volume of uncontaminated air to support proper combustion and equipment ventilation. Air shall be free of chlorides, halogens, fluorocarbons, construction dust or other

contaminants that are detrimental to the burner or boiler heating surfaces.

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA 54 (National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B149/.1 and B149.2 for Canadian installations.

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

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. Refer to Figure B3 - 4.

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

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.

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

Size the openings by using the formula ($\text{Area in ft}^2 = \text{cfm}_a / \text{fpm}_a$), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.

Amount of air required (cfm):

Combustion Air = Maximum boiler horsepower (bhp) times 8 cfm.

Ventilation Air = Maximum boiler horsepower (bhp) times 2 cfm.

Total Air = 10 cfm per bhp (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).

Acceptable air velocity in the boiler room (fpm):

From floor to 7 feet high = 250 fpm.

Above 7 feet from boiler room floor = 500 fpm.

Example of required air openings (Engineered Method):

Determine the area of the boiler room air supply openings for (2) size 4500 Model 5 boilers at 750 feet elevation; each have a rating of 107 boiler horsepower. The air openings will be 5 feet above the floor level.

The total boiler horsepower (bhp): $107 \times 2 = 214$ bhp.

From (F.3) above, total air required = $214 \text{ bhp} \times 10 = 2140$ cfm.

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

Area required: From the formula in E above, $2140 \text{ cfm} / 250 \text{ fpm} = 8.56$ square feet total.

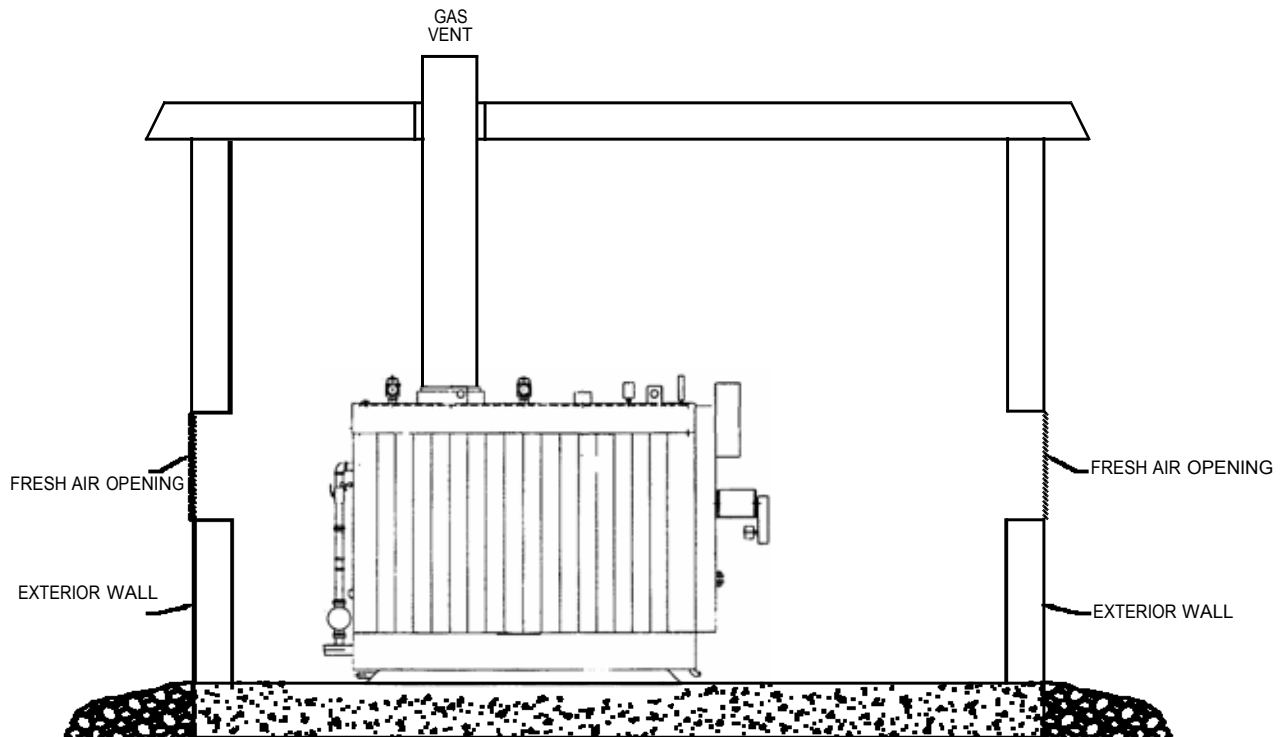
Area opening: 8.56 divided by 2 = 4.28 ft² per opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

See Table B3-24 for combustion air and flue gas flow.

Figure B3-4. Boiler Room Air Flow - "Engineered Design"



Oil Piping

General - Oil operation of the Model 5 boiler requires proper oil to the standard burner mounted oil pump. As the combustion of oil utilizes mechanical pressure atomization, line sizing to the pump must be sufficient to provide 125 gph of oil to the suction side of the pump.

Oil Train Components - Oil flow to the burner is controlled by four solenoid valves. The oil flows through a primary or safety shutoff valve into a manifold block. This valve and the low fire valve are energized simultaneously by the flame safeguard control and when opened, allow flow of oil to the low fire nozzle.

As the damper motor moves to high fire position, the damper motor end switches close to energize in sequence, the intermediate and then high fire oil valve. The purpose of the intermediate valve is to smooth the transition from low to high fire by balancing the oil input with increasing flow of air.

High fire rating of the burner is obtained when all three nozzles are firing, assuming proper oil pressure and normally sized nozzles.

Gas Piping

General - The Model 5 boiler requires appropriate gas supply pressure and volume for proper operation and long burner life. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation

must follow these guidelines and of the local authorities that have installation jurisdiction.

Gas Train Components - Model 5 boilers are equipped with a gas train that meets the requirements of UL as standard. These components also comply with the recommendations of FM, XL GAP (formerly IRI/GE GAP) and ASME CSD-1. The gas train and its components have been designed and tested to operate for the highest combustion efficiency.

Gas Pressure Requirements - For proper and safe operation, each Model 5 boiler requires a stable gas pressure supply. The pressure requirements are listed in previous sections for standard gas train size, and oversized trains for reduced available pressure.

Gas Piping - Model 5 units are standardly equipped with a gas pressure regulator. If upstream pressure to the standard regulator will be greater than 1 psig, an additional upstream regulator should be provided with a pressure relief valve.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c., a "full lockup" type regulator is recommended along with proper overpressure protection. In addition to the regulator, a plug type or "butterball" type gas shutoff cock should be provided upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the boiler gas train during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

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

A survey of all connected gas using devices should be made. If appliances other than the boiler are connected to the gas supply line, then a determination should be made of how much flow volume (cfh = cubic feet per hour) will be demanded at one time and the pressure drop requirements when all appliances are operating.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final connection. As a minimum guideline, gas piping Tables B3 - 16 through B3 - 20 should be used. The data in these tables is from the NFPA source book, 2006 edition.

Table B3-16. Gas line capacity - Schedule 40 metallic pipe

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

Table B3-17. Gas line capacity - Schedule 40 metallic pipe

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

Table B3-18. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	57,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	954	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
1000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
**Fuel: Natural Gas									
**Inlet Pressure: 2.0 psi									
**Pressure Drop: 1.0 psi									
**Specific Gravity: 0.60									

Table B3-19. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	75,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,300	20,300	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,300
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
500	283	593	1,120	2,290	3,430	6,610	10,300	18,600	38,000
1000	195	407	897	1,380	2,360	4,550	7,240	12,000	26,100
1500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
**Fuel: Natural Gas									
**Inlet Pressure: 3.0 psi									
**Pressure Drop: 2.0 psi									
**Specific Gravity: 0.60									

Table B3-20. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
1000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400
**Fuel: Natural Gas									
**Inlet Pressure: 5.0 psi									
**Pressure Drop: 3.5 psi									
**Specific Gravity: 0.60									

Table B3-21. Sound Levels

SOUND LEVEL / FIRING RATE	BOILER SIZE (BHP)									
	1500 (35)	2000 (47)	2500 (59)	3000 (71)	3500 (83)	4000 (95)	4500 (107)	5000 (119)	6000 (143)	8000
LFG (dBA)	70	70	71	71	72	72	74	75	76	
HFG (dBA)	70	70	72	74	74	76	77	78	79	
LFO (dBA)	69	69	70	71	72	73	74	75	76	
HFO (dBA)	71	71	72	73	74	76	76	77	78	

NOTES:

1. Abbreviations: LF=Low Fire, HF=High Fire, O=Oil, G=GAS

2. Measurement: Three (3) feet from front center of boiler and 3-1/2 feet above boiler base. Measurements are decibel ratings on the A-Weighted scale, and were registered without the addition of sound attenuators, mufflers, or silencers.

3. N/A to 8000 LWV.

Table B3-22. Water Quality Requirements

Parameter	Boiler Water Limit
pH	8.3 - 10.5
Iron	0.1 ppm
Oxygen	0.1 mg/liter
Specific Conductivity	2000 μ mho/cm
Suspended Solids	300 ppm
Total Hardness	0 ppm as CaCO ₃

Table B3-23. Feedwater Make-up Rates

Boiler Size	Gallons/Minute
1500	2.5
2000	3.3
2500	4.1
3000	5
3500	5.8
4000	6.6
4500	7.5
5000	8.3
6000	9.9
8000	13.2

Table B3-24. Model 5 Fuel, Combustion Air, and Flue Gas Flow Rates

			Boiler Size									
			1500	2000	2500	3000	3500	4000	4500	5000	6000	8000 LWV
Fuel Consumption	Gas	cfh	1500	1500	2500	3000	3500	4000	4500	5000	6000	8000
	Oil	gph	10.72	14.29	17.86	21.43	25.00	28.57	32.14	35.71	42.85	
Combustion Air	Gas	scfh	15,480	20,640	25,800	30,960	36,120	41,280	46,440	51,600	61,920	
		lb/hr	1,207	1,609	2,012	2,414	2,817	3,219	3,621	4,024	4,828	
	Oil	scfh	17,049	22,733	28,414	34,098	39,782	45,463	51,147	56,831	68,196	
		lb/hr	1,269	1,692	2,115	2,538	2,961	3,384	3,808	4,231	5,077	
Flue Gas	Gas	scfh	17,520	23,360	29,200	35,040	40,880	46,720	52,560	58,400	70,080	
		lb/hr	1,278	1,704	2,130	2,556	2,983	3,409	3,835	4,261	5,113	
	Oil	scfh	17,914	23,886	29,855	35,827	41,799	47,769	53,741	59,713	71,655	
		lb/hr	1,357	1,809	2,261	2,714	3,166	3,618	4,070	4,523	5,427	

- Notes:
- A. Gas consumption, expressed in cubic feet per hour, is based on 1,000 Btu/cu.ft gas value.
 - B. Oil consumption, expressed in pounds per hour, is based on 140,000 Btu/gal oil value.
 - C. Oil supply lines must be sized for 125 gph pumping rate. Oil pump suction pressure to be -10" Hg to 3 psig.

Model 5 Boilers

Steam Specifications

Boiler Capacity B3-32

Boiler Description B3-32

Soot Cleaning B3-33

Boiler Connections B3-33

Boiler Trim/Controls B3-33

Low Water Volume Design (LWV), 150 Psig B3-34

Low Water Volume Design (LWV), 15 Psig B3-34

Burner B3-34

Gas Fired Burner B3-35

Oil Fired Burner B3-36

Gas-Oil Fired Burner B3-37

Burner and Flame Failure Controller B3-38

Burner Control Panel B3-38

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer’s specific needs and application.



PART 1 GENERAL

1.1

BOILER CAPACITY

- A. The steam boiler shall be a Cleaver-Brooks Model 5, Series (100, 200, 700) rated at _____ lbs/hr or _____ boiler horsepower designed for (15, 150, 250, 350 or 500) psig steam. The maximum boiler operating pressure will be _____ psig. (Series 100 is a No.2 oil fired burner; Series 200 is a gas or No.2 oil fired burner; Series 700 is a straight gas burner).
- B. The boiler shall have a maximum output of _____ Btu/hr or _____ boiler horsepower when fired with (No.2 oil) or (natural gas @ _____ Btu/cu-ft). The boiler shall develop _____ lbs/hr when operating at _____ psig with feedwater temperature at _____ ° F. The boiler safety relief valve(s) shall be set at _____ psig.
- C. Electrical power to the boiler shall be _____ volts, _____ phase, _____ Hz. All electrical service connections shall be made to an electrical entrance box mounted on the right hand side of the boiler.

PART 2 PRODUCTS 2.1**BOILER DESCRIPTION**

- A. The boiler shall be an all steel membrane wall watertube design with 3-pass gas travel. It shall be mounted on a heavy duty steel frame with an integral forced draft burner and burner controls. The complete package, boiler-burner unit, shall be certified, tested, and labeled by CSA (Canadian Standard Association). The package shall be completely assembled and receive a factory fire test prior to shipment.
- B. The boiler shell must be constructed and hydrostatically tested in accordance with the A.S.M.E. Boiler and Pressure Vessel Code Section I or IV and receive an authorized boiler inspection. A copy of the inspection report shall be furnished to the purchaser.
- C. Two downcomers shall be located at the rear of the boiler and totally insulated from the generating tubes. The downcomers shall be 2-1/2" OD for 35 and 47 hp; 3" OD for 59 to 83 hp, and 4" OD for 95 hp and greater. Material shall be SA-178A. The 2-1/2" and 3" downcomers shall have 0.105" wall while the 4" downcomers shall have 0.135" wall. The generating tubes shall be 2" OD, SA-178 Grade A with 0.095" wall thickness.
- D. The upper drum shall be 20" OD Schedule 20, SA-53-B seamless pipe with 0.375" wall. The lower drum shall be 6" nominal pipe size, SA-53-B seamless pipe with 0.312" wall up through 150 psig design.
- E. Two lifting eyes shall be located on the top centerline of the upper drum.
- F. Refractory shall be limited to the furnace floor, lower drum, burner throat tile, and the formed rear furnace access door. High temperature insulation shall be installed on the front water wall of the furnace.
- G. Observation ports shall be provided at each end of the boiler for visual inspection of the pilot and main flame conditions.

- H. The exhaust gas vent shall be located at the top rear centerline of the boiler. A stack thermometer shall be shipped loose for field installation by the installing contractor into the stack.
- I. Inspection openings shall be provided in the convection area.
- J. The lower drum shall include capped plugs in the front and rear drum heads, and a handhole shall be provided in the rear upper drum head for waterside inspection.
- K. The vessel shall be insulated with a minimum of 2" fiber glass blanket. This insulation shall be covered with a sheet metal jacket. The jacket and insulation shall be arranged for easy removal and reinstallation if required.
- L. The entire boiler jacket, base frame, and other components shall be factory painted using hard finish enamel.

2.2 SOOT CLEANING

- A. Soot washer lances shall be provided in the upper convection area of the boiler, measuring the full length of the pressure vessel. Each lance assembly shall be capable of rotating 360 degrees. This shall ensure complete washing of the convection zone while the boiler is operating in the low fire mode.
- B. Soot washer drain troughs shall be provided at the bottom of the boiler. These shall be furnished for each convection side running the full length of the boiler with 2" drain connections at the bottom rear. Inspection/cleanout openings for each trough shall be located at the front of the boiler.

2.3 BOILER CONNECTIONS

- A. The steam nozzle shall be located on the top centerline of the upper drum and sized for steam velocity not to exceed 5000 fpm.
- B. A feedwater tapping and an integral feedwater distribution pipe shall be located in the upper drum. This distribution pipe shall blend the feedwater with the boiler water.
- C. A ¾" surface blowoff tapping shall be provided in the rear head of the upper drum.
- D. For blowdown or boiler drain, a tapping shall be provided in the bottom of the lower drum near the front of the boiler.

2.4 BOILER TRIM/CONTROLS

- A. The primary water column shall be located on the left side of the boiler when facing the burner. It shall be piped with union connections for easy removal and include a full size column blowdown valve. A gauge glass with gauge glass valves shall be mounted to the water column.
- B. A primary low water cutoff switch shall be an integral part of the water column and shall be wired into the burner control circuit to prevent burner operation in the event of an unsafe water level condition.
- C. To maintain proper and safe water level within the boiler, an integral feed pump control switch shall be included within the primary water column. This switch may be wired to a control relay for pump on/off operation or wired to control a solenoid water make-up valve.

- D. A secondary low water cutoff control of the manual reset type shall be provided on the right hand side of the boiler, when facing the burner. This control shall include a switch wired into the burner circuit to prevent burner operation in the event that the primary low water control did not function properly during an unsafe water level condition. A control blowdown valve shall be included for maintenance and periodic testing of the level device.
- E. For visual indication of the internal boiler pressure, a steam pressure gauge shall be mounted near the water column and shall include an inspector's test cock and test connection point.
- F. For burner operation, a minimum of three controls shall be provided: one auto reset type for burner start and stop control, one for burner firing rate (modulation on gas or low high low on oil), and one manual reset type for burner shutdown in the event of excessive steam pressure within the boiler.
- G. In compliance with the A.S.M.E. Code, a Code rated safety relief valve(s) shall be provided. This valve(s) may be shipped loose to prevent any damage during shipment.

2.5 LOW WATER VOLUME DESIGN (LWV), 150 PSIG

For applications requiring the use of a low water volume vessel, the following trim, controls and design shall be provided:

- A. The primary water column shall be located on the left side of the boiler when facing the burner, and shall be a McDonnell-Miller #193-7 or approved equal. It shall be piped with union connections for easy removal and include a full size column blowdown valve. A gauge glass with gauge glass valves shall be mounted to the water column.
- B. The primary water level control and water level cut-off settings shall be installed at a level that limits the total water content within the boiler to 75 U.S. Gallons (283.9 liters) or less at full operating capacity.
- C. Feedwater into the boiler shall be controlled by means of an electric proportional feedwater valve, Worchester or approved equal, complete with stop valve, check valve, and 3-valve by-pass.
- D. Controls shall be provided to comply with "Guarded Plant" status requirements.
- E. The upper and lower drums shall be properly insulated to prevent heat transfer onto these surfaces during combustion.

2.6 LOW WATER VOLUME DESIGN (LWV), 15 PSIG

For applications requiring the use of a low water volume vessel, the following trim, controls and design shall be provided:

- A. Controls shall be provided to comply with "Guarded Plant" status requirements.
- B. The upper and lower drums shall be properly insulated to prevent heat transfer onto these surfaces during combustion.

2.7 BURNER

- A. Models 1500 - 6000; all air for combustion shall be supplied by a

forced draft blower mounted in the front head (wind box) above the burner, to minimize vibration and reduce noise emissions. The impeller shall be an enclosed centrifugal fan type, properly balanced and direct connected to the motor shaft. Sound level shall not exceed 80 dBA measured 3 feet in front of the burner.

- B. Models 7500 - 8000; all air for combustion shall be supplied by a forced draft blower mounted within the fan housing of the externally mounted burner. The burner shall be a CB Profire Series V. The fan shall be a squirrel cage design, properly balanced and direct connected to the motor. Sound level shall not exceed 85 dBA measured 3 feet in front of the burner.
- C. When firing gas, the burner shall operate on the full modulation mode and shall be positioned at the low position for the ignition sequence, and shall remain in the low fire position during ignition and until main flame has been proven.
- D. For oil operation, the burner shall operate on the low-high-low principle and shall be positioned at the low position for the ignition sequence, and shall remain in the low fire position during ignition and until main flame has been proven.

2.8 GAS FIRED BURNER

- A. The burner shall be a high radiant multi-port type approved for operation on natural gas.
- B. Automatic electric ignition of the premix gas pilot shall be furnished. An ultra violet (UV) flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established. The gas pilot assembly shall include a pilot solenoid shutoff valve, pilot regulator, and manual shutoff cock.
- C. A single damper motor shall control the combustion air inlet damper and the fuel input control valve (butterfly type) via linkage connections. The damper motor shall modulate the burner in accordance with system demand, responding to the boiler mounted modulating pressure control.
- D. Gas burner piping shall include a primary safety shutoff valve, controlled by the burner flame safeguard control to start or stop the burner. The valve shall close automatically in the event of a power failure, excess steam pressure, low or high gas pressure, or a low water condition.
- E. A main gas pressure regulator shall be piped in the gas train to regulate the incoming pressure for proper burner operating pressure including an upstream manual shutoff valve.
- F. For tightness checking of the primary shutoff valve, a plugged leakage test connection and a lubricated plug cock shall be provided.
- G. The primary shutoff valve shall be of the motorized type.
- H. For sizes 6000 - 8000, a second motorized gas valve shall be provided and piped in series with the primary shutoff valve.
- I. Low and High gas pressure switches of the manual reset type shall be mounted and wired to prevent burner operation if gas pressure is above or below the settings of these switches.

- J. To prove proper air is available for pre purge and combustion, a combustion air proving switch shall be provided.

2.9 OIL FIRED BURNER

- A. The burner shall be a pressure atomizing type approved for operation with commercial grade No. 2 fuel oil.
- B. For 1500 through 6000 units,
 - 1. Automatic electric spark ignition for the low fire oil supply shall be provided with a 10,000 volt ignition transformer and heavy duty electrodes. The ignition period shall be monitored with an electronic scanner of the UV principle to confirm the presence of the low fire oil flame.
 - 2. A single damper motor shall control the combustion air inlet damper and the fuel input control valves via linkage connections. The damper motor shall operate the burner in accordance with system demand, responding to the boiler mounted low high low pressure control.
 - 3. For fuel input control, 4 solenoid type fuel oil valves shall be piped and wired onto the front head of the boiler. Two valves shall be used for low fire ignition and the other two for high fire operation.
 - 4. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, and shutoff cock.
 - 5. An oil pump shall be provided and shall be integral with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via belt connection to the fan motor.
- C. For 7500 - 8000 units, automatic electric ignition of the premix gas pilot shall be furnished. An ultra violet (UV) flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established. The gas pilot assembly shall include a pilot solenoid shutoff valve, pilot regulator, and manual shutoff cock.
 - 1. A single damper motor shall control the combustion air inlet damper and the fuel input control valve via linkage connections. The damper motor shall modulate the burner in accordance with system demand, responding to the boiler mounted modulating pressure control.
 - 2. For fuel input control, metering type fuel oil valve shall be piped and onto the burner housing. Two solenoid valves shall be used for safety shutoff.
 - 3. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, low oil pressure interlock, and shutoff cock.
 - 4. An oil pump shall be provided and shall be shipped loose with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via oil pump starter mounted and wired in the burner control panel.

2.10 GAS-OIL FIRED BURNER

A. General

1. The burner shall be a high radiant multi-port type approved for operation on natural gas and shall be a pressure atomizing type approved for operation with commercial grade No. 2 fuel oil.
2. Automatic electric ignition of the premix gas pilot shall be furnished. An ultra violet (UV) flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established. The gas pilot assembly shall include a pilot solenoid shutoff valve, pilot regulator, and manual shutoff cock.
3. A single damper motor shall control the combustion air inlet damper and the fuel input control valve via linkage connections. The damper motor shall regulate the burner in accordance with system demand, responding to the boiler mounted pressure control.
4. To prove proper air is available for pre purge and combustion, a combustion air proving switch shall be provided.

B. Gas System

1. Gas burner piping shall include a primary safety shutoff valve, controlled by the burner flame safeguard control to start or stop the burner. The valve shall close automatically in the event of a power failure, excess steam pressure, low or high gas pressure, or a low water condition.
2. A main gas pressure regulator shall be piped in the gas train to regulate the incoming pressure for proper burner operating pressure including an upstream manual shutoff valve.
3. For tightness checking of the primary shutoff valve, a plugged leakage test connection and a lubricated plug cock shall be provided.
4. The primary shutoff valve shall be of the motorized type.
5. For sizes 6000 - 8000, a second motorized gas valve shall be provided and piped in series with the primary shutoff valve.
6. Low and High gas pressure switches of the manual reset type shall be mounted and wired to prevent burner operation if gas pressure is above or below the settings of these switches.

C. Oil System

1. For 1500 through 6000 units,
 - a. For fuel input control, 4 solenoid type fuel oil valves shall be piped and wired onto the front head of the boiler. Two valves shall be used for low fire ignition and the other two for high fire operation.
 - b. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, and shutoff cock.
 - c. An oil pump shall be provided and shall be integral with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via belt connection to the fan motor.

2. For 7500 - 8000 units,
 - a. For fuel input control, metering type fuel oil valve shall be piped and onto the burner housing. Two solenoid valves shall be used for safety shutoff.
 - b. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, low oil pressure interlock, and shutoff cock.
 - c. An oil pump shall be provided and shall be shipped loose with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via oil pump starter mounted and wired in the burner control panel.

2.11 BURNER AND FLAME FAILURE CONTROLLER

A third party listed and approved safeguard control shall be provided to control ignition, starting and stopping the burner, and provide pre-combustion and post combustion air purge. The control shall stop and prevent burner operation in the event of ignition, pilot, or main flame failures. Trial for ignition shall be limited to 10 seconds.

- A. The flame safeguard control shall be a microprocessor based burner management control system, designed to provide proper burner sequencing, ignition, and flame monitoring protection.
- B. Through SMART LED's, the control shall provide current operating status and lockout information in the event of a safety shutdown.
- C. A separate preconfigured program module shall plug in to the microprocessor control.
- D. For trouble shooting and retrieving history, a VFD format display shall be mounted onto the control. This alpha numeric display shall provide 2 lines by 16 characters per line display of operating conditions, fault conditions, flame signal strength, and burner run history.
- E. In addition to the VFD display, LED Indicator Lights shall be provided integral with the control for Fan, Open Damper, Close Damper, Auto Operation, and Ignition.
- F. The control shall be a CB120E or equal.

2.12 BURNER CONTROL PANEL

- A. The control panel shall be mounted at the front of the boiler on the burner fan housing (windbox) and conveniently located for the operator. It shall be mounted within a NEMA 1A type enclosure and include a key lock.
- B. Factory mounted and wired components and controls shall include the following:
 1. Fan Motor Starter
 2. Fan Motor Fuses
 3. Control Circuit Transformer with fuses
 4. Oil Pump Starter (size 7500 - 8000 units) firing oil.
 5. Terminals for wiring connections

6. Flame Safeguard Control
 7. Burner On/Off Switch
 8. Manual Damper Positioning Switch
 9. Indicating lights for low water, flame failure, load demand, and fuel valve on.
- C. All electrical equipment shall be in conformity with CSA. Oil, heat, and moisture resistant wire shall be used and number coded relative to the wiring diagram.

Model 5 Boilers

Hot Water Specifications

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SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application. A separate specification is provided for hot water boiler and steam boiler packages.

PART 1 GENERAL

1.1

BOILER CAPACITY

- A. The hot water boiler shall be Cleaver-Brooks Model 5, Series _____ (100, 200, 700), _____ bhp, designed for 140 psig hot water. The maximum supply temperature will be _____ °F, and the minimum return water temperature will be _____ °F. The minimum operating temperature of the boiler shall be 170 °F. (Series 100 - No. 2 oil; 200 - No. 2 oil and gas; 700 - gas.)
- B. The boiler shall have a maximum output of _____ Btu/hr, or _____ hp, when fired with No.2 oil and/or natural gas _____ Btu/cu-ft. Safety relief valves shall be set at _____ psig.
- C. Electrical power available will be _____ volts, _____ phase, _____ Hz. All electrical service connections shall be made to an electrical entrance box mounted on the right hand side of the boiler.

PART 2 PRODUCTS 2.1**BOILER DESCRIPTION**

- A. The boiler shall be an all steel membrane wall watertube boiler with 3-pass gas travel. It shall be mounted on a heavy duty steel frame with integral forced draft burner and burner controls. The complete packaged boiler-burner unit shall be approved by Canadian Standard Association and shall have the CSA label affixed to the front head. The boiler shall be completely assembled and fire tested at the factory.
- B. The boiler shell must be constructed and hydrostatically tested in accordance with the ASME Boiler and Pressure Vessel Code. It must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
- C. Two lifting eyes shall be located on top of the boiler.
- D. Two downcomers shall be located at the rear of the boiler and totally insulated from the generating tubes. The generating tubes shall be 2" OD SA-178 Grade A with .095" wall thickness. The downcomers shall be 2-1/2" OD for 35 and 47 hp; 3" OD for 59 to 83 hp and 4" OD for 95 to 143 hp. Material shall be SA-178-A and the 2-1/2" and 3" downcomers shall have a 0.105" wall. The 4" downcomers shall have a 0.135" wall.
- E. The upper drum shall be 20" OD schedule 20, SA-53-B seamless pipe with .375" wall. The lower drum shall be 6" nominal pipe size, SA-53-B seamless pipe with .312" wall.
- F. Refractory shall be limited to the furnace floor, insulating the lower drum, the burner throat tile, and to the formed rear access door which unbolts for ease of entry and/or inspection. High-temperature insulation shall be installed on the front wall of the furnace.
- G. Observation ports shall be provided at each end of the boiler for visual inspection of the pilot and main flame conditions.
- H. The exhaust gas vent shall be located at the rear of the boiler on the top centerline. A stack thermometer shall be shipped loose for field installation.
- I. Inspection openings shall be provided in the convection area.

- J. The boiler insulation shall be a minimum of 2" fiber glass blanket. This insulation shall be covered with a corrugated sheet metal lagging. The lagging and insulation shall be arranged for easy removal and reinstallation if required. The entire boiler, base frame, and other components shall be factory painted before shipment using a hard finish enamel.

2.2 SOOT CLEANING

- A. Soot washer lances shall be provided in the convection area of the boiler measuring full length of the pressure vessel. Each lance shall be provided with a shutoff valve and the assembly shall be capable of rotating 360 °F. This shall ensure complete washing of the convection zone while the boiler is operating in the low fire mode.
- B. Soot washer troughs shall be provided at the bottom of the boiler. These shall be furnished for each convection side running the full length of the boiler with 2" drain connections at the boiler rear. Inspection/cleanout openings for each trough shall be located at the front of the boiler.

2.3 BOILER CONNECTIONS

- A. The hot water outlet connection shall be located on the top centerline of the boiler and the return connection shall be located at the rear of the lower drum. The design of the boiler shall provide jet induced circulation, which shall mix the return water with the hot water within the boiler.
- B. A dip tube shall be included as an integral part of the hot water outlet. An air vent tapping shall be located on the top centerline of the boiler for connection to an expansion tank.
- C. Handholes shall be provided at the end of the lower drum and in the rear of the upper drum for inspection of the water side surfaces.

2.4 BOILER TRIM

- A. The low water cutoff switch shall be a probe type, mounted in the top center-line of the boiler. It shall be wired into the burner control circuit to prevent burner operation if the boiler water falls below a proper level.
- B. A minimum of three controls shall be provided: one auto reset type for burner on-off control, one for burner firing rate, and one manual reset type for burner cutout on excessive water temperature. The sensing elements shall be located adjacent to the outlet connection.
- C. A hot water circulating pump shall be mounted between the supply and return water connections (standard on ASME Section IV heating boilers only). This pump will blend the supply and the system return water. It will ensure a minimum continuous circulation at all times to a level of 10 boiler water changes per hour.
- D. A combination pressure-temperature gauge shall be located on the boiler.
- E. Water relief valves shall be provided of a type and size to comply with ASME Code requirements.

2.5 BURNER

A. Burner Description

1. All air for combustion shall be supplied by a forced draft blower mounted in the front head (windbox), above the burner, to minimize vibration and noise level.
2. The impeller shall be an enclosed centrifugal fan type, properly balanced and directly connected to the blower motor shaft.
3. The maximum sound level shall not exceed 80 dBA measured 3 feet in front of the boiler.
4. The oil burner shall operate on the low-high-low principle and must return to the low fire position prior to ignition.
5. The gas burner shall operate on the full modulation system and must return to the low fire position prior to ignition.
6. The burner shall remain in the low fire position during ignition and until main flame has been proven.

B. Gas Fired Burner

1. The burner shall be integral with the front head of the boiler and shall be the high radiant multi-port type approved for operation with natural, manufactured, or mixed gas.
2. Automatic electric ignition of the premix gas pilot shall be furnished. A UV flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established.
3. A single damper motor shall control the combustion air damper and the butterfly gas valve. The damper motor shall regulate the fire according to system demand in response to the boiler mounted temperature/pressure control.
4. The gas burner piping system on the unit shall include a primary gas shutoff valve. It shall be controlled by the programming relay to start or stop the burner and to close automatically in the event of power failure, flame failure, excessive pressure or temperature, high or low gas pressure, or a low water condition. A lubricated shutoff cock shall be located ahead of the primary valve for manual shutoff.
5. A plugged leakage test connection and a lubricated plug cock are provided as a means for a tightness check of the primary shutoff valve.
6. A gas pressure regulator shall be factory mounted and piped for proper pressure regulation to the burner.
7. Gas Train Components
8. The primary shutoff valve shall be a motorized type. High and low gas pressure switches shall be provided.

C. No. 2 Oil Fired Burner

1. The burner shall be integral with the front head of the boiler. It shall be the pressure atomizing type approved for operation with commercial grade No.2 oil.
2. The burner shall operate on the low-high-low principle, and must return to the low-fire position prior to ignition.

3. The burner shall remain in the low-fire position during ignition, and until low fire and main flames have been proven.
4. Automatic electric ignition of the low-fire oil supply shall be provided with a 10,000 volt transformer and heavy duty electrodes. The ignition period shall be monitored with an electric scanner of the UV principle to confirm the presence of the low fire oil flame.

Notice

Optional insurance compliance may require a premix gas pilot in lieu of electric ignition.

5. The combustion air damper, low-fire, and high-fire oil valves shall be operated by a single damper control motor. This motor shall regulate the fire according to system demand in response to the boiler mounted high-low fire temperature/pressure control.

2.6 OIL SYSTEM

- A. An oil pump shall be provided. The oil pump, integral with the burner, shall include a built-in relief valve and self-cleaning strainer. The pump shall be belt driven from the blower motor.
- B. The fuel oil system shall include supply and return tubing to a terminal block, oil pressure gauge, shutoff cock, and four solenoid oil shutoff valves. These items shall be factory mounted on the front head.

2.7 NO.2 OIL AND GAS BURNER

A. General

1. The burner shall be integral with the front head of the boiler. It shall be the pressure atomizing type for oil and high radiant multi-port type for gas. The burner must be approved for operation with either commercial grade No.2 oil or natural gas.
2. The oil burner shall operate on the low-high-low principle, and must return to the low-fire position prior to ignition.
3. The gas burner shall operate on the full modulation system and must return to the low fire position prior to ignition.
4. The burner shall remain in the low-fire position during ignition and until main flame has been proven.
5. Automatic electric ignition of the premix gas pilot shall be provided. A UV flame detector shall monitor the pilot to prevent the primary fuel valve from opening until the pilot flame has been established.
6. A single damper motor shall control the combustion air damper, high and low fire oil valves, and the butterfly gas valve. The damper motor shall regulate the fire according to system demand in response to the boiler mounted high-low fire temperature/pressure control.

B. Oil System

1. An oil pump shall be included. The oil pump, integral with the burner, shall include a built-in relief valve and self-cleaning strainer. The pump shall be belt-driven from the blower motor.

2. The fuel oil system shall include supply and return tubing to a terminal block, oil pressure gauge, shutoff cock, and four solenoid oil shutoff valves. These items shall be factory mounted on the front head.

C. Gas System

1. The gas burner piping system on the unit shall include a primary gas shutoff valve. It shall be controlled by the programming relay to start or stop the burner and to close automatically in the event of power failure, flame failure, excessive pressure or temperature, high or low gas pressure, or a low water condition. A lubricated shutoff cock shall be located ahead of the primary valve for manual shutoff.
2. A plugged leakage test connection and a lubricated plug cock are provided as a means for a tightness check of the primary shutoff valve.
3. A gas pressure regulator shall be factory-mounted and piped for proper pressure regulation to the burner.

D. Gas Train Components

1. The primary shutoff valve shall be a motorized type. High and low gas pressure switches shall be provided.

2.8 BURNER AND FLAME FAILURE CONTROLLER

A combustion safeguard control shall be provided to control ignition, starting and stopping the burner and provide precombustion and postcombustion purge periods. It shall stop burner operation in the event of ignition, pilot or main flame failure. Trial for ignition shall be limited to 10 seconds.

2.9 CONTROL PANEL

- A. The control panel shall be mounted on the front head of the boiler and shall be conveniently located for the operator. It shall be a NEMA 1A rated enclosure and have a Yale key lock.
- B. Each boiler shall be factory-equipped with a flame safeguard controller that provides technology and functions equal to the Cleaver-Brooks Model CB100.
- C. Flame safeguard controller shall be microprocessor based, with self-diagnostics, non-volatile memory, and a message center with a vocabulary of 42 different messages. Messages shall scroll across an alpha-numeric display and provide sequence status and failure mode information. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence will include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.
- D. Controller shall be the non-recycle type for maximum safety that will shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open.

- E. The controller shall have a run/test switch. It will allow interruptions to sequence just after pre-purge, during pilot ignition trial, and during run cycles for adjustments to firing rate motor, damper linkages and pilot flame for turndown tests.
- F. In addition to the above functions, the controller shall:
 - 1. Display history of operating hours and totals of completed on-off cycles.
 - 2. Provide a constant flame signal strength read-out.
 - 3. Have provisions for a remote display capability.
- G. The panel shall contain the blower motor starter, control circuit fuses, control circuit transformer, and control switches. A damper positioning switch shall be provided to permit selection of automatic firing or manual selection of low or high fire.
 - 1. A terminal board shall be provided to which all wires entering or leaving the panel shall be connected.
 - 2. All electrical equipment shall be in conformity with the Canadian Standard Association requirements. Oil, heat and moisture resistant wire shall be used and shall be number coded.
 - 3. A low fire hold timer shall be mounted in the panel and wired to hold the boiler in a low firing mode, for a minimum of 10 minutes, each time the boiler cycles on. This low fire hold timer ensures gradual boiler warm up.

HAWK INTEGRATED BOILER CONTROL SYSTEM

The HAWK is a state-of-the-art boiler control system that integrates the functions of a Programmable Controller and Burner Management Controller, as well as other boiler operating and ancillary controls. The HAWK system incorporates a graphical Human Machine Interface (HMI), which displays boiler parameters, fault annunciation and alarm history, as well as providing access to boiler configuration and control functions. The HAWK system includes complete boiler firing rate controls for steam or hot water boilers. The HAWK's advanced technology features utilize the latest communication methods, such as Modbus, Ethernet, and the Internet. The HAWK also has the capability of interfacing with various building/plant automation systems. Additional features include lead/lag capability; e-mailing and paging of alarms, remote monitoring, and HMI alarm history printing.

The HAWK Integrated Control System may be used on most types of steam or hot water boilers, including firetube, industrial watertube, and commercial watertube. It is designed to operate with a gas, oil, or combination burner using a single-point modulating control or a parallel-positioning fuel-air ratio control system.

In addition to installation on new boilers, the HAWK can be added as a retrofit to existing boilers. Contact your local authorized Cleaver-Brooks representative for details.

The HAWK system is offered in Advanced, Intermediate, and Base packages. Table D-1 shows a feature comparison.

FEATURES AND BENEFITS

Advanced Technology

Standard Features:

- Integrates control function of burner sequencing and safety with firing rate, fuel-air ratio, and operating limit controls
- Incorporates a programmable controller
- Touch screen graphical human machine interface (HMI)
- Monitors and displays connected boiler parameters
- Optimizes boiler firing rate control
- Alarm/fault indication and history
- On-screen fault diagnostics
- Built-in two boiler lead/lag control
- Night/day setback control
- Thermal shock protection
- Remote modulation
- Remote setpoint
- Assured low fire cut-off
- Assured start permissive safety interlocking

- High stack temperature alarm and shutdown
- Boiler efficiency calculations

Optional Features:

- E-Mail and pager alarm/fault forwarding
- Fuel-air ratio control
- Display of boiler water level with optional CB Level Master (Advanced and Intermediate systems only)
- Building/plant automation system interface
- Remote monitoring and diagnostics
- O₂ monitoring and trim
- Internet parts and service lookup
- Lead/lag capability for multiple boiler systems
- Variable speed drive on combustion air fan
- Expanded annunciation

Safety Provisions and Diagnostics:**A. Integrated Burner Management**

- Utilizes the CB780E or CB120E flame safety control
- Communicates with the programmable controller via Modbus
- Burner Control status, faults, and diagnostics displayed on HMI

B. Integrated Boiler Controls

- Operating and modulating controls
- Variable speed drive fault shutdown – communicates via Modbus (optional)
- Password protection of programmable controller logic
- Password protection of parallel positioning control (optional)

Powerful Display/Diagnostic Capabilities:

- Touch screen graphical human machine interface (HMI).
Advanced system: 10" color touch screen
Intermediate system: 6" color touch screen standard - 10" color screen optional
Base system: 5.5" monochrome touch screen
- HMI allows easy screen navigation to monitor various boiler parameters & diagnostics and to configure boiler controls.
- Displays alarms/faults, burner status, and flame signal from the flame safety control.
- Diagnostics in plain English and prioritized fault annunciation simplify troubleshooting. Last 100 faults are stored.
- Displays boiler steam pressure, water temperature, firing rate, Stack temperature, boiler efficiency, combustion air temperature (optional), Flue gas O₂ concentration (optional), combustion air fan motor speed and kw (vsd option), combustion air pressure (with VSD option), water level (CB-Level Master option), shell water temperature (steam boilers), and other control points.

- Displays boiler operating status (e.g. “Warm Up”, “Auto/Manual”, “Boiler On”, fuel selection, etc.).
- Displays boiler firing rate control parameters and settings.
- Provides remote monitoring and diagnostic capabilities (optional).
- Touch screen controls simplify screen navigation and boiler configuration
- Reliable and accurate controls using microprocessor-based programming

Simplified Servicing:

- Diagnostics and fault history, up to 100 faults, through touch screen display simplifies troubleshooting procedures
- E-Mail forwarding and paging of system fault codes (optional)
- Connection to user building automation system (optional)

PRODUCT OFFERING

Included in each HAWK system is the following:

- Programmable controller
- Touch screen HMI
- Modbus communication interface to burner management or optional Variable Speed Drive
- Built-in Ethernet/IP capability via L35E (Advanced system) or L32E (Intermediate and Base) processors
- Various controller input/output modules
- Flame safety controller (CB780E or CB120E)
- Various temperature and pressure sensors
- E-mailing via Ethernet

Optional Features and Equipment: (see individual specifications for these options)

- OPC server software for interface with building/plant automation system
- Lead/Lag control of multiple boilers
- Fuel-Air Ratio Control system and actuators
- Variable speed drive for combustion air fan motor
- O₂ analyzer and/or external O₂ trim system
- Combustion air temperature sensor
- Economizer stack flue gas temperature, feed water temperature, oil temperature, and gas & oil pressure sensors
- Steam, water, and fuel flow monitoring
- CB Level Master primary safety water level control
- Paging via phone line with modem

ENGINEERING DATA

- Supply voltage: 120 VAC (+10%/-15%) 50 or 60 Hz.
- Maximum total connected load: 1200 VA
- Operating temperature limits: 32 to 130°F
- 85% RH continuous, non-condensing, humidity
- 0.5G continuous vibration

SAMPLE SPECIFICATIONS

HAWK INTEGRATED BOILER CONTROL SYSTEM

PART 1 GENERAL

1.1 GENERAL

- A. Each unit shall be factory equipped with a boiler control system providing technology and functions equal to the Hawk boiler control system.
- B. Each Boiler Control System shall be factory equipped with a pre- configured Programmable Controller and Human Machine Interface (HMI).

PART 2 PRODUCTS

2.1 MAJOR SYSTEM COMPONENTS

- A. Major system components shall include:
 - 1. Programmable controller
 - 2. Touch screen HMI
 - 3. Modbus communication interface to burner management or optional Variable Speed Drive
 - 4. Various controller input/output modules
 - 5. One burner management controller and wiring sub-base
 - 6. One flame scanner: Infrared, Ultra-Violet, or UV Self-Check
 - 7. One flame amplifier, to correspond with the selected flame scanner
 - 8. Various temperature and pressure sensors
- B. Major functions that the Boiler Control System shall provide:
 - 1. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run and post purge
 - 2. Flame proving and lockout on flame failure during pilot flame proving, main flame proving, or run
 - 3. Low fire damper/valve position for flame ignition trials
 - 4. Full modulating control of fuel and combustion air
 - 5. Utilize solid state controls and sensors to provide various control functions, such as:
 - a. On/Off, and Modulating control
 - b. Modulating control algorithm shall be Proportional- Integral-Derivative (PID) type
 - c. Thermal shock protection based on water temperature and setpoint
 - d. Various high and low limit alarms and shutdowns

6. Touch screen graphical operator interface and monitoring
 - a. Manual control of the boiler-firing rate utilizing control screens on the HMI to increment and decrement the firing rate
 - b. On screen indication of burner management controller status and diagnostics
 - c. On screen real-time display of all connected process parameters
 - d. On screen display of system alarms and faults
 - e. On screen history of alarms and faults
 - f. On screen water level indication (optional) and alarm(s)
 - g. Printing Alarm/Fault history
7. E-mail or paging of boiler alarms (with either Ethernet/IP or modem option)
8. Building/plant automation system interface (with Ethernet/IP option)
9. Ethernet communications (with Ethernet/IP option)
10. Tamper resistant control logic and password protection.
11. Night/day setback control
12. Stack flue gas, combustion air (optional), and shell (water) temperatures
13. Boiler efficiency calculation (corrected efficiency with O₂ option - Advanced and Intermediate systems)
14. Outdoor reset for hot water boilers
15. Remote modulation or firing rate setpoint control
16. Assured low fire cut-off (ALFCO)
17. Assured start permissive safety interlocking
- C. The Boiler Control System shall provide the following safety provisions for:
 1. Integrated burner management
 - a. Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the burner management system should lockout on safety shutdown.
 - b. Closed-loop logic test verifies integrity of safety critical loads (ignition, pilot, and main fuel valves) and must be able to lockout on safety.
 - c. Pre-ignition interlocks (fuel valve proof of closure, etc.) and flame signal checked during Standby and Pre-Purge.
 - d. Dynamic checking of the flame signal amplifier. The control flame signal amplifier must be able to recognize a no flame signal during this dynamic amplifier check.
 - e. Safe start check and expand check to include monitoring flame signal during standby.
 - f. High and Low fire switches checked for proper sequencing.
 - g. Tamper-proof purge timing and safety logic.
 2. Integrated boiler controls
 - a. Operating and Modulating control
 - b. Variable Speed Drive (if used) fault shutdown

- c. Password protection of programmable controller Logic
 - d. Password protection of parallel positioning control (if used)
- D. The Boiler Control System shall provide annunciation and diagnostics:
 - 1. Active alarm annunciation
 - 2. Provide historical alarm information for on screen display
 - 3. Detects and isolates an alarm, and reports internal circuit faults
 - 4. Printer output capable for logging alarms
 - 5. Capability of printing alarm history of date, time, cycle of occurrence and date and time of acknowledgement up to the most recent 100 faults
 - 6. English text description of the system fault and troubleshooting procedures
 - 7. Water level indication and low water shutdown alarm
 - 8. Dynamic self-checking
- E. The Boiler Control System shall be able to operate in these environmental conditions.
 - 1. Supply Voltage: 120 VAC (+10%/-15%) 50 or 60 Hz
 - 2. Maximum total connected load: 1200 VA
 - 3. Operating temperature limits: 32 to 130°F
 - 4. 85% RH continuous, non-condensing, humidity
 - 5. 0.5G continuous vibration
- F. All Boiler Control System wiring shall be in accordance with the National Electrical Codes and local electrical codes.
- G. Boiler Control System component functions shall be as follows:
 - 1. Burner Management Controller: Provides burner sequencing logic to meet FM/IRI/UL/cUL approval body requirements.
 - 2. Touch Screen Graphical Interface: Provides user interface to the control system, boiler overview screen with connected boiler parameter readouts, burner management control status screen, alarm banners, diagnostic screens for fault troubleshooting, alarm history screen, system firing rate screen and system configuration screens.
 - 3. Modbus communication network: provides communication between the programmable controller and burner management system (and optional Variable Speed Drive).
 - 4. Various programmable controller input/output modules: Provides interface for discrete powered and/or isolated relay signals, as well as for analog signals, from and/or to other input/output devices.
 - 5. Stack temperature sensor: measures and transmits a signal to the programmable controller in relation to boiler exit flue gas temperature. It is used for indication and in the calculation of boiler efficiency; it can also be used for high stack temperature alarm and shutdown.
 - 6. Steam pressure transmitter (steam boiler): provides an analog signal to the programmable controller for indication of boiler steam pressure; utilized for on/off and modulating control of the burner.

7. Water temperature transmitter (hot water boilers): provides an analog signal to the programmable controller for indication of boiler water temperature; utilized for thermal shock protection, on/off, and modulating control of the burner.
 8. Water (shell) temperature sensor (steam boilers): measures and transmits a signal to the programmable controller in relation to boiler water temperature; used for indication and thermal shock protection.
- H. Optional equipment/features (see also individual Boiler Book sections below)
1. Lead/Lag Control for multiple boiler systems
 2. Parallel Positioning hardware (Advanced and Intermediate systems)
 3. Variable Speed Drive for combustion air fan motor (Advanced and Intermediate systems)
 4. O₂ analyzer and/or external O₂ trim system
 5. Combustion air temperature sensor (Advanced and Intermediate systems): measures and transmits a signal to the programmable controller in relation to the combustion inlet temperature for indication and for use in the calculation of boiler efficiency; also can be used for high combustion air temperature alarm and shutdown, based on setpoint
 6. Economizer flue gas inlet and outlet temperatures, feed water temperature, economizer water in and out temperature (no thermocouple inputs with Base system)
 7. Steam, water & fuel flow monitoring
 8. CB Level Master primary safety water level control
 9. Email and paging (text messaging) via Ethernet
 10. Paging via phone line (requires modem)
 11. Building automation interface
 12. Remote monitoring with RSView software

SAMPLE SPECIFICATIONS

HAWK ICS PARALLEL POSITIONING SYSTEM

PART 1 GENERAL

The purpose of the parallel positioning system is to control fuel, combustion air and flue gas recirculation (FGR) if applicable. Individual actuators will be used to control each of above functions.

PART 2 PRODUCTS

2.1 CONTROLLER - A/B COMPACT LOGIX PLC COMPRISING THE FOLLOWING COMPONENTS

Row 1

Processor L35E
SM2 Modbus Module
Power Supply 1769-PA4
Discrete Input Module 1769-IA16
Discrete Output Module 1769-OW8I
Analog Input Module 1769-IF4
Analog Output Module 1769-OF2
Themocouple input module 1769-IT6
Discrete Input Module 1769-IA16
Analog Input Module 1769-IF4
Analog Output Module 1769-OF2

Row 2

Power Supply 1769-PA2
Analog Output Module 1769-OA16
Analog Input Module 1769-IF4
Analog Input Module 1769-IF4
Expansion cable
Right hand terminator

2.2 HMI (HUMAN MACHINE INTERFACE)

10" color PanelView touch screen with serial communication.

2.3 ACTUATORS

Quantity up to 4.
Typical actuators arrangement:
Combustion air

Gas

Oil

FGR

ACTUATOR SPECIFICATIONS

General: Reversing Motor with Position Feedback

Application: Control of Dampers and Fuel Valves

Note: Position will be controlled by a PLC; no Servo-Positioning Module is required.

Rotary: 90 Degree Rotation

30 Second Timing (for 90 Degrees)

36 in-lb Torque

0.1% Resolution (over 90 Degrees)

Electrical:

120 VAC Preferred

Control Signal: Pulse position with 0-10 VDC feedback

Duty: Continuous

Enclosure: NEMA 1 Minimum; NEMA 3 or 4 Optional

Approvals:

UL Listed or Recognized and/or FM Approved

Environmental: Temperature 0-130°F.

Whenever possible design without linkages shall be used.

Control Description

Control shall be parallel positioning with cross limiting.

Note: System will not be capable for simultaneous fuel firing.

Air control

Firing rate control signal is compared with corrected fuel actuator position signal. Highest of the two values is a control signal for the combustion air actuator. Velocity limiter with adjustments in both directions (up and down) shall be provided.

Control signal to the actuator is compared with feedback signal. If unacceptable error is detected for the preset amount of time, system will be shut down and fault will be annunciated.

Fuel control

Firing rate control signal is compared with air actuator position signal. Lowest of the two values is an input to the function generator. Output of the function generator is a control signal for the fuel actuator. Function generator has to have a minimum of 10 break points. The X-axis and Y-axis parameters must follow the relationship:

$$X[1] < X[2] < X[3] < \dots < X[n]$$

$$Y[1] < Y[2] < Y[3] < \dots <$$

$$Y[n]$$

Where n is the number of break points (20 maximum).

Velocity limiter with adjustments in both directions (up and down) shall be provided.

Control signal to the actuator is compared with feedback signal. If unacceptable error is detected for the preset amount of time, system will be shut down and fault will be annunciated.

FGR control

Firing rate control signal is compared with air actuator position signal. Lowest of the two values is an input to the function generator. Output of the function generator is a control signal for the FGR actuator. Function generator has to have a minimum of 10 break points. The X-axis parameters must follow the relationship:

$$X[1] < X[2] < X[3] < \dots < X[n]$$

Where n is the number of break points (20 maximum).

Velocity limiter with adjustments in both directions (up and down) shall be provided.

Control signal to the actuator is compared with feedback signal. If unacceptable error is detected for the preset amount of time, system will be shut down and fault will be annunciated.

HAWK COMBUSTION AIR FAN VARIABLE SPEED DRIVE



Provides variable speed output to the burner's Combustion Air Fan blower motor for the purpose of improving boiler efficiency and reducing electrical energy consumption.

FEATURES AND BENEFITS

Improved Efficiency:

Energy Savings:

- Reduces electrical energy consumption
- Soft starting reduces electrical and mechanical stress on the motor, extending the life of the motor
- Provides Substantial Savings from Mid to Low Fire modulation points
- Average Payback in approximately 6 – 8 Months

Communication:

- Communicates with the Boiler Controller via Modbus
- Provides Drive process information on the Boiler Control Panel Display
- Provides Drive faults and troubleshooting suggestions, in "Plain English", on Boiler Control Panel Display

PRODUCT OFFERING

- Cleaver-Brooks shall supply the following equipment:
- Adjustable Frequency Variable Speed Drive.
- Modbus communications
- VSD Compatible Combustion Air Fan Motor.

ENGINEERING DATA

Drive:

- Ambient Operating Temperatures: 32 – 122°F
- Altitude: 3300 Ft (1000 m) Max without derating
- Shock: 15G peak for 11ms duration (± 1.0 ms)
- Vibration: 0.152 mm (0.0006 in.) displacement, 1G peak
- Voltage Tolerance: -10% of minimum, +10% of Maximum
- Frequency Tolerance: 47 – 63 Hz
- Input Phases: Three-phase input provides full rating of all drives, Single- phase operation provides 50% of rated current
- Frequency Accuracy: Digital Input – Within $\pm 0.01\%$ of set output frequency, Analog Input – Within $\pm 0.4\%$ of maximum output frequency
- Intermittent Overload: 110% Overload capability for up to 1 minute, 150% Overload capability for up to 3 seconds
- Current Limit Capability: Proactive Current Limit programmable from 20 to 160% of rated output current; Independently programmable proportional and integral gain
- Line Transients: Up to 6000 volts peak per IEEE C62.41-1991
- Ground Fault Trip: Phase-to-ground on drive output
- Short Circuit Trip: Phase-to-phase on drive output
- Drive Overcurrent Trip: Software – 20 to 160% of rated current, Hardware – 200% of rated current (typical), Instantaneous – 220 to 300% of rated current (dependent on drive rating)
- Electronic Motor Overload Protection: Class 10 protection with speed sensitive response. Investigated by U.L. to comply with N.E.C. Article 430, UL File E59272 Volume 12
- See Drive Manual for other, Model and Voltage Specific, specifications.

Motor:

- Motor suitable for variable speed drive service
- Variable Torque, 3 phase
- Other specifications based on Specific Horsepower, Voltage, and Frequency requirements. Contact your local Authorized Cleaver-Brooks Representative for further details.

SAMPLE SPECIFICATIONS HAWK COMBUSTION AIR FAN VARIABLE SPEED DRIVE

PART 1 GENERAL

- A. The Boiler Manufacturer shall provide a Variable Speed Drive controller for use on the burner's Combustion Air Fan blower motor for the purpose of providing Improved Boiler Efficiency and Reduced Electrical Energy consumption.
- B. The Drive's voltage, frequency, and current ratings shall be rated in accordance with the electrical requirements as dictated by job site specifics, and for the properly rated motor horsepower.
- C. The Variable Speed Drive must be capable of communicating over the Modbus protocol.
- D. A Motor suitable for variable speed drive service must be supplied for use in conjunction with the Variable Speed Drive, and sized to match the motor requirements of the Combustion Air Fan Blower.
- E. Variable Speed Drive shall be interlocked with boiler control to ensure safe operation.

HAWK OXYGEN MONITORING SYSTEM



The HAWK Oxygen Monitoring System provides indication and monitoring of the boiler's exit flue gas O₂ concentration. In conjunction with Stack Flue Gas and Combustion Air Temperature measurements, the system also provides means for a more accurate boiler efficiency calculation.

If O₂ Trim is desired see page D-50, Oxygen Trim, of the CB Boiler Book.

FEATURES AND BENEFITS

Integrated Type In-Situ Zirconia Oxygen Analyzer:

- Reduces wiring, piping and installation costs
- Allows replacement of the zirconia cell on site
- Built-in heater assembly of the probe can be replaced on site
- Can be configured on site without opening the cover using an infrared sensor
- O₂ measurement circuitry built into probe head electronics
- O₂ Level percentages displayed on the Boiler Control Panel Human Machine Interface (HMI)
- Provides accurate Boiler Efficiency Calculations with the HAWK Programmable Controller
- Separate analyzer/converter display panel not required

User Configurable Alarm Points

- Low O₂ Alarm

Analyzer Probe is Direct Insertion, In-situ Zirconia Type Which Provides:

- High accuracy
- Fast Response
- Proven Reliability

PRODUCT OFFERING

- In-Situ Zirconia Probe and Analyzer
- Process Variable% O₂ Readout on Control Panel HMI
- Accurate Efficiency Calculations

Options:

- Separate O₂ Converter/Display Panel
- Replacement Zirconia Cell
- Auto Calibration Pneumatics
- Replacement Heater Assembly
- Remote Indicator/Alarm
- Probe Stack Mounting Adapter
- Calibration Gas Kit

ENGINEERING DATA

Ambient Temperature: -4 to 131°F (-20 to +55°C)

Sample Gas Temperature: 32 to 1292°F (0 – 700°C)

Sample Gas Pressure: -1.5 to 73.8 in Hg (-5 to +250 kPa)

Output Signal: 4 – 20mA DC, One Point, Maximum Load Resistance 550 Ohms

Digital Output (HART): 250 – 500 Ohms

Contact Output Signal: Two Points, 30 VDC 3A, 250 VAC 3A (one is fail safe normally open)

Contact Input Signal: Two Points

Reference Air: Natural Convection, Instrument Air, pressure compensated

Instrument Air: 200 kPa plus the pressure in the furnace

Power Supply: 100 – 240 VAC, 50/60Hz

Power Consumption: Max 300 W, approx. 100 W for ordinary use

SAMPLE SPECIFICATIONS

HAWK OXYGEN MONITORING SYSTEM

PART 1 GENERAL

- A. This specification covers the hardware and monitoring functions of the HAWK Oxygen monitoring system. The system monitors and displays Oxygen concentration and is used, in conjunction with combustion air and stack flue gas temperature sensors, to calculate the overall efficiency of the boiler.
- B. The system shall be completely configured from the factory requiring only job specific data to be entered (or modified) in the field.

Note: O₂ Sensor Requires calibration in the field!

PART 2 PRODUCTS

2.1 HARDWARE

- A. Hardware shall consist of the following:
 - 1. Oxygen Sensor
 - 2. Integrated type Zirconia Oxygen Analyzer
 - 3. Direct Insertion Type
 - 4. Built-in Heater Assembly
 - 5. 4-20mA DC Process Variable Output
 - 6. Heater to be of field replaceable construction
 - 7. Cell to be of field replaceable construction
- B. Analyzer
 - 1. Shall be of the Integrated Type (in probe head)
 - 2. Provide 4 – 20mA DC Signal output in relation to process variable for remote display
- C. Monitoring System
 - 1. Indicate O₂ Percentages
 - 2. Provide Low O₂ Alarm Indication
 - 3. Perform Efficiency Calculations and display results using O₂ percentages

PART 3 EXECUTION

This system is applicable to modulating burners using the HAWK Integrated Control System. This system shall monitor and display O₂ concentration in the boiler's exit flue gas and provide overall boiler efficiency calculations.

HAWK — ETHERNET COMMUNICATION

The HAWK Ethernet communication package provides Ethernet communications between the HAWK programmable controller and other Ethernet compatible devices such as the Boiler Room Master Lead/Lag Control Panel, Building/Plant automation system, and the Internet.

FEATURES AND BENEFITS

- Provides communication between the HAWK programmable controller unit and other Ethernet Compatible Devices
- Provides interface capability with many Building/Plant automation systems when utilizing OPC server or protocol bridge
- Provides interface with plants LAN/WAN
- Provides interface to the Internet (requires static IP address)
- E-mailing of boiler alarms/faults
- Provides means of connection between various boiler room control systems, such as the HAWK Master Panel for lead/lag control
- Provides means of connection to a remote Personal Computer
- Ethernet Industrial Protocol
- IEEE 802.3 Physical and Data Link Standard
- Ethernet TCP/IP protocol suite industry standard
- Control and Information Protocol (CIP) Compliant

PRODUCT OFFERING

- Optional Ethernet Communication Hub (necessary for stand-alone boiler (no Master Panel) connection to LAN/WAN and/or Paging Modem option)
- E-mail functionality — requires customer provided e-mail service and address

ENGINEERING DATA

- Modular connection to HAWK Programmable Controller unit
- Ethernet Industrial Protocol (Allen-Bradley EPIC)
- Follows Ethernet Rules and Practices
- High Noise Rejection
- Cabling: Category 5E rated twisted pair cable (solid core, PVC jacket with RJ45 connections).
- Meets Open Industrial Network Standards
- IEEE 802.3 Physical and Data Link Standard

- Ethernet TCP/IP protocol suite industry standard
- Control and Information Protocol (CIP) Compliant
- OPC (OLE Process Control) communication compatibility with RSLinx OPC Server software

SAMPLE SPECIFICATIONS

HAWK — ETHERNET COMMUNICATION

PART 1 GENERAL

The Boiler Manufacturer shall furnish and install a control module capable of Ethernet communications between the boiler's programmable logic control system and other Ethernet compatible devices, as needed, and provide the following minimum requirements:

- A. Interface with the Compact Logix Programmable Controller Protocol
- B. Ethernet Industrial Protocol (Allen-Bradley EPIC)
- C. Follows Ethernet Rules and Practices
- D. High Noise Rejection
- E. Open Industrial Network Standards
- F. IEEE 802.3 Physical and Data Link Standard
- G. Ethernet TCP/IP protocol suite industry standard
- H. Control and Information Protocol (CIP) Compliant

HAWK — PAGING AND REMOTE DIAL-UP ACCESS WITH MODEM

Provides Paging of Alarms Faults, via Modem, from the HAWK Control System to the customer provided pager or a compatible cell phone.

FEATURES AND BENEFITS

- Paging of boiler system alarms. (Paging Service and Pagers furnished by customer)
- Allows Remote Dial-Up Access for monitoring and troubleshooting.

PRODUCT OFFERING

- Remote Access Paging Modem
- Easy to use configuration software
- Requires customer provided, dedicated phone line
- Requires customer provided Paging Service and pagers (or paging compatible cell phones)
- Requires Pager Numbers and PINs supplied by customer
- Configure up to 10 unique pagers

ENGINEERING DATA

- Voltage: 24 VDC
- Baud Rate: 56K
- Type: External, Serial
- Paging functionality utilizes TAP Protocol



SAMPLE SPECIFICATIONS

HAWK — PAGING AND REMOTE DIAL-UP ACCESS WITH MODEM

PART 1 GENERAL

The boiler manufacturer shall provide a Paging and Remote Dial-Up Access Modem, using customer provided paging systems for the purpose of paging boiler system alarms and providing remote access to the control system.

Pager number(s) and PINs to be supplied by customer.

Dedicated telephone connection to be supplied by customer.

HAWK — LEAD/LAG FOR TWO BOILER SYSTEMS



Provides Lead/Lag control for a two-boiler system when used in conjunction with the CB-HAWK ICS integrated boiler control system.

FEATURES AND BENEFITS

Controls Header Pressure and Temperature:

- Maintains steam pressure or hot water supply temperature based on system load demand.
- Compensates for varying losses between boiler and header.

Sequences of Operation for Two Boilers:

- Provides maximum system efficiency.
- Reduces cycling and boiler wear; thereby reducing maintenance and downtime costs.
- Optimizes fuel savings.

Lead/Lag Start with Lead/Lag Modulation:

- Lead boiler operates at full capacity prior to starting lag boiler.
- Lag boiler starts modulation when lead boiler reaches maximum firing rate position.
- Ideal for steam boilers.

Lead/Lag Start with Unison Modulation:

- Lead boiler operates at full capacity prior to starting lag boiler.
- Lag boiler operates at the same firing rate as a lead boiler.
- Ideal for hot water boilers.

PRODUCT OFFERING

Cleaver-Brooks shall supply the following equipment:

- Boiler control for each boiler shall be HAWK.
- Pressure (steam) or temperature (hot water) transmitter shipped loose for mounting in the common header.

SAMPLE SPECIFICATIONS

HAWK — LEAD/LAG FOR TWO-BOILER SYSTEMS

PART 1 GENERAL

1.1 GENERAL

- A. Lead/Lag Start with either Lead/Lag or Unison Modulation.
- B. Boilers' Start and Stop
 - 1. Steam pressure, or hot water temperature, is compared with the setpoint and controller's processor executes PID algorithm. Lead boiler is commanded to come on line first. Lag boiler is commanded to come on line when a firing rate signal for the lead boiler reaches lag boiler start point. Lag boiler is commanded to stop when a firing rate signal for the lag boiler reaches lag boiler stop point.
- C. Lead/Lag Modulation - Lag boiler starts modulation after lead boiler reaches maximum firing rate.
- D. Unison Modulation - Firing rates for both boilers are equal.
- E. Hot Standby - System shall have a provision for keeping lag boiler in hot standby. Standby routine shall be based on a water temperature signal.

1.2 APPLICATION AND SYSTEM REQUIREMENTS

- A. This option is applicable to full modulation burners utilizing the CB- HAWK ICS advanced boiler control system and modulating controls.
- B. All logic for Lead/Lag Control shall reside in the boiler controller. No additional control panels shall be required.

HAWK — LEAD/LAG FOR UP TO EIGHT BOILERS SYSTEM



Provides Lead/Lag control for up to eight boilers when used in conjunction with the HAWK integrated boiler control system.

FEATURES AND BENEFITS

Controls Header Pressure and Temperature:

- Maintains steam pressure or hot water supply temperature based on system load demand.
- Compensates for varying losses between boiler and header.

Benefits:

- Maximizes system efficiency.
- Reduces cycling and boiler wear, thereby reducing maintenance and downtime costs.
- System shall be provided with a sequence to automatically rotate sequence in which the boilers are fired. Rotation shall be based on the elapsed time.
- Optimizes fuel savings.

Lead/Lag Start with Lead/Lag Modulation:

- Lead boiler operates at full capacity prior to starting lag boiler #1.
- Lag boiler #1 starts when the lead boiler's firing rate is close to the maximum. Operator can select this parameter via HMI.
- Lag boiler #1 starts modulation when the lead boiler reaches the maximum firing rate position.
- Subsequent lag boilers operate in the same fashion.
- Ideal for steam boilers.

Lead/Lag Start with Unison Modulation:

- Lead boiler operates at full capacity prior to starting the lag boiler.
- All boilers operate at the same firing rate as the lead boiler.
- Ideal for Hot Water boiler systems.

PRODUCT OFFERING

Cleaver-Brooks shall supply the following equipment:

- Boiler control for each boiler shall be the HAWK.
- Pressure (Steam) or temperature (Hot Water) transmitter shipped loose for mounting in the common header.
- Master Control Panel shipped loose for field mounting.
- Requires Ethernet/IP Communication Option

SAMPLE SPECIFICATIONS

HAWK — LEAD/LAG FOR UP TO EIGHT BOILERS SYSTEM

PART 1 GENERAL

1.1 GENERAL

- A. Lead/Lag Start with either Lead/Lag or Unison Modulation.
- B. Boilers' Start and Stop
 - 1. Steam pressure, or hot water temperature on hot water systems, is compared with the setpoint and controller's processor executes PID algorithm. Lead boiler is commanded to come on-line first. Lag boiler #1 is commanded to come on-line when a firing rate signal for the lead boiler reaches lag boiler start point. Lag boiler #1 is commanded to stop when a firing rate signal for the lead boiler reaches lag boiler stop point.
 - 2. Lag boiler #2 is commanded to come on-line when a firing rate signal for the lag boiler #1 reaches lag boiler #2 start point. Lag boiler #2 is commanded to stop when a firing rate signal for the lag boiler #1 reaches lag boiler #2 stop point.
 - 3. Subsequent boilers operate in a similar fashion.
- C. Lead/Lag Modulation
 - 1. Lag boiler #1 starts modulation after lead boiler reaches maximum firing rate (or firing rate selected by the operator).
 - 2. Lag boiler #2 starts modulation after lag boiler #1 reaches maximum firing rate (or firing rate selected by the operator).
 - 3. Subsequent boilers operate in a similar fashion.
- D. Unison Modulation - Firing rates for all boilers are equal.
- E. Hot Standby - System shall have a provision for keeping lag boilers in hot standby. Standby routine shall be based on a water temperature signal.
- F. Firing Sequence Selection - Sequence in which boilers come on-line shall be selected via HMI. Adequate check shall be provided that does not allow improper sequence selection.
- G. Automatic Rotation of the Boilers - System shall be provided with a sequence to automatically rotate sequence in which the boilers are fired. Rotation shall be based on the elapsed time.

1.2 HMI (HUMAN MACHINE INTERFACE)

- A. Master panel shall include HMI for display and selection of the following parameters:
- B. Display
 - 1. Available boilers
 - 2. Number of boilers required
 - 3. Selected sequence of firing
 - 4. Control output to each boiler

5. Header steam pressure or water temperature on hot water systems
 6. Setpoint
 7. Elapsed time from last rotation
- C. Selection
1. Number of boilers
 2. Sequence of firing
 3. Automatic or manual rotation
 4. Individual boiler start and stop points with timers
 5. Setpoint
 6. Proportional, integral and derivative gains for control algorithm

1.3 APPLICATION AND SYSTEM REQUIREMENTS

- A. This option is applicable to full modulation burners utilizing the HAWK advanced boiler control system and modulating controls.
- B. Logic for Lead/Lag control shall reside in the Master Control Panel. Communication between the Master Panel and the individual Boiler Control Panels shall be via Ethernet communication or hard wiring.

HAWK ADAC ADVANCED DEAERATOR CONTROL



The CB ADAC Advanced Deaerator Control provides a PLC based control system for a deaerator, surge tank, two tank deaerator-and-surge, or Duo-tank installations. The system is capable of controlling operation of boiler feed and/or transfer pumps, maintaining tank levels, monitoring and responding to system demands, and recording/annunciating alarm conditions.

The ADAC can run as a stand-alone system or connect to a CB-HAWK Master Panel or customer building automation system for monitoring purposes.

FEATURES AND BENEFITS

Standard Features:

- Integration of various deaerator and surge tank devices in a common control system
- Touch screen graphical Human Machine Interface (HMI)
- Deaerator and surge tank water level modulating controls
- Basic Chemical feed pump control
- Boiler feed pump control - up to 6 pumps via variable speed drive, soft starters, combination starters, or contactors
- Surge tank feed pump control (transfer pumps) - up to 3 pumps
- Pump alternating, lead/lag, and automatic rotation
- Serial, Ethernet, BAS, web server communications capability
- Control of remote devices (valves, etc.)
- Alarm/fault annunciation and history with audible alarm
- Red/Yellow/Green stack light for visual status indication
- Resettable Cumulative pump run time totals for maintenance purposes

Optional Features:

- 10" PanelView Plus in lieu of 7" (10" is standard on two tank systems)

- Alarm bell, horn, or electric sounder
- GEMS Mini Sure Site level indicator with 4-20 mA transmitter, DP Level transmitter or discrete level switches
- Steam or water flow transmitters
- Manual hard wired controls for any 4-20 mA controlled valve
- Siemens motorized make-up valve
- RSLinx OPC compliant remote monitoring software
- Recirculation bypass (tank one only)
- NEMA 4/12 entrance panel
- NEMA 4x electrical panel

PRODUCT OFFERING

Standard Features, Single Tank System:

- Compact Logix L32E processor
- 7" color touch screen HMI
- Stack light

Programming and I/O cards for the following:

- I/O for 1-6 pumps using contactors, soft starters, or combination starters
- Hard wired fixed location level inputs for Hi and Low water alarms
- Low water pump cutoff audible alarm output
- Stack light outputs
- Recirculation bypass output
- Chemical feed relay
- Boiler 1-6 'Feed Water Required' inputs for hard piped one pump per boiler systems using contactors, combination starters or soft starters only.
- Pump proving switch inputs for up to 6 feed pumps
- Analog inputs for tank pressure, temperature, level, and discharge header pressure

Optional Features, Single Tank System:

NOTE: Options must be selected in order; each option requires all of the preceding ones.

Option 1	Feedwater make up valve analog output
Option 2	1-6 pump proving flow switch inputs
Option 3	Single tank system emergency make up valve
Option 4	1-3 VSD driven pumps I/O
Option 5	4-6 VSD driven pumps I/O

Standard Features, Duo Tank or DA-and-Surge System:

- Compact Logix L32E processor
- 10" color touch screen HMI
- Stack light

Programming and I/O cards for the following:

- I/O for 1-6 boiler feed pumps and 1-3 transfer pumps using contactors, soft starters, or combination starters
- Hard wired fixed location level inputs for HI and LO water alarms, and low water pump cutoff for 2 tanks
- Audible alarm output
- Stack light outputs
- Recirc bypass output
- Chemical feed relay
- Boiler 1-6 'Feed Water Required' inputs for hard piped one pump per boiler systems using contactors, combination starters or soft starters only.
- Pump proving discrete inputs for up to 6 feed pumps and 3 transfer pumps
- DA tank pressure analog input
- Tank temperature, level, discharge header pressure inputs for 2 tanks
- 1 customer configured analog input

Optional Features, Duo Tank or DA-and-Surge System:

NOTE: Options must be selected in order; each option requires all of the preceding ones.

Option 1	Feedwater make up valve analog output Tank 2
Option 2	Tank 1 Emergency make up valve analog output for 2 Tank systems
Option 3	Tank 2 Emergency make up valve analog output for 2 Tank systems
Option 4	I/O for 1-3 feed pumps and 1 transfer pump VSD driven
Option 5	I/O for 4-6 feed pumps and 2-3 transfer pump VSD driven

ENGINEERING DATA

- Supply voltage: 120 VAC (102 VAC - 132 VAC), 50 or 60 Hz
- Maximum total connected load: 500 VA
- Operating temperature limits: 32 to 130°F
- Humidity: 85% relative humidity continuous, non-condensing
- 0.5G continuous vibration

SAMPLE SPECIFICATIONS

CB ADAC ADVANCED DEAERATOR CONTROL

PART 1 GENERAL

1.1 GENERAL

- A. Each ADAC system shall be factory equipped with a pre-configured Programmable Controller and Human Machine Interface.
- B. System shall provide control logic for the following:
 - 1. 1-6 feed pumps and 1-3 transfer pumps
 - 2. Make up water level control for DA tank or DA and Surge
 - 3. Low Water, Hi Water, and Aux Low Water alarms
 - 4. Chemical feed control

PART 2 PRODUCTS

2.1 STANDARD SYSTEM AND OPTIONS

- A. Hardware Platform - Standard System
 - 1. Compact Logix L32E Processor
 - 2. Power Supply
 - 3. Discrete Input Module
 - 4. Discrete Output Module
 - 5. Analog Input Module 4 Channel
 - 6. Analog Input Module 8 Channel
 - 7. Analog Output Module 2 Channel
 - 8. Analog Output Module 8 Channel
 - 9. Right Termination End Cap
 - 10. HMI Display, 7" Serial Color - Standard on single tank systems
 - 11. HMI Display, 10" Serial Color Standard on two tank systems, optional on single tank systems
- B. Optional Components
 - 1. Veris Current Switch - sized for pump
 - 2. Electric actuators for pump water recirculation bypass - sized for system
 - 3. PowerFlex 70, 400, or 700 Variable Speed Drive

2.2 SENSORS AND TRANSMITTERS

- A. Tank level indication
 - 1. Standard
 - a. DA tank - GEMS Mini Sure Site with transmitter
 - b. Surge tank - GEMS Mini Sure Site with transmitter
 - 2. Optional
 - a. DA tank - Differential pressure level transmitter
 - b. Surge tank - Differential pressure level transmitter
- B. Tank Pressure and Temperature (see table)

Tank Pressure/Temperature Transmitters

	Standard	Optional
DA tank pressure transmitter	E&H	Rosemount-3051
DA pump discharge pressure transmitter	E&H	Rosemount-3051
Surge tank transfer pump pressure transmitter	E&H	Rosemount-3051
DA tank temperature transmitter	Siemens	Rosemount-3144
Surge tank temperature transmitter	Siemens	Rosemount-3144

- C. Pump flow proving sensors
 - 1. Pressure switch mounted after each pump or differential pressure switch across pump or Veris current switch on the high voltage pump motor leads.
- D. E&H flow transmitters - sized per application

2.3 VALVES

- A. Make-up water valves - all sized per application
 - 1. DA tank make-up valve - Siemens SK electronic actuator with optional 3 valve bypass and strainer
 - 2. DA tank emergency or raw water make-up valve - Siemens SK electronic actuator with optional 3 valve bypass and strainer
 - 3. Surge tank make-up valve - Siemens SK electronic actuator with optional 3 valve bypass and strainer

2.4 PUMPS

- A. Feed water pumps - Grundfos
- B. Transfer pumps - Grundfos

2.5 SOFTWARE DEVELOPMENT PLATFORM**(software not required - for informational purposes only)**

- A. RSLogix 5000 (controller logic programming)
- B. RSView ME (HMI programming)
- C. RSView32 / Factory Talk (control room display and data acquisition)
- D. RSLinx OEM version (OPC server - Building Automation System)

2.6 MAJOR FUNCTIONS THAT THE ADAC SYSTEM SHALL PROVIDE:**(controller functions based on customer configuration and purchase of options)**

- A. Feed water pump control
 - 1. System will be able to support up to 6 pumps, selected using the HMI (no PC or additional software required). Upon selection, graphics and control logic will be activated automatically.
 - 2. Pumps may be part of a common header or may feed individual boilers. If part of a common header pumps may be configured to operate in a lead/lag sequence based on system demand. If one pump per boiler hard piped, NO vsd option is available and there is not lead lag or alternation.
 - 3. Order of pump alternation can be automatically rotated to share running time and wear equally between pumps.
 - 4. For a common boiler feedwater pump discharge system, PLC monitors 4-20 mA pressure signal from boiler feedwater header to determine when to command pumps to start/stop. In a VSD system the 4-20 mA pressure signal will determine VSD output.
 - 5. If the pumps are feeding individual boilers, pumps will be turned on/off based on individual discrete 110 VAC signals from each boiler.
 - 6. PLC/VSDs can only control pumps that are in AUTO mode. Pumps in manual will run continuously. The hard wired Aux Low Water pump cutoff will prevent pumps from running in any mode if water level drops below set point..
- B. Transfer pump control
 - 1. System will be able to support up to 3 pumps for transferring water from the Surge tank to the DA. Pumps are selected using the HMI; no PC or additional software required. Upon selection, graphics and control logic will be activated automatically.
 - 2. Pumps may be configured to operate in a lead/lag sequence based on system demand. In addition, order of pump alternation can be automatically rotated to share running time and wear equally between pumps.
- C. DA make-up water level control
 - 1. The lead pump runs continuously. If DA tank level falls below set point, make up valve will modulate to add condensate. If condensate tank discharge pressure falls below set point, the PLC will command the lag transfer pump to start.
 - 2. If surge tank discharge pressure continues to fall below set point, the PLC will sound an alarm. Operator must respond to the alarm condition and reset the alarm.
 - 3. When level control is in manual mode, the make up valve can be opened or closed from the HMI screen, or optionally by a manual potentiometer. Either method will allow the operator to manually adjust the valve between fully open and fully closed to control the incoming flow of make up water

4. An optional Surge tank MUV biasing mode is available.

A bias may be enabled (user defined) to force the primary MUV feeding the DA tank to close as level falls in the surge tank. The bias factor applied to the primary MUV position increases as the level in the surge tank gets lower.

This prevents the surge tank from pumping down to low water cutout so it can continue to run while condensate is returned to it.

You would then have the secondary valve plumbed to the DA from a separate source and add water to the DA to be heated, deaerated and sent to the boilers instead of adding cold water to the surge tank.

D. Surge tank make up water level control

1. The PLC receives a 4-20 mA signal indicating surge tank water level. Signal is compared to the operator input set point and valve modulates accordingly to control the incoming flow of make-up water.
2. When the valve is in manual mode the HMI or optional manual potentiometers will allow the operator to manually adjust the valve between fully open and fully closed.

E. Pump Lead/Lag and Alternating Control

1. Selection of pumps and rotation schedule are configurable from the HMI. PLC will monitor all pumps and determine availability; pumps may be taken out of rotation for maintenance.
2. When system is in auto rotation, if a pump is not available the PLC will alternate to the next available one. If no pumps are available an alarm will sound, requiring manual reset. PLC will maintain equal run time between all pumps.
3. If Lead/Lag option is selected, pump start/stop set points are set from the HMI. Start point is based on percentage of set point achieved by previous pump in sequence. PLC internal timers will maintain minimum load fluctuations.
4. If Lead/Lag and VSD options are selected, VSD% to start/stop lag pump is set from the HMI. When lag function is activated, VSDs function in unison modulation until the speed reaches VSD stop point; then lag pump shuts off.
5. When pump alternation is selected, alternation schedule is configured from the HMI. When current pump run time is met, next pump will start and come up to speed; previous pump will then stop.

F. Chemical Feed Control

1. One set of dry contacts wired to terminal blocks will be provided to change state when any boiler feed pump is running, enabling customer chemical feed pump.

2.7 ADDITIONAL ADAC SYSTEM FUNCTIONS:

- A. A pressure sensor mounted in steam space monitors Deaerator pressure.
- B. A set of contacts on each pump's overload relay provides indication of pump failure. If VSDs or soft starters are used, a fault contact is monitored by the PLC to indicate pump failure.
- C. A set of contacts on each pump starter indicates pump running. If VSDs or soft starters are used, a contact is monitored by the PLC to indicate run status.
- D. A selector switch is mounted at each pump starter to allow Hand- Off-Auto switching. 'Hand' ignores all external signals except Aux Low Water Cutoff. 'Off' ignores all signals and prevents pump from running, 'Auto' allows pump to run based on commands from the PLC.

2.8 ALARM FEATURES

- A. DA Tank water level alarms
 - 1. Low Water — If water level as indicated by the tank level device falls to a pre-set point, the PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
 - 2. Low Low Water — If water level falls further to the pre-set Low Low Water point, the PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light and shut off all pumps.
 - 3. Hi Water — If water level as indicated by the tank level device rises to a pre-set point, the PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
 - 4. Aux Low Water — If water level falls to the pre-set Aux Low Water point, the hard wired Aux Low Water device will open, signalling the PLC and shutting down all pumps for that tank. The PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
- B. Surge Tank water level alarms (same as above)

2.9 ADAC COMMUNICATION OPTIONS

- A. Ethernet connectivity
 - 1. PLC features an OPC compliant Ethernet/IP port for connection to a Building/Plant Automation System or Local Area Network.
 - 2. Remote monitoring/data logging available using RSView software.
 - 3. Connection to HAWK Master Panel (**Note: Existing Master Panels would require a program upgrade and possibly a processor upgrade to use this option**).
 - 4. Compliance with IEEE 802.3 Physical and Data Link, TCP/IP protocol, and Control and Information Protocol (CIP) standards.
- B. Other communication options
 - 1. For Monitoring purposes only, communication to most major building management system interfaces such as Johnson Controls Metasys, ASHRAE Bacnet, LON, and Siemens will be available via a Cleaver- Brooks protocol translator bridge. Check with Cleaver-Brooks for specific information.

2. Data can be transferred by Ethernet through a CB Master Panel to a customer BAS. If a Master Panel is unavailable, the protocol translator can be configured to communicate directly between the ADAC and the customer BAS.

CB LCS-150E.1 LEVEL CONTROL SYSTEM

The Cleaver-Brooks LCS-150E.1 Level Control System utilizes a level transmitter and programmable controller to control water level and water level alarms.

System includes modulating make-up valve with user-selectable manual or automatic control.

FEATURES AND BENEFITS

Standard Features:

- Programmable controller with display, trending, data logging, and Modbus RTU communications
- Set points, alarm points, transmitter span, and PI controls configurable using controller keypad
- Manual or automatic control of up to two make-up valves
- Easy-to-read level indication
- No sight glass - water is contained in a pressure-tight housing

PRODUCT OFFERING

The following are included as standard in each LCS-150E.1 control system:

- Programmable controller
- Controller display with keypad
- I/O module
- Level sensor and transmitter
- Modulating feed water valve and actuator
- Alarm horn and silence button
- High-High, High, Low, Low-Low and Low Water Cut-Off alarm lights

ENGINEERING DATA

- Supply voltage 120 VAC
- Max load 3 amps
- Ambient temperature range 32 - 122 deg F
- Humidity, non condensing 5-95%
- Degree of protection
 - Display/keypad: IP65, Type 3R, Type 12R
 - Panel Nema 4/12
 - Lights and switches IP66
 - Level indicator / transmitter Nema 4
 - Siemens valve Nema 1; optional weather shield will change it to Nema 3R



Sample Specifications

CB LCS-150E.1 Level Control System

1.1 GENERAL

General

- A. Each LCS-150E.1 system shall be factory equipped with controller including display and I/O, NEMA 12 cabinet, primary and optional secondary make up valves and GEMS magnetic level sensor with transmitter.
- B. System shall provide the following functions:
 - 1. Adjustable transmitter span
 - 2. Individual adjustable water level set point for each MUV
 - 3. Adjustable high-high water alarm point (with differential)
 - 4. Adjustable high water alarm point (with differential)
 - 5. Adjustable low water alarm point (with differential)
 - 6. Adjustable low-low water alarm point (with differential)
 - 7. Adjustable low water cutoff point (with differential)
 - 8. Adjustable P and I (proportional and integral gain) parameters
 - 9. Manual or automatic make-up valve operation
 - 10. On-screen alarm indication and relay outputs for high water, low water, low water cutoff, and general alarms
 - 11. Alarm Silence input
 - 12. On-screen trending, Modbus RTU communications and data logging to an optional micro SD card.

2.1 PRODUCTS

Standard System

- A. Hardware Platform
 - 1. Controller with backlit graphic display
 - 2. Power Supply 115VA/24VDC 30 Watts
 - 3. I/O module:
 - (12) 24VDC inputs
 - (12) 24VDC outputs
 - (2) 4-20 mA analog output for 2 make-up valves
 - (1) 4-20 mA input for a level transmitter
- B. Level sensor and transmitter
 - 1. GEMS Mini Sure Site magnetic level indicator
 - 2. Level transmitter 4-20 mA
- C. Make-up valve
 - 1. Siemens modulating feed water valve - sized per application
 - 2. Electronic actuator 4-20 mA.

D. Alarms

1. Panel mounted alarm horn
2. Alarm silence switch
3. LED alarm lights for High-High, High, Low, Low-Low and Low Water Cut- Off
4. Customer Relay contacts for High-High, High, Low, Low-Low and Low Water Cut-Off

CB LCS-250E LEVEL CONTROL SYSTEM

The Cleaver-Brooks LCS-250e Level Control System utilizes 2 level transmitters and a programmable controller to control water level and water level alarms for two separate tanks.

System includes 2 modulating make-up valves with user-selectable manual or automatic control.

FEATURES AND BENEFITS

Standard Features:

- Programmable controller with display, trending, data logging, and Modbus RTU communications
- Set points, alarm points, transmitter span, and PI controls configurable using controller keypad
- Manual or automatic control of make-up valves
- Easy-to-read level indication
- No sight glass - water is contained in a pressure-tight housing

PRODUCT OFFERING

The following are included as standard in each LCS-250E control system:

- Programmable controller
- Controller display with keypad
- I/O module
- 2 Level sensor and transmitter
- 2 Modulating feed water valves and actuators
- Alarm horn and silence button
- High-High, High, Low-Low, Low, and Low Water Cut-Off alarm lights

ENGINEERING DATA

The following are included as standard in each LCS-250E control system:

- Supply voltage 120 VAC
- Max load 3 amps
- Ambient temperature range 32 - 122 deg F
- Humidity, non condensing 5-95%
- Degree of protection
 - Display/keypad: IP65, Type 3R, Type 12R
 - Panel Nema 4/12
 - Lights and switches IP66



- Level indicator / transmitter Nema 4
- Siemens valve Nema 1; optional weather shield will change it to Nema 3

Sample Specifications

CB LCS-250E Level Control System

1.1 GENERAL

General

- A. Each LCS-250E system shall be factory equipped with controller including display and I/O, NEMA 12 cabinet and GEMS magnetic level sensor with transmitter.
- B. System shall provide the following functions:
 - 1. Adjustable transmitter span
 - 2. Adjustable water level set point
 - 3. Adjustable high-high water alarm point (with differential)
 - 4. Adjustable high water alarm point (with differential)
 - 5. Adjustable low water alarm point (with differential)
 - 6. Adjustable low-low water alarm point (with differential)
 - 7. Adjustable low water cutoff point (with differential)
 - 8. Adjustable P and I (proportional and integral gain) parameters
 - 9. Manual or automatic make-up valve operation
 - 10. On-screen alarm indication and relay outputs for high-high, high, low, low-low, low water cutoff, and general alarms
 - 11. Alarm Silence input
 - 12. On-screen trending, modbus RTU communications and data logging to an optional micro SD card.
- C. DA make-up water level control
 - 1. If DA tank level falls below set point, make up valve will modulate to add condensate.
 - 2. When level control is in manual mode, the make up valve can be opened or closed from the HMI screen. This will allow the operator to manually adjust the valve between fully open and fully closed to control the incoming flow of make up water.
 - 3. An optional Surge tank MUV biasing mode is available.

A bias may be enabled (user defined) to force the primary MUV feeding the DA tank to close as level falls in the surge tank. The bias factor applied to the primary MUV position increases as the level in the surge tank gets lower.

This prevents the surge tank from pumping down to low water cutout so it can continue to run while condensate is returned to it.

You would then have the secondary valve plumbed to the DA from a separate source and add water to the DA to be heated, deaerated and sent to the boilers instead of adding cold water to the surge tank.
- D. Surge tank make up water level control
 - 1. The controller receives a 4-20 mA signal indicating surge tank water level. Signal is compared to the operator input set point and valve modulates accordingly to control the incoming flow of make-up water.

2. When the valve is in manual mode the HMI, the operator to manually adjust the valve between fully open and fully closed

2.1 PRODUCTS

Standard System

- A. Hardware Platform
 1. Controller with backlit graphic display
 2. Power Supply 115VA/24VDC 30 Watts
 3. I/O module:
 - (12) 24VDC inputs
 - (12) relay outputs
 - (2) 4-20 mA analog output for make-up valves
 - (2) 4-20 mA input for level transmitters
- B. Level sensor and transmitter
 1. GEMS Mini Sure Site magnetic level indicator
 2. Level transmitter 4-20 mA
- C. Make-up valve
 1. Siemens modulating feed water valve - sized per application
 2. Electronic actuator 4-20 mA
- D. Alarms
 1. Panel mounted alarm horn
 2. Alarm silence switch
 3. LED alarm lights for High-High, High, Low, Low-Low and Low Water Cut- Off
 4. Customer Relay contacts for High-High, High, Low, Low-Low and Low Water Cut-Off

CB PCS-140E PUMP CONTROL SYSTEM

The Cleaver-Brooks PCS-140E Pump Control System utilizes a pressure transmitter and a programmable controller to control pump sequencing and pump alarms for up to 4 pumps.

System includes user-selectable manual or automatic control.

System does not include contactors or soft starters and will not operate VSD's.

FEATURES AND BENEFITS

Standard Features

- Programmable controller with display
- Set points, alarm points, transmitter span, and PI controls configurable using controller keypad
- Manual or automatic control of pumps
- Trending, modbus RTU communications and data logging to an optional micro SD card

PRODUCT OFFERING

The following are included as standard in each PCS-140E control system:

- Programmable controller
- Controller display with keypad
- I/O module
- Pressure transmitter
- Alarm horn and silence button
- Illuminated Pump Hand-Off-Auto Selectors switches, 1 per pump

ENGINEERING DATA

- Supply voltage 120 VAC
- Max load 3 amps
- Ambient temperature range 32 - 122 deg F
- Humidity, non condensing 5-95%
- Degree of protection
 - Display/keypad: IP65, Type 3R, Type 12R
 - Panel Nema 4/12
 - Lights and switches IP66
 - Pressure transmitter Nema 4

Sample Specifications

CB PCS-140E Pump Control System

1.1 GENERAL

General

- A. Each PCS-140E system shall be factory equipped with controller including display and I/O, NEMA 12 cabinet, and pressure transmitter.
- B. System shall provide the following functions:
 - 1. Adjustable transmitter span
 - 2. Adjustable pump lead lag set point
 - 3. Adjustable pump lead lag sequence
 - 4. Adjustable pump rotation method
 - 5. Low water pump cutoff input
 - 6. Adjustable P and I (proportional and integral gain) parameters
 - 7. Manual or automatic pump control
 - 8. On-screen alarm indication and relay output for alarms
 - 9. Alarm Silence input

2.1 PRODUCTS

Standard System

- A. Hardware Platform
 - 1. Controller with backlit graphic display
 - 2. Power Supply 115VA/24VDC 30 Watts
 - 3. I/O Module
 - (12) 24VDC inputs
 - (12) 24VDC outputs
 - (1) 4-20 mA output for pressure retransmit
 - (1) 4-20 mA input for pressure transmitter
- B. Pressure transmitter
 - 1. Pressure transmitter 4-20 mA
- D. Alarms
 - 1. Panel mounted alarm horn
 - 2. Alarm silence switch
 - 3. LED alarm light for pump failure and High or Low pressure

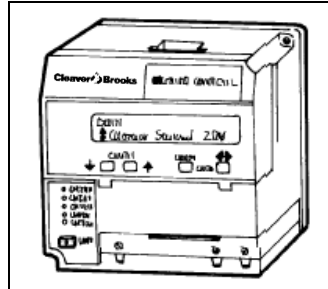
Functionality

- Individual delays for low pressure add a pump and high pressure shed a pump
- Select from 2 different pump operation modes
- In 'First On-First Off' mode when a pump is called to shut off, the lead pump is re-assigned to the last position in the sequence and the other pumps move up. The former lead pump (now lag 3) is turned off.
- In 'Timed Rotation' mode when a pump is called to shut off, the running pump with the lowest position on the sequence is shut off (Last On-First Off). When the run time of the lead pump exceeds the rotation time set point, the lag1 pump is started. When the lag1 pump is confirmed to be running, the lead pump is reassigned to the last position in the sequence, shuts off, and the other pumps move up.

Trending, modbus RTU communications and data logging to an optional micro SD card

CB780E CONTROL

The CB 780E is a microprocessor-based flame safeguard control used to monitor the presence of a flame inside a boiler, and to sequence the burner through several stages of operation to provide proper air purge, ignition, normal operation and shut down for safe operation.



FEATURES AND BENEFITS

Dynamic self-check logic and diagnostics:

- Dynamic self-check safety circuit checks microprocessor and safety relay to ensure safe and proper operation.
- Dynamic input check verifies controls ability to recognize the true status of external controls, limits and interlocks.
- Closed-loop logic test verifies integrity of safety critical loads (ignition, pilot, and main fuel valves) for proper operation.
- Pre-ignition interlocks and flame signal checked during Standby and Pre-Purge.
- High and Low fire switches checked for proper sequencing.
- Tamper-proof Purge Timer Card.

Valve Proving System

- Programmable valve proving system provides fuel valve proof-of-closure.

Powerful Display/Diagnostic Capabilities:

- 2 line x 20 character Vacuum Fluorescent Display is easy to read under all lighting conditions.
- Status and diagnostic messages displayed in English Language with no scrolling necessary (Spanish also available).
- Displays flame signal in Volts dc, eliminating need for separate meter.
- Displays burner hours and numbers of cycles.
- Diagnostic displays include on/off status of inputs and outputs, RUN/TEST switch status, selected purge time, amplifier type and configuration data.
- Fault history (retained in non-volatile memory) displays the cycle, hours, code, description, and condition for the last six fault occurrences.
- Capability to mount display on front of Control Panel for improved access, or remotely, in separate control room. (Optional)
- 5 LEDs on base provide at-a-glance status of Power On, Pilot, Flame, Main

Valves, and Alarm conditions (Power LED blinks periodically to indicate proper control operation).

- Diagnostic display capabilities are further enhanced by the optional CB783 Expanded Annunciator which provides 36 additional specific HOLD and Fault messages, as well as 26 LEDs to indicate current status or first-out alarm indication (user-selectable).
- Communication capabilities to a local or remote Personal Computer, with optional CB-LINK communications module and Combustion System Manager™ software (runs under Microsoft Windows®).

Application Flexibility:

- Purge Timing Cards available in 30, 60, 90 seconds or 2-1/2 minutes cover a wide range of applications, while eliminating need for a separate purge timer.
- Separate output for ignition transformer simplifies applications requiring early spark termination.
- Selectable configuration jumpers allow application-specific configuration.
- Communication interface capability.

Simplified Servicing:

- Diagnostic and fault history information available through display simplifies troubleshooting procedures.
- Removable access covers for checking voltage at terminals.
- 5-function RUN/TEST switch eases start-up procedure.
- Flame signal display facilitates pilot/light-off test procedures.

PRODUCT OFFERING

Included in each CB 780E system is the following:

- One CB780E chassis, including display module.
- One Purge Timer Card.
- One wiring sub-base.
- One flame scanner, either Infrared, Ultra-Violet, or UV Self-Check.
- One flame amplifier, to correspond with the selected flame scanner.

Included with the optional CB783 Expanded Annunciator:

- One CB783 Annunciator.
- One wiring sub-base.
- All limits and interlocks are wired into wiring sub-base to provide individual hold/fault indication on LEDs of Expanded Annunciator, as well as on display module of CB 780E control.

ENGINEERING DATA

- Supply voltage: 120 Vac (+10%/-15%) 50 or 60 Hz.
- Maximum total load: 2000 VA.



- Load rating-fuel valve output: 65 VA pilot duty plus 1150 VA inrush, 460 VA opening, 250 VA holding.
- Operating temperature limits: -40 to 140 °F.
- Maximum ambient humidity: 85% non-condensing.

Sample Specification

CB780E Control

PART 1 GENERAL

Flame safeguard shall be a Cleaver-Brooks Model CB 780E microprocessor-based control to monitor all critical boiler and burner interlocks, control and supervise burner light off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. The system shall provide status, fault history, and diagnostic information by means of a two-line alpha-numeric display and alarm/status LEDs. The system shall be approved by UL, FM, and CSA, and shall be acceptable by IRI.

CB120/120E CONTROLS

The CB120 is a microprocessor-based burner management control system designed to provide the proper burner sequencing, ignition, and flame monitoring protection on automatically ignited oil, gas, and combination fuel burners. In conjunction with limit and operating controls, it programs the burner/blower motor, ignition, and fuel valves to provide for proper and safe burner operation.



The CB120E includes all of the features of the CB120 with the addition of an alphanumeric display.

FEATURES AND BENEFITS

Display and Diagnostic Capabilities:

- (CB120E) 2 x 16 character display with keypad. Available display types are vacuum fluorescent (VFD) and liquid crystal (LCD). VFD has increased brightness and extended operating temperature range to -40°F. Messages are spelled out in English (optional Spanish version is also available). Provides indication of flame signal during operation.
- Lockout history stores last 10 lockouts with burner cycle and burner hour when occurred.
- Display module can be mounted remotely from the CB120 for external indication (optional).
- Optional expanded annunciator provides increased messaging and diagnostic capabilities.
- Optional communication via Modbus with local or remote PC.

Modular Design:

- Interchangeable program modules in English or Spanish.
- Adjustable purge time programmable via display.
- Chassis available for infrared, ultra-violet, or UV self-check flame scanners.
- Reduces part replacement costs.



PRODUCT OFFERING

Included in each CB120 System is the following:

- Chassis with corresponding flame amplifier
- Plug-In Programmer Module.
- Wiring base.
- Flame scanner - either infrared, ultra-violet, or UV self-check.

Included in each CB120E System is the following:

- All of the above
- Alphanumeric display

Display is required for Modbus communication or to access special functions.

ENGINEERING DATA

- Supply voltage: 120 Vac (+10%/-15%) 50/60 Hz.
- Fuel valve output load rating: 6.5 VA pilot duty plus 3850 VA inrush, 700 VA open, 250 VA hold.
- Operating temperature limits: -40°C (-40°F) to 60°C (140 °F). LCD display min. temp. limit -20°C (-4°F).
- Maximum ambient humidity: 90% non-condensing.

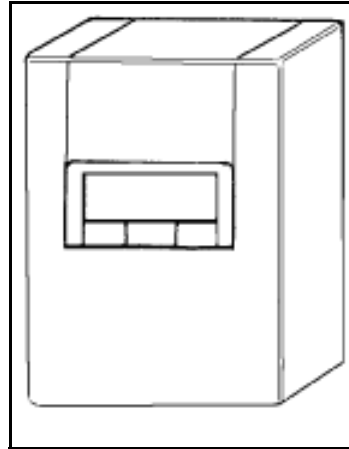
Sample Specification CB120/120E Control

PART 1 GENERAL

Flame safeguard shall be a Cleaver-Brooks Model CB120/120E microprocessor-based control to monitor all critical boiler and burner interlocks, control and supervise burner light-off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. CB120E system shall provide status, fault history, and diagnostic information by means of a 2 x 16 VFD or LCD display. The system shall be approved by UL, FM, and CSA, and shall be acceptable by IRI.

CB100E CONTROL

The CB100E is a microprocessor-based, flame safeguard control used to monitor the presence of a flame inside a boiler, and include various interlocks to ensure safe operation. The flame safeguard also sequences the burner through several stages of operation to provide proper air purge, ignition, normal operation and shut down for safe operation.



FEATURES AND BENEFITS

Display and Diagnostic Capabilities:

- 2 x 16 Backlit LCD display with a 3- key tactile dome keypad indicates 38 different messages regarding status and fault indication. Messages are spelled out in English. (Optional Spanish version is also available.) Provides indication of flame signal during operation.
- Provides indication of burner cycles and run time.
- Non-volatile memory retains last 6 fault/lockout conditions on power failure.
- Display module can be mounted in cabinet door for external indication . (Optional)
- Optional E300 expansion module provides additional 31 messages pertaining to fault or “hold” status indication.
- Communication with local or remote PC by means of an optional E500 communication module.

Modular Design:

- Interchangeable program modules in English or Spanish.
- Purge time is selected via dip switches.
- Interchangeable amplifiers for infrared , ultra-violet, or UV self-check flame scanners.
- Reduces part replacement costs.

PRODUCT OFFERING

Included in each CB100E System is the following:

- One chassis, including a dust cover.
- One 2-line display module.
- One Programmer Module.
- One wiring sub-base.
- One flame scanner, either infrared, ultra-violet, or UV self-check.
- One flame amplifier — to correspond with the selected flame scanner.

Included with optional E300 Expansion Module is:

- One E300 expansion module.
- One wiring subbase.
- One interconnection cable to E100E.
- All interlocks are wired into wiring sub base to provide individual hold/fault indication on display of CB100E control.

ENGINEERING DATA

- Supply voltage: 120 Vac (+10%/-15%) 50/60 Hz.
- Maximum total load: 2000 VA.
- Fuel valve output load rating: 1250 VA opening, 500 VA holding.
- Operating temperature limits: 32 °F to 125 °F.
- Maximum ambient humidity: 85% non-condensing.

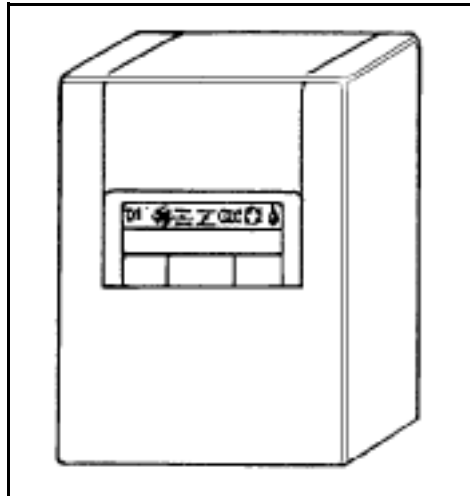
Sample Specification CB100E Control

PART 1 GENERAL

Flame safeguard shall be a Cleaver-Brooks Model CB100E microprocessor-based control to monitor all critical boiler and burner interlocks, control and supervise burner light-off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. The system shall provide status, fault history, and diagnostic information by means of a 2 x 16 backlit LCD display. The system shall be approved by UL, FM, and CSA, and shall be acceptable by IRI.

CB110 CONTROL

The CB 110 is a micro -processor-based, flame safeguard control used to monitor the presence of a flame inside a boiler, and include various interlocks to ensure safe operation. The flame safeguard also sequences the burner through several stages of operation to provide proper air purge, ignition, normal operation and shut down for safe operation.



FEATURES AND BENEFITS

Self Diagnostics:

- Seven LED display provided to indicate: Fan, High Fire, Low Fire, Ignition, Flame detected, Auto and Alarm.
- 23 Fault indications.

Modular Design:

- Interchangeable amplifiers for infrared, ultra violet, or UV self-check flame scanners.
- Reduces part replacement costs.
- Easily upgradeable to a CB 100E by replacing programmer and display modules.

PRODUCT OFFERING

Included in each CB 110 System is the following:

- One CB 110 chassis, including dust cover.
- One Programmer/Display Module.
- One wiring subbase.
- One flame scanner, either infrared, ultra-violet, or UV self-check.

- One flame amplifier — to correspond with the selected flame scanner.

ENGINEERING DATA

- Supply voltage: 120Vac (+10%/-15%) 50/60 Hz.
- Maximum total load: 2000 VA.
- Fuel valve output load rating: 1250 VA opening, 500 VA holding.
- Operating temperature limits: -40 °F to 125 °F
- Maximum ambient humidity: 85% non-condensing.

Sample Specification CB110 CONTROL

PART 1 GENERAL

Flame safeguard shall be a Cleaver-Brooks Model CB 110 microprocessor-based control to monitor all critical boiler and burner interlocks, control and supervise burner light-off sequence, and initiate an orderly safety procedure in the event of interlock or flame failure. The system shall provide status, fault history, and diagnostic information by means of an LED display. The system shall be approved by UL, FM, and CSA, and shall be acceptable by IRI.

Accu-Trim O₂TRIM SYSTEM

The C-B Accu-Trim O₂ Trim System is a stand-alone PLC -based control system designed to maintain the proper fuel-air ratio of a boiler/burner. The system will automatically compensate for changes in temperature, barometric pressure, or fuel characteristics, as well as correcting for normal hystereses. The system is intended for use on a Cleaver -Brooks boiler or burner with single point positioning, or jackshaft-type, combustion controls; however, it may be customized for special applications such as parallel positioning or alternate fuel firing. A complete system includes oxygen and firing rate sensors, a control panel which houses the PLC, and an actuator or VSD system which trims either the fuel or air flow.



FEATURES AND BENEFITS

- Single unit PLC / HMI with 6" color touchscreen
- Modular DIN rail mounted I/O - 8 analog inputs, 8 analog outputs, 4 digital inputs, 4 relay outputs
- Analog signals are 0-10 VDC, digital inputs are 24 VDC
- Modbus RTU communication
- Quick overview of O₂ setpoint and actual value
- Real time data trending for visual confirmation of system operation
- Displays stack temperature, variable speed drive output, excess air, and fuel selection
- Uses CB O₂ probe, Yokogawa probe, or any 4-20 mA probe
- Compatible with natural gas, propane, and #2 oil using the CB O₂ probe and with heavy oils using the Yokogawa probe
- Password protected operating parameter values
- 12-point setup for up to three fuel curves
- Independent PID loops for each trim device/fuel
- Ability to integrate with Base and Intermediate Hawk ICS packages

- Active and historical alarms
- Flash card available for data logging

PRODUCT OFFERING

Basic configurations:

The Accu-Trim system can be supplied for either fuel trim or air trim in the following configurations:

- Fuel trim - electric actuators only
- Fuel trim - pneumatic actuators only
- Fuel trim - electric and pneumatic actuators combined
- Air trim with VSD

Analyzer:

Yokogawa integrated type Zirconia oxygen analyzer

OR

Cleaver-Brooks model oxygen analyzer

Controller:

- Integrated PLC/touchscreen HMI
- Discrete input/output module
- Analog input module
- Analog output module

Actuators:

Electric, pneumatic, or combination

Options:

O₂ process value retransmission

ENGINEERING DATA

Electrical	120 VAC, 60 Hz, or 110 VAC 50 Hz 6 Amp 3-wire grounded system.
Environmental	Temperature: Control Panel 32-122 °F Firing Rate Sensor 0-180 °F
Air Supply (For pneumatic actuators only)	25-125 PSIG, 2 SCFM CLEAN, DRY instrument quality air Oil content 1 ppm maximum Dew point 35 °F or less at line pressure.



Sample Specifications Accu-Trim

PART 1 GENERAL

1.1 GENERAL

- A. This specification covers the hardware and control of the C-B Accu-Trim O₂ Trim System. The system adjusts the fuel-to-air ratio in order to maintain maximum efficiency and features reliable monitoring and control of oxygen concentrations.
- B. The system shall be completely configured from factory, requiring only job-specific data to be entered (or modified) in the field. Controller/analyzer shall be shipped with “default” values and have a limit on the range of adjustments where applicable.
- C. Oil fuel trim available on integral head boiler applications only.

PART 2 PRODUCTS

2.1 HARDWARE

- A. Analyzer - choose one of the following:
Yokogawa integrated type Zirconia oxygen analyzer
OR
Cleaver-Brooks model oxygen analyzer
- B. Actuator – Siemens electric actuator for gas pressure, Controlair or Bellofram mounted on the oil pressure regulator (system without air trim via VSD).
- C. Controller
 - 1. Integrated PLC/HMI touchscreen (6” color screen standard)
 - 2. HMI shows bar graph and ‘moving pen’ data value indication
 - 3. Overview of O₂ setpoint and process value
 - 4. Display of stack temperature, VSD output, excess air, and fuel selection
 - 5. 8 Analog Inputs, 8 Analog Outputs
 - 6. 4 Digital Inputs and 4 Relay Outputs
 - 7. Modbus RTU
 - 8. Password protection of operating parameters.
 - 9. Active and historical alarms

Control algorithm shall be PID (Proportional, Integral, and Derivative) type. Proportional action shall be applied to the process variable and not to the deviation. PV (Process Variable) is oxygen concentration in flue gases. This is a 4-20 mA or 0-10 VDC signal from the oxygen analyzer. The O₂ input is scaled from 0 to 25% O₂. When analyzer is not measuring O₂ in flue gas (warm-up, calibration, fault) control output shall be at 50%. The oxygen setpoint shall be based on the burner firing rate. Set point curve shall have 12 adjustable break points. The setpoint shall have independent settings for up to 3 fuels.

- Systems with Fuel Trim - Correction to the fuel air ratio is accomplished by changing fuel pressure. In the case of natural gas this is done via an electric



or pneumatic actuator mounted on the gas pressure regulator. In the case of oil fuel, this is done by applying air pressure to the top side of the PRV diaphragm.

- Systems with Air Trim - Applying adjustment to the calculated combustion air blower speed performs the correction to the fuel-air ratio.

2.2 APPLICATION

This system is intended for use on a Cleaver-Brooks boiler or burner with single point positioning, or jackshaft-type, combustion controls; however, it may be customized for special applications such as parallel positioning or alternate fuel firing. System is compatible with natural gas, propane, and #2 oil using the CB O₂ probe and with heavy oils using the Yokogawa probe.

STANDARD ECONOMIZER
PRODUCT GUIDE



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Overview

An Economizer recovers heat from flue gases and uses it to increase boiler feedwater temperatures, prior to entering the boiler. Cleaver-Brooks offers two types of Standard Economizers - CCE (Cylindrical) and CRE (Rectangular) units.

Reduces Fuel Use and Cost:

- Recovers heat from flue gases that would otherwise be wasted
- Heat is used to raise boiler feedwater temperature prior to entering the boiler

Load Changes:

- Rapid changes in load demands can be met faster due to higher feedwater temperature

Emissions:

- Reduced fuel-firing rates for any given steam output means reduced NOx emissions

ASME Construction:

- Ensures high quality design and manufacturing standards
- Provides safety and reliability

High Efficiency Heat Exchanger:

- Provides uniform fin-to-tube contact for maximum heat transfer
- Fin tubing offers up to 12 times the heat exchange surface of bare tubing of the same diameter

Self-Draining Design:

- Suitable for outdoor installation.

Low Pressure Drop:

- Provides low gas side pressure drops.
- Permits use of smaller forced draft fans.
- Permits use of existing fans in almost all installations.

Gas Tight Combustion Stack:

- Stainless Steel casing.
- Compact dimensions provide for easy installation.

Applications

Note:

- Must always have continuous water flow through the economizer when flue gas is travelling through the economizer.
 - Not Recommend
 - Running the economizer dry.

Boiler Feedwater

- Running Feedwater directly through the economizer (direct feedwater heating) – continuous run pump and modulating feedwater control is required.

On/Off Feedwater Control

- Convert to modulating control OR
- Supply Circulating Pump and Tank System must be proposed
 - Circulating pump and tank systems are only available up to 150 lb boiler design pressure.
 - Storage Tank Selection
 - Based on MBH of Economizer Recovery
 - General rule of thumb is to pick 20-30 GPM for the circulating pump flowrate.
 - Minimum water flow rate through the economizer should be the maximum evaporation rate of the boiler.
 - Add liquid temperature control assembly
 - ByPass Damper Open reduces the heat recovery by up to 50%
 - May need additional means of removing the excess heat within the system.

Make-up Water Heating

- Must have Minimum of 50% makeup to ensure a sufficient heat sink
- Even with this guideline, flow may still be interrupted, which can cause steaming in the economizer.
 - Add a tank and pump upstream of the feedwater tank.
 - Then flow is not interrupted.
- Recommend SS Headers (All SS Liquid Side)
 - Untreated Condensate – Carbonic Acid
 - MU Water – O₂ Corrosion
- If water is less than 150°F, may recommend a C1X – Single Stage Condensing Economizer

Hot water boilers

- Supply Circulating Pump to draw water from, and return it to, the system hot water return.
- Use approximately 2-3 gpm per economizer tube as the minimum water flow rate.
- Note:
 - Saturated Steam Temp versus Feedwater Temperature
 - High Fire use lowest flow possible to keep a Temperature difference of 15 or 20°F below the sat. temp of the boiler
- Supply Temperature + Boiler Delta T (LPS/HW) = Flue Gas Temp

Potable Water

- Depends on local code if you can run direct through economizer or need a secondary heat exchanger
- Quote a circulating pump kit
- Select a second identical pump
- Second pump not with the kit
- Controller with kit is set up to only control one pump
- Would have to provide own means of switching over to the backup pump

*Guide:***Special Applications (Contact Milwaukee Sales):**

- Low Pressure Steam
- Hot Water Boiler
- Operating Pressure Less Than 35 psi
- Heavy Oil Fuel
- On/Off Feedwater Control
- Maximum Feedwater Temperature is greater than what is allowed within the program
- Multiple Boilers into 1 Economizer
 - Not Recommended
 - Size for maximum capacity
 - Must include a SCCA

Tab 1: Application Data**Model Selection**

- Select the correct Cleaver Brooks boiler model.
 - For non Cleaver Brooks models select "Other"

Load Points

- Firetube Models will provide 4 Load Points
- Model 4/ Model 5 will provide 1 Load Point at 100% Load
- Model FLX will Provide 2 Load Points

Fuel Series Consideration

- **Natural Gas Only:**
 - Condense Temperature ~140°F
 - Stack Temperature (Economizer leaving temp)
 - 290 – 300°F target
 - Stack corrosion control assembly not required.
 - 290°F (85% efficiency requires 265 - 275°F stack temp)
 - May require the Stack Corrosion Control Assembly if temperature falls below @ 230°F at low fire.
 - SCCA also recommended for tall or un-insulated stacks to prevent condensation.
 - Feedwater Temperature
 - 40°F minimum.
 - Inlet water temperature below 100°F requires all stainless steel liquid side surfaces.
 - Construction
 - Standard Al-Fuse stainless tube/aluminum fin construction.
 - Fin Spacing:
 - Maximum 6 Fins/inch.
- **Natural Gas and/or #2 Oil:**
 - Natural Gas Condense Temp ~140°F
 - #2 oil Condense Temperature: ~180°F
 - Stack Temperature (Economizer leaving temp)
 - 300 – 325°F target,
 - Stack corrosion control assembly not required.
 - Below 290°F (85% efficiency requires 265 - 275°F stack temp)
 - Stack Corrosion Control Assembly is required.
 - Feedwater Temperature
 - 120°F minimum.
 - Construction
 - Standard Al-Fuse stainless tube/aluminum fin construction.

- Fin Spacing
 - Maximum 6.0 Fins/inch.
- **#6 Oil:**
 - Forward all #6 oil selection to Cleaver Brooks.
 - Stack Temperature (Economizer leaving temp)
 - 325 – 350°F target
 - Stack corrosion control assembly required for all applications.
 - Automatic sootblower required
 - Feedwater Temperature
 - 220°F minimum required.
 - Feedwater must be from DA or otherwise preheated
 - Maximum fuel sulfur content
 - 3%
 - Construction
 - Stainless Steel tube/ Carbon Steel fin for low sulfur
 - Stainless Steel tube/ Stainless fin for 2% or greater sulfur content.
 - Fin Spacing
 - 4 – 5 fins/inch.

Pressure Drop:

- Majority of Cleaver Brooks Boilers
 - 0.25" w.c. maximum Gas Side pressure drop
- Some Cleaver Brooks Boilers
 - 0.50" w.c. maximum Gas Side pressure drop.
- Industrial watertube boilers
 - 0.8" w.c. maximum pressure drop.

Feedwater Temperature

- Maximum Temperature
 - Calculated and set at a temperature to assure at least a 25°F Differential between the Boiler Operating Temperature and the Economizer Outlet Feedwater Temperature

Flue Gas Temperatures

- Predicted Values are Calculated
- Can override the Defaulted Value

Hours of Operation

- Can override the Defaulted Value: 2190

Tab 2: Economizer Selection**Boiler Performance Baseline**

- Display field in the upper left corner
- Shows the Boiler Information formed from Tab 1 Selections

Stack Temperature Loss

- Display field in the upper right corner
- Shows the minimum recommended exit temperature from the economizer to avoid condensation.
- Uses Stack Height, Feet and Stack Construction for calculation

Economizer Type

- CCE
 - Cylindrical Model
 - Horsepower is less than or equal to 250HP
 - Base price includes economizer and stack transitions with flanges, Qty. (2) mating flanges, and Qty. (2) mating flange gaskets.
 - Standard Design Pressure
 - 300psig
 - Standard Test Pressure
 - 375 psig
 - 150psi – 250psi Boiler Design
 - Switch Design Press/Test to 400/600
 - Change Relief Valve to 400psig
 - Above 550°F
 - Special Request
 - Other materials required
 - Features
 - Does not have a field replaceable tube core
 - The Unit can be rebuilt at the factory if needed.
 - Header manifold for high liquid flow rates
 - UM Stamp Standard

- Hinged stainless steel access door panels
 - Quick release tension for doors
 - Manual bypass control lever
 - Stainless steel internal bypass assembly
 - Vertical Flow Only
 - Internal thermal expansion design
 - Built in by-pass damper
 - Allow manual stack temperature control and heat adjustment
 - Mounting flanges for bolting to mating flanges or adapters
 - Single Row Construction
 - Have much higher water side pressure drops.
 - Water side pressure drop limit is 10 psig, unless the rep can accept a higher drop.
 - 2 Row Construction (CRE-M2D, L2H, etc.)
 - More likely to achieve higher efficiency
 - Will have much higher gas side pressure drops.
- CRE
 - Rectangular Model
 - Boiler HP 150 HP up to 2200 HP
 - Standard Design Pressure
 - 300psig
 - Standard Test Pressure
 - 450 psig
 - 150psi – 250psi Boiler Design
 - Switch Design Press/Test to 400/600
 - Change Relief Valve to 400psig
 - Above 550°F
 - Special Request
 - Other materials required
 - Features
 - Removable tubes with unions and Compression fittings
 - Tube replacement without welding or cutting
 - Hinged access door
 - Water Side Pressure drop is not a concern with rectangular CRE units.

- UM stamp standard
- Stainless steel interior shell
- Built in by-pass damper
 - Allow manual stack temperature control and heat adjustment
- Removable panels allow for complete cleaning
- Vertical or Horizontal Flow
- Built-stainless steel condensate pan and drain
- Mounting flanges for bolting to mating flanges or adapters
- Square pieces for transitions are 2x2 angle flanges

Exhaust Flow Direction

- CRE
 - Vertical or Horizontal
- CCE
 - Vertical Only

Target Stack Temperature

- Default: 310 – 330 Deg. F (84 - 84.5)
 - Selects Economizers that would produce an outlet flue gas temperature between 310 to 400
- 290 – 310 Deg. F (84.5 - 85)
 - Selects Economizers that would produce an outlet flue gas temperature between 290 to 310
- 275 – 290 Deg. F (85 plus)
 - Selects Economizers that would produce an outlet flue gas temperature between 275 to 290

Tube Construction

- 316L SS Tube w/Al-Fuse Fin
 - Standard Offering
 - Most efficient for the price
 - Higher Allowed Maximum Temperature than Duplex SS
- CS Tube / CS Fin, Nickel Braze
- Duplex SS Tube w/ Al-Fuse Fin

Selection Criteria

- Used to narrow down the Economizer Selections
- Best Payback
 - Best Heat Transfer Recovered versus Cost
- Lowest Price
 - Lowest Dollar Amount in selection range

Economizer Model

- Select economizer model
- Clarification Example: CCE-16A6AL
 - CCE – Model Type (CCE – Cylindrical; CRE – Rectangular)
 - 16 – Core Size (Ex.: 16, 18, 20, etc.)
 - CCE – Diameter; CRE – Length x Width
 - A – Number of Rows (Ex.: 6 = 6 Rows; 8 = 8 Rows; A = 10 rows, etc.)
 - Determines Economizer Height
 - 6 – Fin Spacing (per inch)
 - AL – Fin and Tube Construction
 - AL = 316L SS Tube w/ Al-Fuse Fin
 - DS = Duplex SS Tube w/ Al-Fuse Fin
 - CS = CS Tube / CS Fin, Nickel Brazed
- Total Height of Economizer with Transition Pieces
 - If (core size – vent size) ≥ 12
 - (Model Size – Vent Size) + 10 + Height of Economizer
 - If (core size – vent size) < 12
 - $5 \times 2 = 10$ + Height of Economizer

Economizer Model Displays

- Displays all of the information once an Economizer model is selected
- Economizer Weights and Dimensions
 - Links
 - CCE_Dims and Weights.pdf
 - CRE_Dims and Weights.pdf
- Sales Brochure Link
 - Links
 - CB-8089_Stack_Economizer_NL.pdf
- Dimensions – Charted DD's

- Links
 - [DD_CCE_06-08.pdf](#)
 - [DD_CCE_10-14.pdf](#)
 - [DD_CCE_16-20.pdf](#)
 - [DD_CCE_H2-J2.pdf](#)
 - [DD_CCE_L2-M2.pdf](#)
 - [DD_CRE_16-30_Flat Tran.pdf](#)
 - [DD_CRE_36-42_Angle Tran.pdf](#)
 - [DD_CRE_36-42_Flat Tran.pdf](#)
 - [DD_CRE_48_Angle Tran.pdf](#)
 - [DD_CRE_54-60_Angle Tran.pdf](#)
 - [DD_CRE_66-72_Angle Tran.pdf](#)
- Estimated Performance (Based on Fuel Series Selection)

Tab 3: Economizer Options**Standard Equipment**

- Designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, 'UM' Stamp
- Incorporates self-draining design.

Boiler Vent Mating Flanges and Gaskets

- Standard on CCE Model (Qty. 2)
- CRE Models Option

Flange Size (CB Mating Flange)	Mating Flange Gasket
6" I.D.	6" I.D.
8" I.D.	8" I.D.
10" I.D.	10" I.D.
12" I.D.	12" I.D.
16" I.D.	16" I.D.
18" I.D.	18" I.D.
20" I.D.	20" I.D.
24" I.D.	24" I.D.
32" I.D.	32" I.D.
36" I.D.	36" I.D.
42" I.D.	42" I.D.

Relief Valves

Cannot be sized any higher than the Design Pressure of the Economizer

- ¾" NPT ASME Relief Valve: 300 PSI
- ¾" NPT ASME Relief Valve: 400 PSI
- PRV Sized For
 - ¾" 300psi
 - Relieves 106 gpm
 - 880 lbs/min
 - 1" 300psi
 - Relieves 165 gpm
 - 1370 lbs/min
 - Criteria
 - Only way to build up pressure is if close off the valves and continue to run
 - Example: 227°F (5psi) ¾" 300psi relief
 - Raise to 300psi or 421°F

- Delta T = 196
- = 196 x 500 x 106gpm
- Relieves Over 10million btu/hr

Outdoor Coat – Paint

Required for outdoor insulations

Flue Gas Thermometer

- Recommend: (2) Two
- Gauge Mounting
 - Inlet – 2 pipe diameters away from inlet
 - Outlet – 2 pipe diameters away from outlet
 - Allows for mixing of the gas moving through the bypass damper and gas moving around the bypass damper to mix adequately for an accurate reading.

Flue Gas Thermometer
3" Dial; 150-750°F
3" Dial; 200-1000°F
3" Dial, Adjust. < 150-750°F
3" Dial, Adjust. <200-1000°F
5" Dial; 150-750°F
5" Dial 200-1000°F
5" Dial, Adjust. < 150-750°F
5" Dial, Adjust. <200-1000°F

Liquid Thermometer

- Recommend: (2) Two
- Gauge Mounting
 - Water (inlet and outlet)
 - Before and after the headers

Liquid Thermometer
3" Dial, bimetal 150-750 w/well
3" Dial, bimetal 50-300 w/well
3" Dial, bimetal 50-500 w/well

Timed Automatic Sootblower

The Timed Automatic Sootblower has a ring nozzle assembly that travels the length of the economizer while jetting steam at the finned tubes. The traveling action of the sootblower, along with the single row arrangement of the finned tubes, ensures coverage of the finned tubes by the steam jets. Maximum steam pressure to the sootblower is 100 psig, pressure reducing valve, if required, is to be supplied by others.

Select by Model and Core Size

- Ex: **CCE-108A**
 - Select if Model is CCE and Core Size is 08

Sizes

Timed Automatic Sootblower	Timed Automatic Sootblower
CCE-108A	CRE-114
CCE-110A	CRE-116A
CCE-114C	CRE-118B
CCE-116C	CRE-120B
CCE-118D	CRE-124C
CCE-120D	CRE-130E
CCE-124D	CRE-136H
CCE-130D	CRE-142G
CCE-136E	CRE-148H
	CRE-154H
	CRE-160L
	CRE-166N
	CRE-172T

Options

- NEMA 4 panel in lieu of NEMA 12
 - Only (1) Adder Required if a SCCA and a Sootblower is selected

Stack Corrosion Control Assembly

The Stack Corrosion Control Assembly (SCCA) automatically modulates the internal exhaust gas bypass to control the temperature of the cooled exhaust gas leaving the economizer. A desired minimum temperature is entered on the digital indicating controller. The controller has a continuous temperature display.

Includes

- Damper Actuator Factory Mounted
- One controller (Pre-Programmed)
- Thermocouple
- Thermocouple wire shipped loose.

Sizes

- Core Size 42 and Lower
- Core Size Larger than 42
 - SCCA 600"lbs Torque/120V./10S

Options

- NEMA 4 panel in lieu of NEMA 12
 - Only (1) Adder Required if a SCCA and a Sootblower is selected

Circulating Pump and Tank Systems:

- Only applicable to boilers with design pressures of 150 psig or less
 - Circulating pumps with higher pressure ratings
 - Not readily available to support higher design pressures
- Tanks are only rated to 200 psig.
 - Storage tank selections based on MBH of Economizer Recovery
- Circulating pump and tank systems consist:
 - (1) Pump kit assembly
 - (1) BTU Storage tank.
- The pump kit includes:
 - (1) circulating pump
 - (1) flow control valve
 - (1) check valve
 - (1) relief valve (for the storage tank, economizer relief valve is still required)
 - (1) pump controller
 - (2) Gas side thermometers.
 - Do not include Gas Side Thermometers Separately
 - Included in pump kit

Vent Extension

- Only Required for CBLE, 4WI, and CBR boilers.
- 2000lb. 12" Vent Stub Extension
- Available for 70 HP to 800 HP
- Additional support is needed to completely secure an Economizer

12" 2000lb. Vent Extension (Equivalent Horsepower)
70 HP to 100 HP
125 HP to 225 HP
250 HP to 350 HP
400 HP to 800 HP

Economizer Supports

- Option available within the Firetube Program (Tab: Pressure Vessel)

ASME Stamp / CRN

- ASME National Board "UM"
 - Standard
- ASME National Board Stamp – Sec. VIII; Div. I ('U')
- Optional
- Required (Water Volume is larger at the specified Design Pressure)
 - 1-1/2 ft³ @ 600psi (Design Pressure)
 - 3 ft³ @ 350psi (Design Pressure)
 - 5 ft³ @ 250psi (Design Pressure)
- ASME National Board Stamp – Sec. I ('S')
 - Optional
- CRN (Must Specify CRN Province)
 - Optional

International Orders

- Ship to Thomasville
- Export Packaging

Other offerings

- C1X
 - Single Stage Condensing Economizer
 - Process or Make-Up Water
 - Hot Water or Low Pressure Steam Application
- C2X
 - Two Stage Condensing Economizer
 - 1st Stage
 - Boiler Feedwater

BOILER EXHAUST ECONOMIZER SPECIFICATIONS

CRE Section VIII

1.0 GENERAL DESIGN

- 1.1 Furnish and install an exhaust gas economizer in the vertical exhaust duct of the boiler in accordance with the following specifications as designed and manufactured by Cain Industries, Inc.
- 1.2 The economizer shall be a light weight design for easier installation, rectangular, and manufactured and tested in accordance with the requirements of Section VIII, Division I of the ASME Boiler and Pressure Vessel Code.
- 1.3 The economizer shall be designed to include as standard, an internal, high temperature heat resistant design Flue Gas By-pass Diverter to provide for: emergency by-pass, requiring no additional duct work for controlling either:
 - A. Stack Corrosion
 - B. Turn Down Performance
 - C. Excessive flue gas back pressure due to fouling
- 1.4 The Economizer shall have a hinged, full face, gas tight, inspection door, providing access to the heating surface for inspection and/or cleaning.
- 1.5 The Economizer must be completely drainable when mounted in the vertical position or horizontal position.
- 1.6 Header manifolds for low liquid flow pressure drop shall be provided. The liquid header manifolds shall also contain 3/4" NPT connections for venting, draining, and/or safety relief valves as required.
- 1.7 Compression fitted Al-Fuse fin tubes shall be connected to header manifolds for ease of tube replacement requiring no welding.

2.0 CONSTRUCTION

- 2.1 Design Pressure: 300 psig @650°F.; Test Pressure: 450 psig; Max. Flue Gas Inlet Temperature: 750°F.
- 2.2 Fins: pitch 6 Fins/In. Max.; Material: Aluminum; Thickness: .020"; Height: .50"; Alfuse metallurgically bonded to the tube.
- 2.3 Tube: outside diameter: 1.0"; Wall Thickness: .065"; Material: TP316 Stainless steel ERW
- 2.4 Headers: material: SA106 Gr.B/ SA 53 Gr. B
- 2.5 2" thks. 1000°F thermofiber factory installed, high temperature insulation shall cover the shell less the header assemblies and stack adapters.
- 2.6 Exterior surfaces shall be 10ga. carbon steel and shall be primed and painted with a high temperature metallic paint rated for 1000°F. The inner shell shall be 304 stainless steel.

3.0 OPTIONAL EQUIPMENT

- 3.1 (2) 50-500°F, bimetal, 3" adjustable dial, water temperature thermometers with wells
- 3.2 (2) 150-750°F Bi-metallic flue gas temperature thermometers, 5" dial.

- 3.3 (1) 300 psig safety relief valve.

CRE Section I

1.0 GENERAL DESIGN

- 1.1 Furnish and install an exhaust gas economizer in the vertical exhaust duct of the boiler in accordance with the following specifications as designed and manufactured by Cain Industries, Inc.
- 1.2 The economizer shall be a light weight design for easier installation, rectangular, and manufactured and tested in accordance with the requirements of Section I of the ASME Boiler and Pressure Vessel Code.
- 1.3 The economizer shall be designed to include as standard, an internal, high temperature heat resistant design Flue Gas By-pass Diverter to provide for: emergency by-pass, requiring no additional duct work for controlling either:
- A. Stack Corrosion B. Turn Down Performance C. Excessive flue gas back pressure due to fouling
- 1.4 The Economizer shall have a hinged, full face, gas tight, inspection door, providing access to the heating surface for inspection and/or cleaning.
- 1.5 The Economizer must be completely drainable when mounted in the vertical position or horizontal position.
- 1.6 Header manifolds for low liquid flow pressure drop shall be provided. The liquid header manifolds shall also contain 3/4" NPT connections for venting, draining, and/or safety relief valves as required.
- 1.7 Tubes are welded to the header manifolds.

2.0 CONSTRUCTION

- 2.1 Design Pressure: 300 psig @650°F.; Test Pressure: 450 psig; Max. Flue Gas Inlet Temperature: 750°F.
- 2.2 Fins: pitch 6 Fins/In. Max.; Material: Carbon Steel; Thickness: .030"; Height: .50"; Nickel brazed/welded to the tube.
- 2.3 Tube: outside diameter: 1.0"; Wall Thickness: .083"; Material: SA178 Gr.A
- 2.4 Headers: material: SA106 Gr.B/ SA 53 Gr. B
- 2.5 2" thks. 1000°F thermofiber factory installed, high temperature insulation shall cover the shell less the header assemblies and stack adapters.
- 2.6 Exterior surfaces shall be 10ga. carbon steel and shall be primed and painted with a high temperature metallic paint rated for 1000°F. The inner shell shall be 304 stainless steel.

3.0 OPTIONAL EQUIPMENT

- 3.1 (2) 50-500°F, bimetal, 3" adjustable dial, water temperature thermometers with wells
- 3.2 (2) 150-750°F Bi-metallic flue gas temperature thermometers, 5" dial.
- 3.3 (1) 300 psig safety relief valve.

Notes

TWO STAGE ECONOMIZER PRODUCT GUIDE



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OVERVIEW

Cleaver-Brooks, the innovator in packaged boiler designs, introduces the C2X line of condensing economizers with the unique ability to maintain peak efficiency while firing different fuels and while liquid flow rates through the system vary from 0-100%. These SYSTEMS are unmatched in the industry and can deliver up to 95% fuel to steam efficiency.

The lower section of the economizer recovers energy by preheating the boiler feed water. The upper section preheats virtually any cool liquid stream (makeup water, wash water, hot water preheating, etc.) and the control system maximizes condensing when firing natural gas, then automatically switches to a near condensing mode when firing #2 oil (if applicable).

FEATURES AND BENEFITS

Reduces Fuel Use and Cost:

- Recovers heat from flue gases that would otherwise be wasted.
- Heat is used to raise boiler feedwater temperature prior to entering the boiler.
- Typical payback is less than one year

Load Changes:

- Rapid changes in load demands can be met faster due to higher feedwater temperature.

Emissions:

- Reduced fuel-firing rates for any given steam output means reduced NOx emissions.
- Reduce your fuel cost by up to 15% over a conventional steam boiler
- Reduce Greenhouse gas emissions by up to 15%

ASME Construction:

- Ensures high quality design and manufacturing standards.
- Provides safety and reliability.

High Efficiency Heat Exchanger:

- Provides uniform fin-to-tube contact for maximum heat transfer.
- Fin tubing offers up to 12 times the heat exchange surface of bare tubing of the same diameter.

Self-Draining Design:

- Suitable for outdoor installation.

Low Pressure Drop:

- Provides low gas side pressure drops.
- Permits use of smaller forced draft fans.
- Permits use of existing fans in almost all installations.

Gas Tight Combustion Stack:

- Stainless Steel casing.
- Compact dimensions provide for easy installation

Condensing Economizer Control Options

- Hawk ICS Advanced
 - 10" color HMI
- CEC200
 - 5.7" color HMI
 - 8 DI, 4 AI, 6 RO
- CEC100
 - 2" LCD
 - 8 DI, 4 AI, 6 RO

Application**1st Stage**

- Preheat Boiler Feedwater
 - Running Feedwater directly through the economizer (direct feedwater heating) – continuous run pump and modulating feedwater control is required.
- On/Off Feedwater Control
 - Convert to modulating control OR
 - Supply Circulating Pump and Tank System must be proposed
 - Circulating pump and tank systems are only available up to 150 lb boiler design pressure.
 - Storage Tank Selection
 - Based on MBH of Economizer Recovery
 - General rule of thumb is to pick 20-30 GPM for the circulating pump flowrate.
 - Minimum water flow rate through the economizer should be the maximum evaporation rate of the boiler.
- Add liquid temperature control assembly
 - ByPass Damper Open reduces the heat recovery by up to 50%
 - May need additional means of removing the excess heat within the system.

- Make-Up Water / Process Water Heating
 - Must have Minimum of 50% makeup to ensure a sufficient heat sink
 - Even with this guideline, flow may still be interrupted, which can cause steaming in the economizer.
 - Add a tank and pump upstream of the feedwater tank.
 - Then flow is not interrupted.
 - Recommend SS Headers (All SS Liquid Side)
 - Untreated Condensate – Carbonic Acid
 - MU Water – O₂ Corrosion
 - If water is less than 150°F, may recommend a C1X – Single Stage Condensing Economizer
- Hot Water Return
 - Supply Circulating Pump to draw water from, and return it to, the system hot water return.
 - Use approximately 2-3 gpm per economizer tube as the minimum water flow rate.
 - Note:
 - Saturated Steam Temp versus Feedwater Temperature
 - High Fire use lowest flow possible to keep a Temperature difference of 15 or 20°F below the sat. temp of the boiler
 - Supply Temperature + Boiler Delta T (LPS/HW) = Flue Gas Temp

2nd Stage

- Any Cool Liquid Stream (50 - 120 F)
 - Make-Up Water
 - Utilize the valve package and controls to feed water through the second stage and into the DA
 - Process Water
 - Circulating pump or storage tank may be needed.
 - Have to ensure continuous flow through the second stage when the boiler is in operation
 - Wash Water
 - Circulating pump or storage tank may be needed.
 - Have to ensure continuous flow through the second stage when the boiler is in operation
 - Hot Water Preheating
 - Supply Circulating Pump to draw water from, and return it to, the system hot water return.
 - Use approximately 2-3 gpm per economizer tube as the minimum water flow rate.

GUIDE

Tab 1: Application Data

Number of Boilers fed by DA

- The number of boilers selected determines the options for controls
- 1 Boiler is selected an existing Hawk, new Hawk, or CEC controller can be utilized
- Greater than 1 boiler requires a separate CEC-20x controller to monitor the economizer

Boiler Model Selection

- Select the correct Cleaver Brooks boiler model.
- For non Cleaver Brooks models select "Other"

Fuel Series

- Natural Gas Only:
 - Condense Temperature ~140°F
- Natural Gas and/or #2 Oil:
 - Natural Gas Condense Temp ~140°F
 - #2 oil Condense Temperature: ~180°F
 - Note: Economizer CANNOT be using the Condensing Mode when firing #2 Oil

Flue Gas Temperatures

- Predicted Values are Calculated
- Can override the Defaulted Value

Feedwater Temperature

- Minimum Temperature: 200°F
- Maximum Temperature: 230°F

2nd Stage Inlet Water Type

- Options
 - Make Up, Percentage
 - Process, gpm

2nd Stage Inlet Water

- Make Up, Percentage
 - Minimum: 50
 - Maximum: 200
- Process, gpm
 - Minimum: 50% of Feedwater Flow Rate (gpm)
 - Maximum: 200% of Feedwater Flow Rate (gpm)

2nd Stage Inlet Water Temperature

- Minimum: 50°F
- Maximum: 110°F

Exhaust Flow Direction

- Options:
 - Vertical
 - Horizontal
- Default: Vertical

Tab 2: Economizer Selection**Boiler Data Display**

- Display field in the upper left corner
- Shows the Boiler Information formed from Tab 1 Selections

Model Selection

- C2X Economizer model is selected based on Horsepower
 - 100-2200 HP high pressure
- C2X Features
 - All upper coil components are 316 stainless steel
 - All gas side surfaces are 316 stainless steel to eliminate corrosion
 - Tube core assemblies are individually removable and made from 316 stainless steel tube with Aluminum fins (Al-Fuse)
 - Tube to header connections are externally located compression fitting, no welding is required for tube replacements
 - 316 stainless steel exhaust gas bypass, interior shell, condensate drain, and transition connections
 - 2" of factory insulation, inlet/outlet gaskets, ASME relief valves, and drain are included
 - Hinged, full face access door for inspecting
 - ASME Stamp-SEC.VIII:DIV.I("UM")
 - Removable tubes with unions and Swagelok fittings
 - Tube replacement without welding or cutting
 - Hinged access door
 - UM stamp standard
 - Removable panels allow for complete cleaning
 - Built-stainless steel condensate pan and drain
 - Built in by-pass damper
 - Allow manual stack temperature control and heat adjustment
 - Standard design pressure of 300 psig – higher pressures are also available
 - 12 gauge 316 stainless steel exterior

- Internal bypass for W.C. back pressure control
- The upper coil, lower coil, modulating valves, control system and other system components are sized as a system to deliver the maximum possible cost savings.

Boiler HP	Economizer Model	Length (in.)	Width (in.)	Height (in.)	Liquid Conn.	Surface Area (ft ²)	Dry Wt. (lbs.)	Wet Wt. (lbs.)
100	C2X-K3466AL	52	43	43.92	2"	635	1105	1166
125	C2X-K36a6AL	52	43	59	2"	1079	1545	1647
150	C2X-K37C6AL	52	43	67.6	2"	1335	1805	1931
200	C2X-K3Ac6AL	52	43	76.3	2"	1590	2045	2195
300	C2X-M38B6AL	70	58	65.5	2"	1907	2401	2575
400	C2X-M3Ac6AL	70	58	76.3	2"	2383	2861	3078
500	C2X-R3Ac6AL	80	66	76.3	2.5"	2780	3255	3501
600	C2X-R3BE6AL	80	66	87	2.5"	3337	3785	4080
700	C2X-S3BE6AL	88	73	87	2.5"	3813	3995	4336
800	C2X-S3Cf6AL	88	73	97.8	2.5"	4450	4601	4998
900	C2X-T3Df6AL	98	82	102.14	2.5"	5291	5455	5952
1000	C2X-T3DH6AL	98	82	108.6	2.5"	5720	5865	6402
1100	C2X-T3Ei6AL	98	82	119.4	2.5"	6435	6555	7159
1200	C2X-U3DH6AL	106	90	108.6	2.5"	6355	6415	6999
1300	C2X-U3EI6AL	106	90	119.4	2.5"	7150	7175	7831
1400	C2X-U3FK6AL	106	90	130.17	2.5"	7945	7935	8664
1500	C2X-U3GI6AL	106	90	141	2.5"	8740	8695	9534
1800	C2X-U3HN6AL	106	90	151.7	2.5"	9535	9455	10370
2200	C2X-U3JQ6AL	106	90	173.3	2.5"	11123	10975	12041

Economizer Model Displays

- Displays all of the information once an Economizer model is selected
 - Economizer Weights and Dimensions
 - Natural Gas Estimated Performance

Tab 3: Economizer Options

Relief Valves

- Recommend
 - (1) 1st Stage
 - ¾" NPT ASME Relief Valve: 300psig
 - Default: 150 Desig Pressure
 - ¾" NPT ASME Relief Valve: 400psig
 - Default: 200ST, 250ST
 - (1) 2nd Stage
 - ¾" NPT ASME Relief Valve: 300psig
 - Default

Economizer Design Pressure

- If 3/4" NPT ASME Relief Valve: 300psig Selected
 - 1st Stage: 300psig / 2nd Stage: 300psig
- If 3/4" NPT ASME Relief Valve: 400psig Selected
 - 1st Stage: 400psig / 2nd Stage: 300psig

Boiler Vent Mating Flanges and Gaskets

- C2X Models Option

Flange Size (CB Mating Flange)	Mating Flange Gasket
12" I.D.	12" I.D.
16" I.D.	16" I.D.
18" I.D.	18" I.D.
20" I.D.	20" I.D.
24" I.D.	24" I.D.
32" I.D.	32" I.D.
36" I.D.	36" I.D.
42" I.D.	42" I.D.

Modulating MakeUp Valve

- Modulating Make-Up ByPass, 1/2" NPT, N.C. Valve
- Recommended in Make-Up Flow applications
 - Valve diverts Make-Up Water into the second stage to help prevent steaming
- Not Required for Process Flow Applications

3-Way Condensate ByPass Valve V3 (Three Way Diverting Valve)

- Recommended in Make-Up Flow Applications
- Diverts Condensate to the Second Stage when Steaming is sensed
- Size Based on Specified Pressure Drop and Boiler Flow Rate
 - Pressure Drop
 - Minimum: 5psi
 - Maximum: 20psi
 - Optional Sizes
 - 1" NPT (Cv = 10)
 - 1-1/4" NPT (Cv = 16)
 - 1-1/2" NPT (Cv = 25)
 - 2" NPT (Cv = 40)
 - 2-1/2" NPT (Cv = 63)

Flow Balancing Valves

- Recommended in Make-Up Flow and Multiple Boiler/Economizer Applications
- Require (1) Valve per Economizer
- Ensures consistent flow to the Second Stage of Multiple Economizers
- Size Based on Specified Pressure Drop and Boiler Flow Rate
 - Pressure Drop
 - Minimum: 5psi
 - Maximum: 20psi
 - Optional Sizes
 - 1/2" NPT (Cv = 26)
 - 3/4" NPT (Cv = 55)
 - 1" NPT (Cv = 110)
 - 1-1/4" NPT (Cv = 180)
 - 1-1/2" NPT (Cv = 270)
 - 2" NPT (Cv = 500)

Transmitters

- Water Temperature Transmitter 0-1000F
 - Recommend: (4) Four
- Gas Temperature Transmitter 0-1000F
 - Recommend: (2) Two

Controls

- CEC-10x (x – Specifies the Number of Boilers)
 - Utilized for (1) Economizer or Retrofit Applications
 - LCD Text Display
- CEC-20x (x – Specifies the Number of Boilers)
 - Utilized for 1 – 4 Economizer Application
 - LCD 6" Touch Color Display
- Hawk
 - Utilized for (1) Economizer Application
 - Existing or New Hawk can be Utilized

Vent Extension

- Only Required for CBLE, 4WI, and CBR boilers.
- 2000lb. 12" Vent Stub Extension
- Available for 70HP to 800 HP
- Additional support is needed to completely secure an Economizer

12" 2000lb. Vent Extension (Equivalent Horsepower)
70 HP to 100 HP
125 HP to 225 HP
250 HP to 350 HP
400 HP to 800 HP

Outdoor Coat – Paint

- Required for outdoor insulations

Economizer Supports

- Option available within the Firetube Program (Tab: Pressure Vessel)

ASME Stamp / CRN

- ASME National Board “UM”
 - Standard
- ASME National Board Stamp – Sec. VIII; Div. I (‘U’)
 - Optional
 - Required (Water Volume is larger at the specified Design Pressure)
 - 1-1/2 ft³ @ 600psi (Design Pressure)
 - 3 ft³ @ 350psi (Design Pressure)
 - 5 ft³ @ 250psi (Design Pressure)
- ASME National Board Stamp – Sec. I (‘S’)
 - Optional
- CRN (Must Specify CRN Province)
 - Optional

International Orders

- Ship to Thomasville
- Export Packaging

Other offerings

- CRE or CCE
 - Single Stage (Non-Condensing) Economizer
 - Boiler Feedwater, Hot Water Return, Make-Up Water
- C1X
 - Single Stage Condensing Economizer
 - Process or Make-Up Water
 - Hot Water of Low Pressure Steam Application

TWO STAGE (C2X) BOILER EXHAUST ECONOMIZER SPECIFICATIONS

1.0 GENERAL DESIGN

- 1.1 Furnish and install an exhaust gas economizer in the exhaust duct of the boiler in accordance with the following specifications as designed and manufactured by Cain Industries, Inc.
- 1.2 The economizer shall be a light weight design for easier installation, rectangular, and manufactured and tested in accordance with the requirements of Section VIII, Division I of the ASME Boiler and Pressure Vessel Code.
- 1.3 The economizer shall have two liquid circuits. The circuit closest to the entering exhaust gas shall be used to preheat boiler feedwater. The circuit closest to the exiting exhaust gas shall be used to heat boiler make-up water or process water.
- 1.4 The economizer shall be designed to include as standard, an internal, high temperature heat resistant design Flue Gas By-pass Diverter to provide for: emergency by-pass, requiring no additional duct work for controlling either:
A. Stack Corrosion B. Turn Down Performance C. Excessive flue gas back pressure due to fouling
- 1.5 The Economizer shall have a hinged, full face, gas tight, inspection door, providing access to the heating surface for inspection and/or cleaning.
- 1.6 The Economizer must be completely drainable when mounted in the vertical position or horizontal position.
- 1.7 Header manifolds for low liquid flow pressure drop shall be provided. The liquid header manifolds shall also contain 3/4" NPT connections for venting, draining, and/or safety relief valves as required.
- 1.8 Compression fitted Al-Fuse fin tubes shall be connected to header manifolds for ease of tube replacement requiring no welding.

2.0 CONSTRUCTION

- 2.1 Feedwater section: Design Pressure: 300 psig @650°F.; Test Pressure: 450 psig; Max. Flue Gas Inlet Temperature: 750°F.
- 2.2 Make-up water section: Design Pressure: 150 psig @550°F.; Test Pressure: 225 psig; Max. Flue Gas Inlet Temperature: 750°F.
- 2.3 Fins: pitch 6 Fins/In. Max.; Material: Aluminum; Thickness: .020"; Height: .50"; Alfuse metallurgically bonded to the tube.
- 2.4 Tube: outside diameter: 1.0"; Wall Thickness: .065"; Material: TP316 Stainless steel ERW
- 2.5 The Feedwater header manifolds are constructed of carbon steel. The make-up/process water header manifolds are constructed of 304 stainless steel. All of the make-up/process water liquid side surfaces are stainless steel.
- 2.6 2" thks. 1000°F thermofiber factory installed, high temperature insulation shall cover the shell less the header assemblies and stack adapters.
- 2.7 Exterior surfaces shall be 12ga. 304 stainless steel and shall be primed and painted with a high temperature metallic paint rated for 1000°F. The inner shell shall be 304 stainless steel.
- 2.8 (2) Stainless steel economizer to stack adapters are included.

3.0 OPTIONAL EQUIPMENT

- 4.1 (2) 50-500°F, bimetal, 3" adjustable dial, water temperature thermometers with wells.
- 4.2 (2) 50-300°F, bimetal, 3" adjustable dial, water temperature thermometers with wells.
- 4.3 (2) 150-750°F Bi-metallic flue gas temperature thermometers, 3" dial.
- 4.4 (1) 300 psig safety relief valve.
- 4.5 (1) 150 psig safety relief valve.

CONTINUOUS BLOWDOWN SYSTEM PRODUCT GUIDE



Overview

Proportional blowdown heat recovery system is designed to operate with either an atmospheric boiler feed system or a deaerator.

- Model BDHR-S Series for single boiler applications.
- Model BDHR-M Series for multiple boiler applications.

Notes and Conditions

- Minimum Operating Pressure is 35 psig
- Maximum Operating Pressure is 250 psig
- A system can manage 1 – 6 boilers as described below.
- A surface blowdown tap on the boiler must exist and be used for this system.

FEATURES AND BENEFITS

BDHR-S and BDHR-M Series (High Pressure Steam Applications)

Integrated System Automatically Adjusts to Changing Demands:

- Recovers 90% of heat normally lost
- Automatically controls surface blowdown flow to maintain the desired concentration of dissolved solids within the boiler
- Automatically controls boiler dissolved solids
- Compact Size for Convenient Placement
- Reduced installation costs
- Removable Shell for Easy Inspection and Cleaning
- Reduces maintenance costs
- Significant Fuel Savings for Any Size Boiler
- Transfers the blowdown heat to the make-up, thereby decreasing fuel costs
- Saves chemical costs by reducing blowdown
- Blowdown is Cooled Before Discharging Into the Sewer
- Complies with discharge water codes

PRODUCT OFFERING

BDHR-S and BDHR-M Series

Continuous boiler surface blowdown is the most effective method of purging destructive solids from any steam boiler system. However, this protective procedure also results in a constant and costly heat loss, unless a blowdown heat recovery system is used.

Cleaver-Brooks blowdown/heat recovery systems adjust automatically to changing system demands, and recover 90% or more of the heat normally lost during boiler surface blowdown operation.

The blowdown/heat recovery systems will usually result in a payback in a few short months from fuel savings alone. Refer to Figure H12-1 for selection and payback calculations.

The Cleaver-Brooks Packaged Blowdown Heat Recovery System serves two primary functions.

1. It automatically controls the surface blowdown to maintain the desired level of total dissolved solids (TDS) in the boiler, reducing the amount of blowdown to a minimum.
2. It recovers the heat from the high temperature blowdown, and transfers it to the incoming cold make-up water, maximizing boiler efficiency. Use of BDHR also improves deaerator efficiency by reducing surges caused by adding large amounts of cold make-up water to the system.

The control valve within the unit performs two functions. The valve senses the flow of make-up, and positions itself to maintain the desired ratio of blowdown and make-up flows. As a result, the dissolved solids concentration within the boiler is maintained automatically.

The proportioning control also provides for very effective heat recovery since hot blowdown flows only when there is a corresponding flow of cold water (make-up).

Model BDHR-M Systems for multiple boiler installations include a flow control valve for each boiler. This allows for proportioning the overall system blowdown between different boilers, which may be operating at different loads. A strainer and sampling valve are also provided for each boiler, with a sample cooler mounted on the system. Thus, all boilers can be sampled at one convenient location.

The heavy duty blowdown heat exchangers are uniquely designed to handle the blowdown on the tube side. This allows many tube side passes, which ensures maximum heat transfer, and maintains high fluid velocities preventing scaling and fouling. Due to the severe service, tubes are stainless steel, and because of the abrasive nature of the fluid, return bends are fabricated of extra thick material. Since vibration is a common problem with blowdown exchangers, hold down devices are provided to clamp the tube bundle in place.

Each system is equipped with a blowdown outlet thermometer so that performance can be monitored. By logging data regularly, a cleaning schedule can be established for each exchanger.

Package Description

The single boiler package consists of the following equipment:

- Thermostatic control
- Heat exchanger

- Thermometer
- Interconnecting pipe

The multiple boiler packages consist of the following equipment:

- Thermostatic control
- Heat exchanger
- Flow control valves
- Sample cooler
- Valve assemblies
- Thermometer
- Interconnecting pipe

All systems include an ASME “U” stamp for the heat exchanger

Packages

Model Number	Blowdown Total Max Capacities (gpm)	Make-up Total Max Capacities (gpm)	Shipping Weight (lbs.)
BDHR-2S	2	48	200
BDHR-4S	4	48	300
BDHR-9S	9	130	600
BDHR-14S	14	130	760
BDHR-22S	22	180	900

Blowdown system for one boiler

Model Number	Blowdown Total Max Capacities (gpm)	Make-up Total Max Capacities (gpm)	Shipping Weight (lbs.)
BDHR-2M-2	2	48	275
BDHR-4M-2	4	48	380
BDHR-9M-2	9	130	700
BDHR-14M-2	14	130	870
BDHR-22M-2	22	180	1,025

Blowdown system for two boilers

Model Number	Blowdown Total Max Capacities (gpm)	Make-up Total Max Capacities (gpm)	Shipping Weight (lbs.)
BDHR-2M-3	2	48	300
BDHR-4M-3	4	48	400
BDHR-9M-3	9	130	720
BDHR-14M-3	14	130	880
BDHR-22M-3	22	180	1,050

Blowdown system for three boilers

Model Number	Blowdown Total Max Capacities (gpm)	Make-up Total Max Capacities (gpm)	Shipping Weight (lbs.)
BDHR-4M-4	4	48	400
BDHR-9M-4	9	130	720
BDHR-14M-4	14	130	880
BDHR-22M-4	22	180	1,050

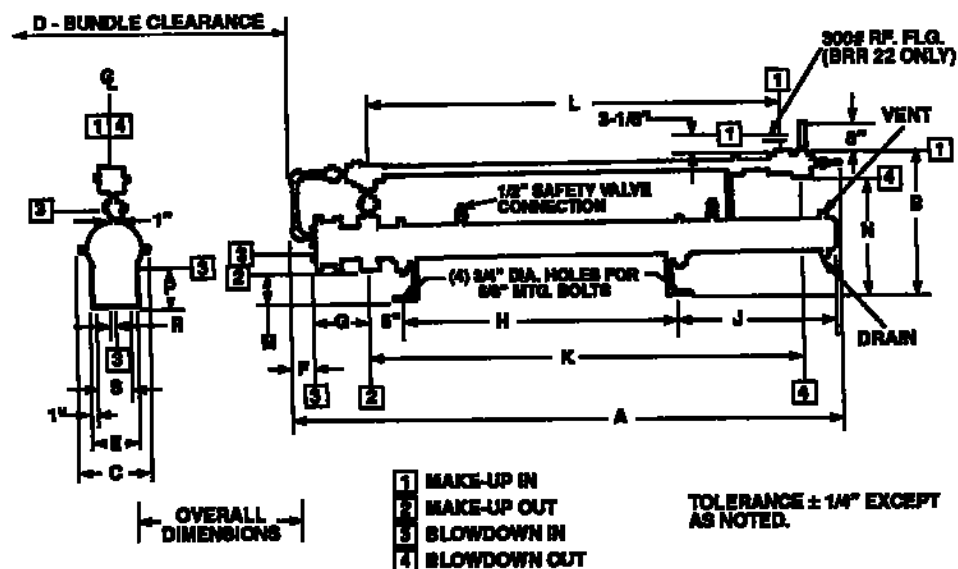
Blowdown system for four boilers

Model Number	Blowdown Total Max Capacities (gpm)	Make-up Total Max Capacities (gpm)	Shipping Weight (lbs.)
BDHR-9M-5	9	130	750
BDHR-14M-5	14	130	925
BDHR-22M-5	22	180	1,060

Blowdown system for five boilers

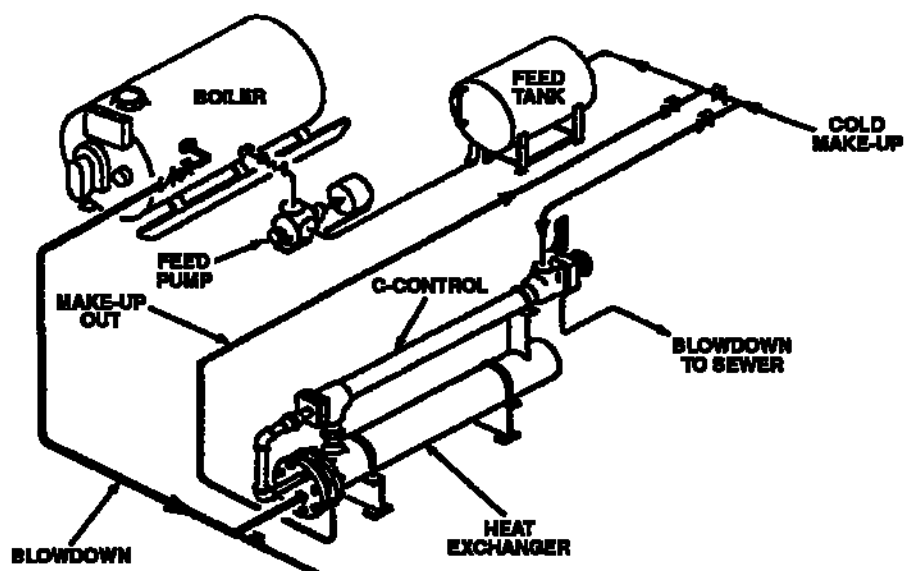
Model Number	Blowdown Total Max Capacities (gpm)	Make-up Total Max Capacities (gpm)	Shipping Weight (lbs.)
BDHR-22M-6	22	180	1,070

Blowdown system for six boilers



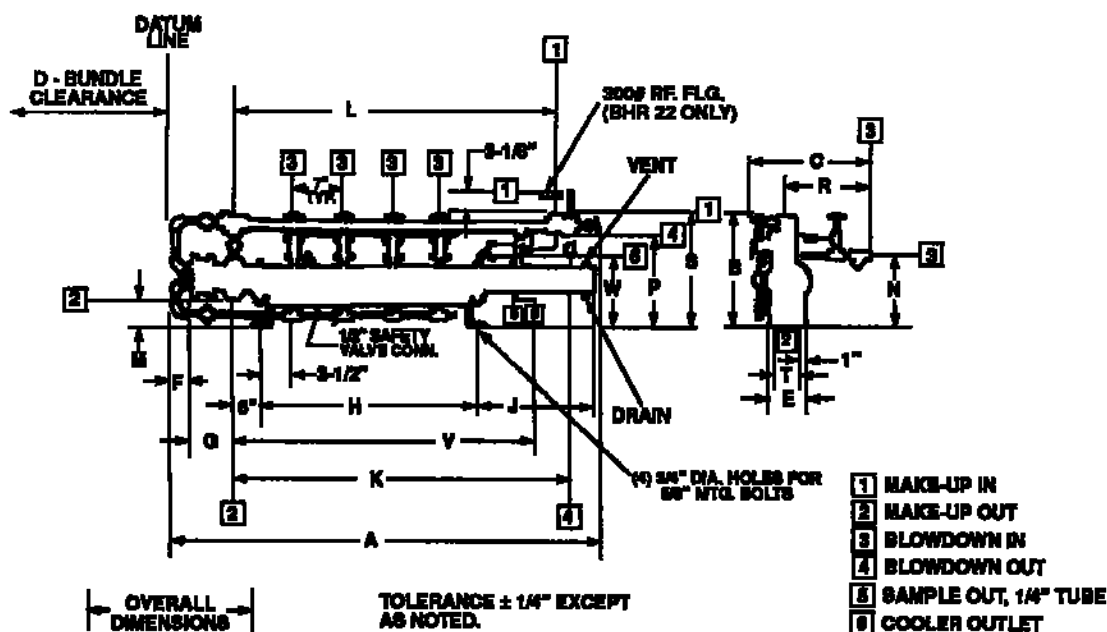
MODEL BDHR-S SERIES DIMENSIONS					
MODEL NO.	BDHR-2S	BDHR-4S	BDHR-9S	BDHR-14S	BDHR-22S
A REF	54-1/2	81-1/2	84	127	128
B	20-1/2	20-1/2	23-1/2	23-1/2	33
C REF	8	8	10	10	12-1/2
D REF	28	64	64	100	100
E REF	7	7	9-1/8	9-1/8	11-1/8
F EF	5-1/2	5-1/2	5-1/2	5-1/2	6
G	7-1/2	7-1/2	8	8	9-1/2
H + 1/8	16-1/2	38-1/2	38-1/2	64-1/2	64-1/2
J REF	9	22-3/4	22-3/4	33-1/2	31-1/2
K	35-3/4	62-5/8	62-5/8	107-1/2	105
L	33	60	60	105	96-1/2
M	4-1/2	4-1/2	4-3/8	4-3/8	4
N	16-1/2	16-1/2	19-1/2	19-1/2	24-1/2
P	7	7 7 7			7-1/2
R	1/2	1/2	*	*	3/4
S + 1/8	5	5	7-1/8	7-1/8	9-1/8
CONNECTIONS					
1	1-1/2 FPT	1-1/2 FPT	2 FPT	2 FPT	3FLG
2	1-1/2 FPT	1-1/2 FPT	2 FPT	2 FPT	3 FPT
3	3/4 FPT	3/4 FPT	3/4 FPT	3/4 FPT	1 FPT
4	3/4 FPT	3/4 FPT	3/4 FPT	3/4 FPT	1 FPT

Figure H12-2. Model BDHR-S Dimensions



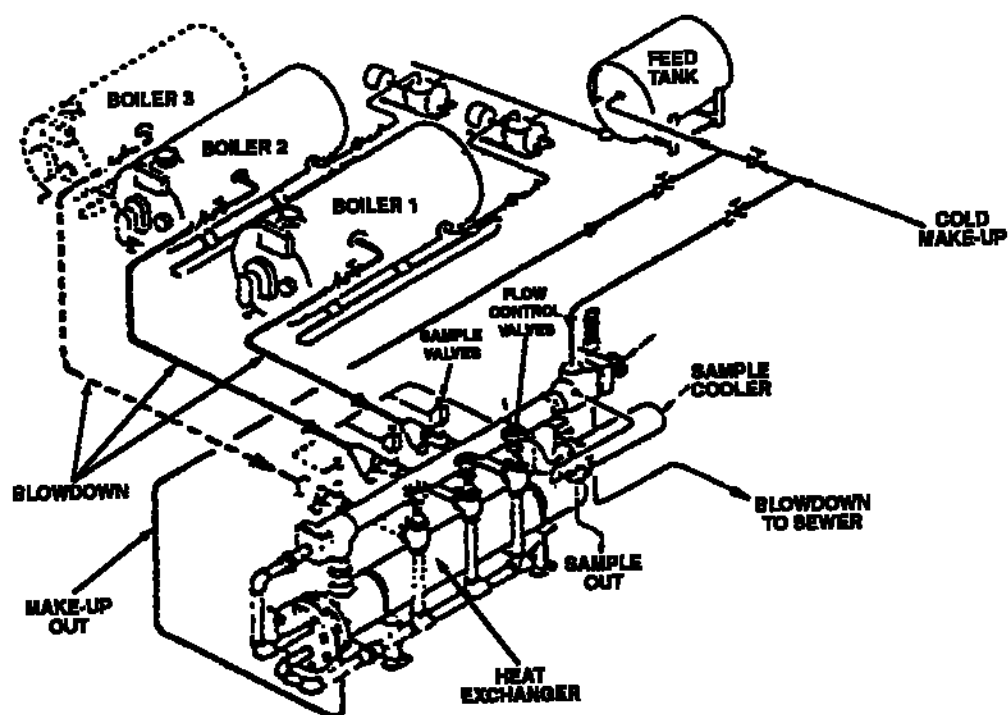
MAXIMUM CAPACITIES (GPM)		
Model No.	Blowdown	Make up
BDHR-2S	2	48
BDHR-4S	4	48
BDHR-9S	9	130
BDHR-14S	14	130
BDHR-22S	22	180

Figure H12-3. Model BDHR-S Ratings/Capacities



MODEL BDHR-M SERIES DIMENSIONS					
MODEL	BDHR-2M	BDHR-4M	BDHR-9M	BDHR-14M	BDHR-22M
MAX NO.OF BOILERS	4	4	5	5	6
A REF	54-1/2	81-1/2	84	127	128
B REF	22	22	24	24	28
C REF	19-1/4	17-1/4	18-1/2	18-1/2	19-1/2
D REF	28	64	64	100	100
E EF	7	7	9-1/8	9-1/8	11-1/8
F REF	5-1/2	5-1/2	5-1/2	5-1/2	6
G	7-1/2	7-1/2	8	8	9-1/2
H + 1/8	16-1/2	38-1/2	38-1/2	64-1/2	64-1/2
J REF	9	22-3/4	22-3/4	33-1/2	31-1/2
K	35-3/4	62-5/8	62-5/8	107-1/2	105
L	33	60	60	105	96-1/2
M	4-1/2	4-1/2	4-3/8	4-3/8	4
N	14	14	16	16	20
P	13-1/2	13-1/2	15-1/2	15-1/2	21
R	11-1/2	11-1/2	11-1/2	11-1/2	11-1/2
S	20-1/2	20-1/2	23-1/2	23-1/2	33
T + 1/8	5	5	7-1/8	7-1/8	9-1/8
V	25-1/2	61-1/4	61-1/4	92-1/4	95-3/4
W	15-1/2	15-1/2	18	18	22-1/2
CONNECTIONS					
1	1-1/2 FPT	1/1/2 FPT	2 FPT	2 FPT	3 FPT
2	1-1/2 FPT	1-1/2 FPT	2 FPT	2 FPT	3 FPT
3	3/4 FPT	3/4 FPT	3/4 FPT	3/4 FPT	3/4 FPT
4	3/4 FPT	3/4 FPT	3/4 FPT	3/4 FPT	1 FPT
6	1/4 FPT	1/4 FPT	1/4 FPT	1/4 FPT	1/4 FPT

Figure H12-4. Model BDHR-M Dimensions



MAXIMUM CAPACITIES (GPM)		
MODEL	BLOWDOWN	MAKE-UP
BDHR-2M	2	48
BDHR-4M	4	48
BDHR-9M	9	130
BDHR-14M	14	130
BDHR-22M	22	180

Figure H12-5. Model BDHR-M Ratings/Capacities

Freight

Pricing is based upon F.O.B. factory - Oconomowoc, WI 53066



DIVISION OF AQUA-CHEM, INC.
P O BOX 421 • MILWAUKEE, WIS. 53201

BLOWDOWN HEAT RECOVERY SYSTEM SELECTION & PAYBACK

Job Name _____ Sales Agency _____

Location _____ Date _____

CAUTION: BHR SYSTEMS ARE FOR BOILER PSIG OF 35 MINIMUM TO 250 MAXIMUM.

1.0 DEFINITIONS/DATA:

- 1.1 THERM = 100,000 BTU.
- 1.2 Steaming Rate Lbs./Hr = (34.5) (Max HP Usage).
- 1.3 Lbs. Water/Hr ÷ 500 = GPM.
- 1.4 MU = Makeup.
- 1.5 BD = Blowdown.
- 1.6 TDS = Total Dissolved Solids.
- 1.7 $C = \text{Concentration} = \frac{\text{Boiler TDS} - \text{Gross MU}}{\text{MU TDS} - \text{BD}}$
- 1.8 Net MU = (Max Lbs/Hr) (1 - Fraction Ret'd Condensate).
- 1.9 Gross MU = Net MU + BD.

1.10 Saturated Steam Tables

PSIG	TEMP °F
75	320
90	331
100	338
125	353
150	366
175	377
200	388
250	406

2.0 BOILER OPERATING CONDITIONS (obtained from Owner)

Par →	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Boiler No.	Max HP Usage	Steam, Max Lbs/Hr	Operating PSIG	Operating Temp °F	Fraction Returned Condensate	Boiler Eff. %	MU Temp °F	ppm MU TDS	Operating Hrs/Yr
1									
2									
3									
4									
TOTAL									

3.0 FUEL DATA (obtained from Owner): % Gas = _____ ; % Oil = _____

3.1 Gas Cost _____ = \$ _____ /THERM

3.2 Oil Cost = (\$____/Gal) (100000) ÷ (150000 BTU/Gal) = \$ _____ /THERM

3.3 Average Cost = (Fraction Gas) (Gas Cost) + (Fraction Oil) (Oil Cost) = \$dollars/THERM.
Average Cost = (_____) (_____) + (_____) (_____) = \$ _____ /THERM.

4.0 BOILER TDS LEVEL REQ'D (obtained from Owner) = _____ ppm

5.0 C (Concentrations) = $\frac{\text{TDS Boiler} - \text{Par 4.0}}{\text{TDS MU} - \text{Par 2.8}}$ = _____ C

6.0 NET MU = (Max Lbs/Hr) (1 - Fraction Returned Condensate)
NET MU = (Par 2.2) (1 - Par 2.5) = (_____) (_____) = _____ Lbs/Hr.

7.0 BD = $\frac{\text{Net MU}}{(C-1)}$ = $\frac{(\text{Par 6.0})}{(\text{Par 5.0}-1)}$ = _____ Lbs/Hr = _____ GPM

8.0 GROSS MU = (Net MU) + (BD) = (Par 6.0) + (Par 7.0) = (_____) + (_____) = _____ Lbs. Hr.
= _____ GPM





DIVISION OF AQUA-CHEM, INC.
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BLOWDOWN HEAT RECOVERY SYSTEM SELECTION & PAYBACK

9.0 EQUIPMENT SELECTION TABLE

9.1 Select Model with maximum GPM capacities which are adequate for the GPM of BD (Par 7.0) and Gross MU (Par 8.0). DO NOT EXCEED MAX GPM VALUES FOR MODELS TO AVOID DAMAGING EROSION AND VIBRATION.

9.2 Where practical, select next larger size because:

- (a) Larger sizes will better accommodate MU surges caused by large and abrupt steam demands, and . . .
- (b) Larger sizes recover more BD energy, and
- (c) Systems have a sufficiently fast Payback and high ROI to cost justify the added first costs of larger systems.

9.3 Table of Models, BHR SYSTEMS:

Model	Max BD GPM	Max Gross MU GPM	MU Pressure Drop at Max GPM
BHR-2	2 GPM	48 GPM	1.5 PSI
BHR-4	4 GPM	48 GPM	2.0 PSI
BHR-9	9 GPM	130 GPM	7.5 PSI
BHR-14	14 GPM	130 GPM	10.0 PSI
BHR-22	22 GPM	180 GPM	3.5 PSI

10.0 MODEL SELECTED = _____ (using Par 9.3).

11.0 HEAT RECOVERY EFFICIENCY (at Par 7.0 BD GPM & Par 5.0 "C" value) = _____
(reference Efficiency curves, Par 18.0 Page 3)

12.0 HEAT RECOVERED = (Efficiency (BD Lbs/Hr) (Opert Temp - MU Temp)
= (Par 11.0) (Par 7.0) (Par 2.4-Par 2.7) ÷ (100000)
= () () () ÷ (100000)
= _____ THERMS/Hr.

13.0 ENERGY SAVED = (Heat Recovered) ÷ (% Boiler Efficiency - 100)
= (Par 12.0) ÷ (Par 2.6 ÷ 100)
= () ÷ () = _____ THERMS/Hr.

14.0 \$ SAVINGS/YEAR = (Energy Saved) (Hrs/Year) (Fuel Cost)
= (Par 13.0) (Par 2.9) (Par 3.3)
= () () () = \$ _____ /Yr.

15.0 \$ EQUIPMENT COST (from pricing date) = \$ _____

16.0 PAYBACK IN YEARS = (Equipment Cost) ÷ (\$ Savings per Year)
= (Par 15.0) ÷ (Par 14.0)
= () ÷ () = _____ Yrs = _____ Mos.

17.0 % RETURN ON INVESTMENT = (100) (\$ Savings per year) ÷ (\$ Equipment Cost)
= (100) (Par 14.0) ÷ (100) () = _____ %
(Par 15.0) ()

BLOWDOWN HEAT RECOVERY SYSTEMS

SAMPLE SPECIFICATIONS

CONTENTS

GENERAL.....	H12-13
BDHR-S SERIES.....	H12-13
BDHR-M SERIES	H12-14

PART 1 GENERAL

1.1 GENERAL

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's requirements.

PART 2 PRODUCTS

2.1 BDHR-S SERIES

- A. Furnish _____ Cleaver-Brooks Model BDHR-S Package blowdown heat recovery system designed to handle a maximum blowdown rate of _____ gpm (2 to 22) and a maximum make-up rate of _____ gpm (48 to 180).
- B. The heat recovery system shall be designed for a boiler of _____ hp (150 - 1500), hp operating at _____ psig (35 to 250). The unit shall be designed to cool the blowdown to within 30 °F of the make-up water temperature. The unit shall have a 250 psig rating at 400 °F.
- C. The heat recovery system shall consist of a differential temperature control valve that shall automatically regulate the blowdown of make-up flow. The flow of blowdown shall be regulated by the thermal expansion of the inner brass tube pressing against a valve seat. The inner tube will contract only when cold make-up water passes through the brass jacketed steel outer tube shell, allowing the blowdown to cool and go out the exchanger.
- D. The system shall also have a heat exchanger, including a removable U-tube bundle manufactured of 19 gauge, 304 stainless steel tubes and steel sideshell with hold down clamps to stop tube bundle vibration. The vessel shall be ASME code stamped for 250 psig at 400°F. The system shall have interconnecting piping of steel and stainless steel. The exchanger shall have a minimum sq-ft of surface area. The flow of the blowdown make-up shall flow in opposite directions for maximum heat transfer efficiency of _____ percent.
- E. A heat treated stainless steel valve seat and plunger shall manually control the blowdown flow by a handwheel.
- F. A blowdown thermometer Weksler Type 152 shall be furnished at the blowdown outlet.

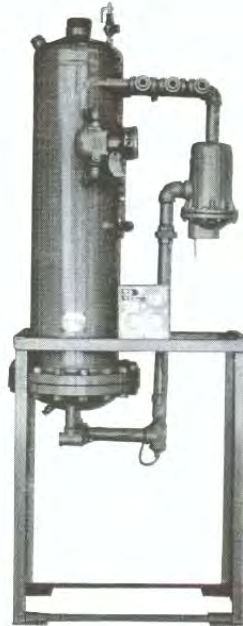
- G. The entire system shall be supported by steel channel legs with 3/4" diameter holes for customer-supplied 5/8" diameter anchor bolts.
- H. The system will be painted with a hard enamel coating.

2.2 BDHR-M SERIES

- A. The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's requirements.
- B. Furnish _____ Cleaver-Brooks Model BDHR-M package blowdown heat recovery system designed to handle a maximum blowdown rate of _____ gpm (2 to 22) and a maximum make-up rate of _____ gpm (48 to 180).
- C. The heat recovery system shall be designed for boilers of _____ hp (250 - 1500), hp operating at _____ psig (35 to 250). The unit shall be designed to cool the blowdown to within 30 °F of the make- up water temperature. The unit shall have a 250 psig rating at 400°F
- D. The heat recovery system shall consist of a differential temperature control valve that shall automatically regulate the blowdown and make-up flow. The flow of blowdown shall be regulated by the thermal expansion of the inner brass tube pressing against a valve seat. The inner tube will contract only when cold make-up water passes through the brass jacketed steel outer tube shell allowing the blowdown to cool and go out the exchanger.
- E. The system shall also have a heat exchanger, including a removable U-tube bundle manufactured of 19 gauge, 304 stainless steel tubes and steel sideshell with hold down clamps to stop tube bundle vibration. The vessel shall be ASME code stamped for 250 psig at 400°F. The system shall have interconnecting piping of steel and stainless steel. The exchanger shall have a minimum sq-ft of surface area. The flow of the blowdown make-up shall flow in opposite directions for maximum heat transfer efficiency of _____ percent.
- F. A heat treated stainless steel valve seat and plunger shall manually control, the blowdown flow by means of a handwheel. A blowdown outlet thermometer Weksler Type 152 shall be furnished at the blowdown outlet.
- G. A flow control assembly shall be furnished for each boiler. The assembly shall consist of a _____ inch Hancock #4595 flow control valve rated at 300 psig, bronze construction and a _____ inch cast steel strainer with a stainless steel screen and have a 250 psig pressure rating.
- H. A SC-22 sample cooler with isolation valves and interconnecting piping will be supplied.
- I. The entire system shall be supported by steel channel legs with 3/4" diameter holes for customer-supplied 5/8" diameter anchor bolts.
- J. The system will be painted with a hard enamel finish coating.

Notes

FLASH TANK ECONOMIZER PRODUCT GUIDE



Overview

A flash tank is used to recover blowdown energy in the form of flash steam and blowdown. This can only be used with a deaerator or some other pressurized device. This unit requires back pressure in excess of 2 psig on the flash tank economizer. It can be ordered for a single boiler or multiple boilers.

Package Includes:

- ☐ Flash Separator with Stainless Steel Coil Heat Exchanger
- ☐ Floor Supports
- ☐ Liquid Level Controller
- ☐ Liquid Level Indicator, Brass Body Michigan Gauge
- ☐ Temperature Control Panel with (3) Indicating Thermometers (Drain Temperature, Make-up in, Make-Up out)
- ☐ Safety Valve
- ☐ ASME Code Construction (150# Design)

FEATURES AND BENEFITS

Flashing:

- Hot, high-pressure blowdown water from each boiler is piped to individual flow control valves on the inlet manifold. Pressure drops across the flow control valve to 5-20 psig, causing the blowdown water to flash into a mixture of steam and water.

Separation Steam/Water:

- An entrainment baffle directs the mixture around the inside of the tank in a centrifugal motion. Efficient baffling separates the dirty blowdown water from the clean steam.

Discharge:

- Steam then rises through the top of the flash tank and is piped to the feedwater heater, or wherever low pressure steam is required. The remaining hot, dirty water flows out the bottom of the flash tank to a heat exchanger for additional heat recovery, or to a blow-off tank or sewer.

Heat Recovery:

- In addition to the heat recovered as flashed steam, the heat exchanger will transfer the remaining heat normally lost during blowdown, to the cold make-up water as it flows to the feedwater heater.

PRODUCT OFFERING

Flash tank heat exchangers are used when operating pressures exceed 25 psig and continuous blowdown heat recovery is desired for cost savings. They consist of an ASME approved and stamped flash tank and a blowdown heat exchanger. Water from continuous blowdown enters the tank and separates into steam and water. The steam, normally at 5 psig, can be returned to the deaerator to help meet heating needs. Hot water leaves the flash tank at temperatures of 220 °F, or more. It goes into the heat exchanger, where it heats cold makeup water entering the system. The systems quickly pay for themselves with fuel savings resulting from recycled heat that would otherwise be wasted. The Model AHR (Figure H13-1) is available in sizes ranging from 3 to 30 gpm blowdown and 9 to 150 gpm makeup. The model AHR is a coil type flash tank heat exchanger. It is a compact, low cost alternative to the shell and tube design. The basic difference is the heat exchanger, constructed of stainless steel, is integral with the ASME approved flash tank. The space saving system includes floor supports, liquid level control, three indicating thermometers, and a safety valve as standard equipment.

Standard Offering

- Flash separator with stainless steel coil heat exchanger.
- Floor supports.
- Liquid level controller
- Liquid level indicator, brass body Michigan gauge.
- Temperature control panel with three indicating thermometers (drain temperature, make-up inlet, make-up outlet).
- Safety Valve.

Major Components

- ASME Code Construction (150# Design).

- Blowdown system.
- Flashtank.
- Heat exchanger.
- Stand.

Optional Equipment

- Drain valve and level control.
- Sample coolers and assembly.
- Flow control valve and assembly.
- Manifold.
- Safety valve.
- Gauge glass.
- Pressure gauge.
- Gauge panel.
- Level alarm.
- Level alarm control panel.
- Thermometers for exchanger operation.

Packages

Model Number	Blowdown GPM Maximum Capacity	Make-Up GPM Maximum Capacity	Shipping Wt.
ACC-AHR-3-9	3	9	1030
ACC-AHR-3-15	3	15	1095
ACC-AHR-6-12	6	12	1230
ACC-AHR-6-30	6	30	1265
ACC-AHR-10-20	10	20	1805
ACC-AHR-10-50	10	50	1840
ACC-AHR-20-40	20	40	2110
ACC-AHR-20-100	20	100	2360
ACC-AHR-30-60	30	60	2435
ACC-AHR-30-150	30	150	2935

Options

	Shipping Wt. (lbs)
High Level Alarm Switch	20
Multiple Boiler Manifold (per Boiler)	5
SC325SS Sample Cooler (w/SS Coil & Accessories)	30
Sample Cooler Mounting w/One Boiler	10
Each Additional Boiler	5
ASME 'U' Stamp	

FLASH TANK HEAT EXCHANGERS

SAMPLE SPECIFICATIONS: MODEL AHR

PART 1 GENERAL

1.1 GENERAL

The following sample specification is provided by cleaver- brooks to assist you in specifying your customer's requirements.

PART 2 PRODUCTS

1.2 MODEL AHR

A. General

1. Furnish Cleaver-Brooks Model ACC-AHR ____ packaged flash tank coil type heat exchanger system, designed to handle a maximum blowdown rate of ____ gpm (3 to 30) and a maximum makeup rate of ____ gpm (9 to 150).
2. The system shall be designed for boilers of (130-2200) hp operating at (0-600) psig. The unit shall be designed to cool the blowdown to within 30 °F of the makeup water temperature. The unit shall have a 150 psig rating at 365 °F.
3. The system's flash tank shall have an ASME code design pressure of 150 psig and an internal flash pressure of ____psig (5 to 15). The flash tank shall be ____" diameter and ____" high and shall be complete with a ____" tangential blowdown inlet, stainless steel wear plate, steam outlet, ball type float trap with all working parts constructed of stainless steel, tank stand, brass-bodied Michigan site glass, and a safety relief valve set at 150 psig. The flash tank shall have a flanged bottom section for quick access to the sludge area and to the coil.
4. The system shall also have a vertical coil-type heat exchanger. The exchanger shall be constructed of stainless steel and shall be integral with the flash tank. The coil shall be complete with ____" threaded connections for the makeup water inlet and outlet.
5. A gauge panel shall be furnished and shall include dial thermometers for indicating makeup inlet temperature, makeup outlet temperature and blowdown outlet temperature. The gauge panel shall be prepiped and mounted on the unit.
6. The entire system shall be supported by steel legs with 3/4" diameter holes for customer-supplied 1/2" diameter bolts. The system will be painted with Cleaver-Brooks blue finish paint.

B. Optional Equipment

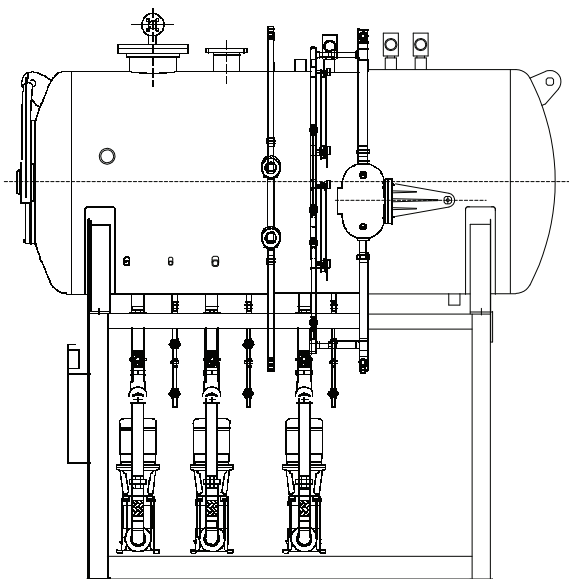
1. A SC-325 Sample Cooler with isolation valves and interconnecting piping shall be supplied for a single boiler application. With each additional boiler, a sample valve assembly shall be added and manifolded to the sample cooler.

C. Multiple Boiler Operation

1. A manifold assembly shall be necessary for multiple boiler installations and shall consist of the necessary piping with threaded connections for the customer-supplied continuous blowoff valves.

Notes

SPRAYMASTER CLASSIC DEAERATORS (SINGLE TANK)



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ILLUSTRATIONS

Figure H1a-1. Spraymaster Tank Supports and Saddles, Details and Dimensions	H1a-7
Figure H1a-2. Spraymaster Deaerator Dimensions and Ratings (Single Tank) – Sheet 1 of 2.....	H1a-8

TABLES

Table H1a-1. Spraymaster Deaerator Product Offering	H1a-4

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long- lasting boiler equipment for industrial and commercial boiler users. Built of corrosion-resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proven most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component sizing information.

FEATURES AND BENEFITS

Low Profile Design:

- Low head allows installation in space restricted areas.

Two-Stage Deaeration in a Common Vessel:

- Recycle pumps are not required.
- Packaged for easy maintenance.

ASME Code Design (Section VIII):

- Assures deaerator vessel quality in materials and fabrication to meet safety requirements.

Internal Stainless Steel Vent Condenser:

- Protects deaerator vessel against corrosive gases while providing a means for removal of corrosive gases from boiler feedwater.

Self-Cleaning Water Spray Valve:

- Angles associated with the water spray valve assembly and actual water spray pattern, maintains deposit-free surfaces.
- Reduces maintenance requirements.

Internal Automatic Check Valves Prevent Back Flooding:

- Both the water spray valve and steam atomizing valve are in the normally closed position under no flow conditions.
- Prevents steam back-flow through the water spray valve and water back flow through the steam atomizing valve.

Removable Water Spray Inlet Assembly:

- Flanged assembly allows easy access for maintenance and/or inspections.

Stainless Steel Deaeration Assembly:

- Ensures a longer life of wetted materials in intimate contact with corrosive liquids and released corrosive gases.

Pressurized Tank Reduces Flashing and Minimal Venting:

- Recovery of exhaust and turbine steam.
- Saves Btu's that would normally be exhausted to atmosphere. Improves plant efficiency.

Auto Vent Valve Eliminates Dissolved Gases at Start-Up:

- Atmospheric contamination virtually eliminated for incoming water.

Exceeds ASME Recommendations for Oxygen Level:

- Guaranteed to remove oxygen concentrations to 0.005 cc/liter while operating between 5% and 100% capacity.
- Carbon dioxide concentrations are practically reduced to zero.

Capacity Not Affected by Mixed Inlet Temperature:

- Consistent performance under variable conditions.

Integral Level Control Automatically Introduces Cold Water Make-Up to Supplement Condensate Only When Necessary to Meet Boiler Demand:

- Saves Btu's by accepting condensate before cold make-up water. Maintains a minimal water level within the deaerator vessel to prevent damage to the boiler feedpumps, and to maintain system operation.

Variety of Tank Sizes to Handle Volume-Swings in Condensate Return:

- Provides flexibility for selecting a tank for specific applications, limiting the loss of hot condensate to drain.

Packaged Units for Cost Effective Installation:

- Complete packages are pre-fabricated in the manufacturing facility to ensure piping alignment and control wiring function. The unit is partially disassembled, and match marked for efficient field re-assembly.

Available in Horizontal and Vertical Configuration:

- Provides adaptability for installation in space restricted areas.

Internal Pump Suction Vortex Breakers:

- Eliminates the problems of loss in NPSHA and cavitation associated with the creation of vortices within pump suction piping.

PRODUCT OFFERING

Information in this section applies directly to Cleaver- Brooks packaged Spraymaster Deaerators ranging from 7,000 to 280,000 pounds/hour. For larger capacities contact your local Cleaver-Brooks authorized representative. The product offering for Spraymaster Deaerators is shown in Table H1a-1.

Table H1a-1. Spraymaster Deaerator Product Offering

MODEL NO.	RATING (LBS/H)	TANK CAPACITY	STORAGE CAP. (MIN)
SM- 7	7000	230	16
SM-15	15000	300	10
SM- 30	30000	600	10
SM- 45	45000	900	10
SM -70	70000	1400	10
SM-100	100000	2000	10
SM-140	140000	2800	10
SM-200	200000	4000	10
SM- 280	280000	5600	10

NOTE: Model number designation (example, SM-7) is: SM = Spraymaster Deaerator. 7 = 7,000 lbs/hr rating. Optional tank sizes available, contact your local Cleaver-Brooks authorized representative.

The Spraymaster Deaerator is a pressurized low-headroom system designed to remove dissolved oxygen in boiler feedwater to 0.005 cc per liter, or less, and eliminate carbon dioxide. A typical deaerator package includes the deaerator tank mounted on a stand of appropriate height along with all operating controls, feed pumps assembled and piped (typically knocked down for shipment and field assembly). The tank conforms to section VIII of the ASME code.

The main deaerating portion is located internally and consists of a water collector and steam atomizing valve. Built into a flange on top of the tank is a spring loaded water spray nozzle which includes an automatic and manual vent valve.

Packaged Spraymaster systems offer substantial advantages through, lower cost installation and simplified operation and maintenance. Spraymaster Deaerators arrive on site ready for hookup to your water, steam, and electric power connections.

The deaerator stand comes with feed pump/motor set mounted on a solid base. The base is specially reinforced to prevent vibration wear on vital system components. Rugged square structural tubing combines lasting strength with generous working space for inspection or routine servicing.

Control Panel

The control panel, complete with starters, fuse protection, switches, lights and pre-wired terminal blocks is mounted on the stand assembly. Wiring to feed pump motor and all controls is standard.

Deaerator Tank

ASME construction - certified to 50 psig. All tanks provided with manhole, individual pump suction tapplings and other openings as required. Saddles or legs standard on all sizes. Select from sizes for 5 to 30 minutes of storage to overflow.

Piping

Pump and motor sets are mounted on individual bases before mounting on stand base.

Individual suction piping (including strainer, shutoff valve, flexible connector) are provided for all feed pumps.

Standard Equipment

- Spraymaster deaerator.
- Deaerator storage tank.
- Deaerator water inlet atomizing valve.
- Deaerator steam inlet atomizing valve.
- Deaerator manual and automatic vent.
- Gauge glass.
- Steam pressure gauge.
- Feedwater thermometer.
- Required tapplings.

Optional Equipment

- Steam pressure reducing valve.
- Three valve bypass and strainer (PRV).

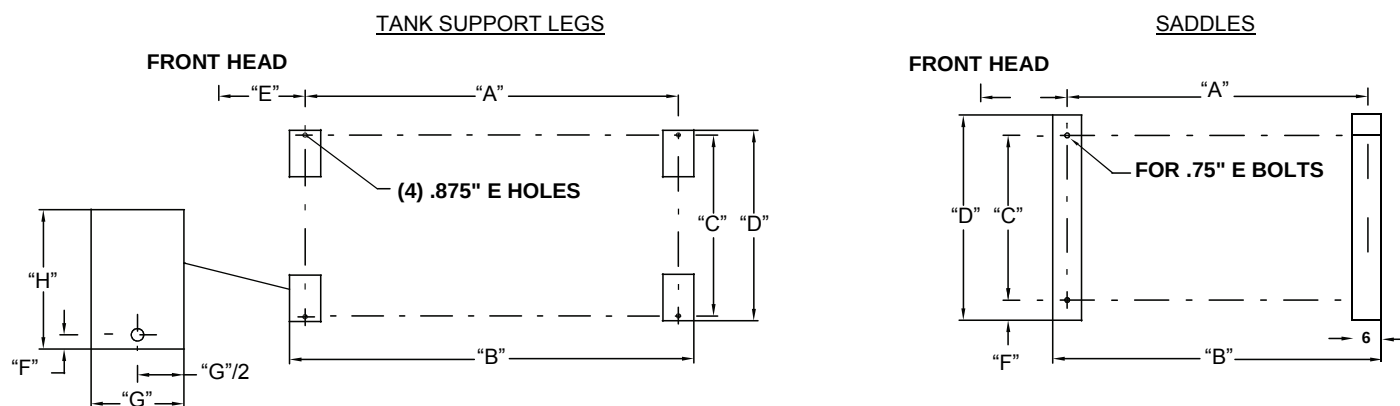
- Water level controller with make-up valve.
- Three valve bypass and strainer (MUV).
- Steam relief valves.
- High water alarm.
- Low water alarm.
- Low water pump cut off.
- High temperature condensate diffuser tube (over 227 °F).
- Boiler feed pump and motor sets.
- Recirculation orifice or relief valve
- Suction shutoff valve.
- Suction strainer.
- Suction flexible fitting.
- Discharge check valve.
- Discharge shutoff valve.
- Discharge pressure gauge.
- Discharge manifold.
- Overflow drainer.
- Control panel.
- Chemical feed quill.
- Vacuum breaker.
- Insulation and lagging.
- Sentinel relief valve.
- Tank drain valve.
- Back pressure relief valve.
- Magnesium anode (not available with lined tanks).
- Stand.

Packaging

- Fully packaged, factory piped and wired.
- Half packaged, suitable for field erection with interconnecting piping and wiring by others.

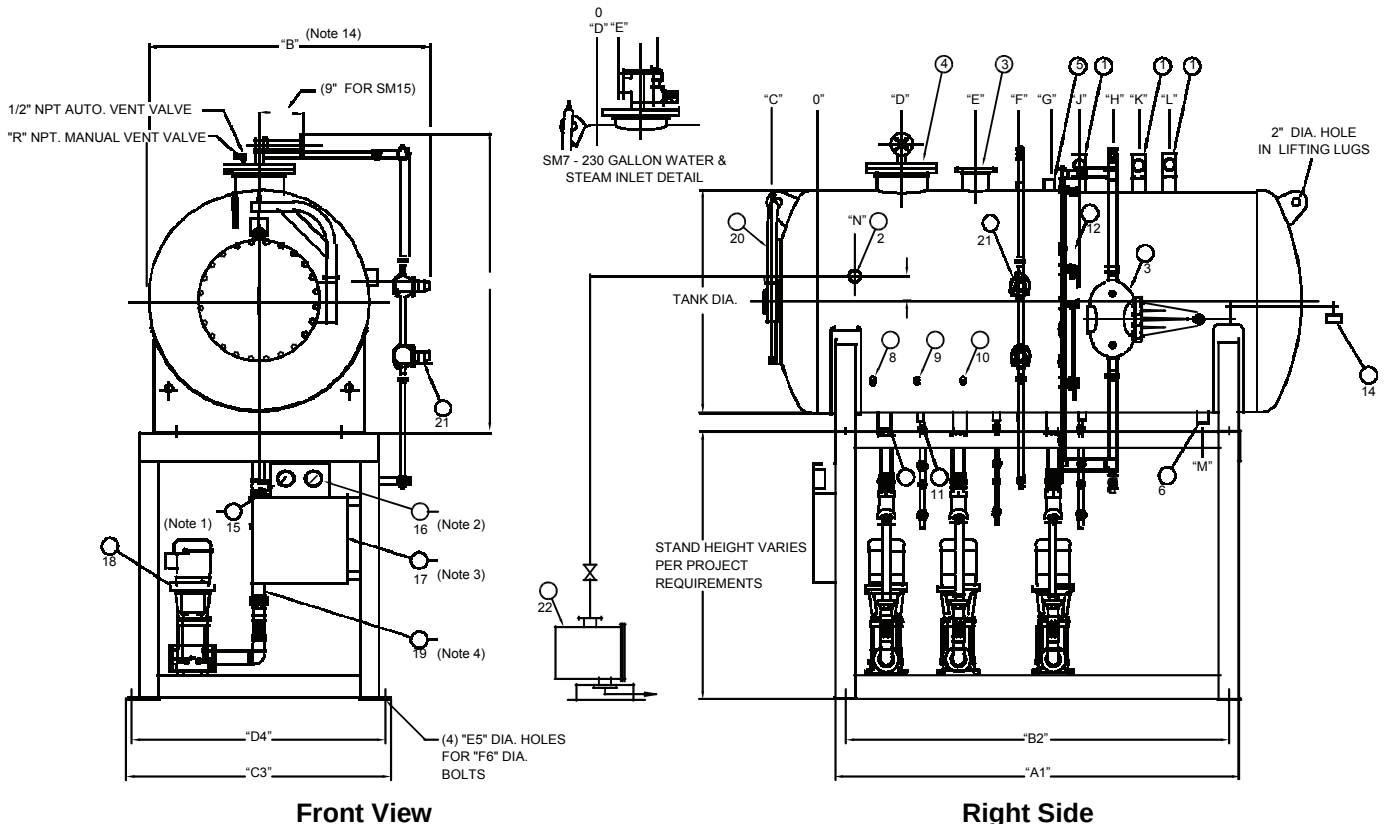
DIMENSIONS AND RATINGS

Dimensions and ratings for Spraymaster Deaerators are shown in Figure H1a-1 and Figure H1a-2.



TANK CAPACITY (GALLONS)												
	230	300	450	600	700	900	1000	1400	2000	2800	4000	5600
	LEGS						SADDLES					
A	47	67.5	102	86	102	95	102.5	138	156	138	128	145
B	52.5	74	108.5	92.5	108.5	101	108.5	144	162	144	134	151
C	29.5	38	38	44.75	44.75	44.75	44.75	50	52	62	72	83
D	31.25	40	40	46.75	46.75	57	57	62	67	77.5	88	98.75
E	12	14.25	16	16	17	17	19.75	19	21.5	22.5	24.5	26
F	0.875	1	1	1	1	6.125	6.125	6	7.5	7.75	8	7.875
G	5.5	6.5	6.5	6.5	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	7	9.75	9.75	13.75	13.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure H1a-1. Spraymaster Tank Supports and Saddles, Details and Dimensions



Front View

Right Side

1. Mounted at dim. "H" (top of tank) on non-packaged units.
2. Tank mounted on non-packaged units.
3. Packaged units only. Mounted on front of stand.
4. Suction piping includes strainer, gate valve and flexible connector.
5. All couplings are 3000# F.S.
6. All flanges are 150# F.F. except as noted.
7. SM-200 is the same as SM-100 and SM-280 is the same as SM-140 except 2 water & steam inlets are used per vessel (dual inlet).
8. Customer to plug all fittings not being used.
9. Mount tank above pump at elevation necessary for static head including safe allowance for piping friction as approved by pump manufacturer.
10. Deaerator tank is built to ASME Code.
11. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
12. Add Suffix "P" to Model No. for packaged units (SMP-45).
13. Optional tanks available for 5 minutes storage (except SM7 & SM15), other combinations of capacities as required - contact your local Cleaver-Brooks authorized representative.
14. Dimension "B" will change depending on controls required - contact your local Cleaver-Brooks authorized representative.
15. No interconnecting piping or wiring furnished on non-packaged units unless specified, contact your local Cleaver-Brooks representative for specific piping or wiring furnished on packaged assemblies.
16. Weights shown are without controls or packaging - contact your local Cleaver-Brooks representative for additions.
17. Capacities other than shown as standard available by proper selection of controls - contact your local Cleaver-Brooks authorized representative.
18. Optional tank sizes and ratings available - contact your local Cleaver-Brooks authorized representatives.
19. Lifting lugs are for lifting empty tank only.

Figure H1a-2. Spraymaster Deaerator Dimensions and Ratings (Single Tank) – Sheet 1 of 2

RATINGS		SM TANK											
Capacity (Gal. to Overflow)		230	300	450	600	700	900	1000	1400	2000	2800	4000	5600
Tank Weight (Dry) (lb)													
Tank Weight (Flooded) (lb)		3600	7850	10700	11750	13450	15500	17000	25450	33650	41550	52500	73600
Tank Size (Dia x Length)		36 x 71	48 x 96	48 x 134	54 x 118	54 x 136	60 x 129.5	60 x 142.5	66 x 177	72 x 200	84 x 184	96 x 179	108 x 199
TANK DIMENSIONS													
A	Overall Height	58	70	70	76	76	82	82	88	94	108	120	132
B	Overall Width	51	63	63	69	69	75	75	81	87	99	111	123
C	Front Head	8	10	10	11	11	12	12	14	15	17.5	20	21.5
D	W ater Inlet - SM 7	17.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	W ater Inlet - SM 15 thru 100	N/A	20	22	22	22	22	22	22	22	22	22	22
	W ater Inlet - SM140	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18	18	18	18	18
E	Steam Inlet	6.5	40	42	42	42	42	42	42	42	42	42	42
F	Level Alarm	32	50	54	54	54	54	54	56	56	56	56	56
G	High Temperature Return	27	55	62	62	62	62	62	63	63	63	63	63
H	Level Control	44.5	60	79	79	79	79	79	90	90	90	90	90
J	Relief Valve	38.5	66 *	70	70	70	70	70	100	100	100	100	100
K	Relief Valve	50	66 *	86	86	86	86	86	111	111	111	111	111
L	Relief Valve	N/A	N/A	N/A	N/A	N/A	N/A	N/A	122	122	122	122	122
M	Drain	10	30	98	84	98	93	103	135	153	135	127	144
N	Overflow	5	10	10	10	10	10	10	14	14	14	14	14
P	Overflow	10	0	0	3.75	3.75	6.75	6.75	6.5	8	14.5	26.5	27.5
	Sprayhead	SM15		SM30		SM45		SM70		SM100/200		SM140/280	
R	Manual Vent Valve Size	0.75		0.75		0.75		1		1.5		2	
STAND DIMENSIONS													
Capacity (Gal. to Overflow)		230	300	450	600	700	900	1000	1400	2000	2800	4000	5600
A1	Overall Length	52.5	74	108.5	92.5	108.5	101	108.5	144	162	149	134	151
B2	C/L to C/L Bolt Holes	47.5	69	102.5	87.5	102.5	95	102.5	138	155	146	127	144
C3	Overall Width	49	62	66	64	66	71	71	76	83	86.5	102	113
D4	C/L to C/L Bolt Holes	46	59	63	61	63	68	68	73	80	79.5	99	110
E5	Hole Size	0.75	1	1	0.75	1	1.125	1.125	1.25	1.125	1.125	1.125	1.25
F6	Anchor Bolt Size	0.625	0.875	0.875	0.625	0.875	1	1	1.125	1	1	1	1.125
CONNECTIONS AND TRIM													
1	Relief Valve Size	Contact Your Local Cleaver-Brooks Authorized Representative											
2	Overflow Size	1.5" NPT	3" NPT	3" NPT	3" NPT	3" NPT	3" NPT	3" NPT	4"-150# FF	4"-150# FF	4"-150# FF	6"-150#	6"-150# FF
3	Steam Inlet Size	See Table Below											
4	Water Inlet Size	See Table Below											
5	High Temperature Return Size	1.5" NPT	1.5" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	3" NPT	3" NPT	3" NPT	3" NPT	3" NPT
6	Drain Size	1.5" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT
7	Suction Size	2.5" NPT	2.5" NPT	2.5" NPT	2.5" NPT	2.5" NPT	2.5" NPT	2.5" NPT	4"-150# FF	4"-150# FF	4"-150# FF	4"-150#	4"-150# FF
8	Thermometer (3/4" NPT)												
9	Sample (1/2" NPT)												
10	Chemical Feed (1" NPT)												
11	Recirculation (1" NPT)												
12	Gauge Glass Assembly												
13	Level Controller (1.5" NPT)												
14	Make-Up Valve												
15	Pressure Gauge												
16	Thermometer												
17	Control Panel (Optional)												
18	Feed Pump/Motor (Optional)												
19	Suction Piping (Optional)												
20	Manway Size - SM 7	20"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Manway Size - SM 15 thru 70	N/A	28"	28"	28"	28"	28"	28"	28"	28"	28"	28"	28"
	Manway Size - SM100, 200	N/A	32"	32"	32"	32"	32"	32"	32"	32"	32"	32"	32"
	Manway Size - SM140, 280	N/A	N/A	N/A	N/A	N/A	N/A	N/A	36"	36"	36"	36"	36"
21	Level Alarms (Optional) (1" NPT)												
22	Overflow Drainer (Optional)												
	RATINGS for												
	SPRAYMASTER MODEL	TANK SIZES		RATING (lb/hr)		Conn 3 Steam Inlet		Conn 4 Water Inlet					
	SM-7	230		7000		3"-150# FF Flg		1" NPT					
	SM-15	300 thru 700		15000		6"-150# FF Flg		1.5"-150# RF Flg					
	SM-30	300 thru 5600		30000		6"-150# FF Flg		2"-150# RF Flg					
	SM-45	300 thru 5600		45000		6"-150# FF Flg		2"-150# RF Flg					
	SM-70	300 thru 5600		70000		6"-150# FF Flg		2.5"-150# RF Flg					
	SM-100	300 thru 5600		100000		6"-150# FF Flg		3"-150# RF Flg					
	SM-140	2000 thru 5600		140000		8"-150# FF Flg		4"-150# RF Flg (2)					
	SM-200 (NOTE 7)	2000 thru 5600		200000		6"-150# FF Flg		3"-150# RF Flg					
	SM-280 (NOTE 7)	2000 thru 5600		280000		8"-150# FF Flg		4"-150# RF Flg (2)					

* 2 relief valve tappings for SM 300 located at 66" are offset 6" on either side of top centerline.

Figure H1a-2. Spraymaster Deaerator Dimensions and Ratings (Single Tank) – Sheet 2 of 2

RETURN ON INVESTMENT

Payback for a pressurized deaerator versus an atmospheric boiler feed system is based on an additional capital expenditure required divided by the yearly operating cost savings. The differential in yearly operating costs are in the following areas:

- Flash steam
- Exhaust steam
- Blowdown
- Chemical treatment
- Makeup water
- Sewer
- Intangibles

Flash Steam

A percentage of the high-pressure condensate returns will flash to steam and be lost in an atmospheric vessel application. This flash steam loss can be converted to an energy loss and associated fuel cost.

Exhaust Steam

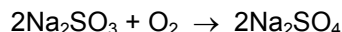
Exhaust steam cannot be recovered in an atmospheric vessel application. This exhaust steam loss can be converted to energy loss and associated fuel cost. An example would be steam turbine exhaust.

Surface Blowdown

Increased makeup water is required because of lost flash and exhaust steam. This increase in makeup water requires an increase of surface blowdown. This is directly related to cycles of concentration in the boiler. The additional blowdown loss can be converted to an energy loss and associated fuel cost. The additional surface blowdown may also result in an increase in capital expenditure for a larger blowdown heat recovery system.

Chemical Treatment

Dissolved oxygen content in an atmospheric boiler feedwater system is a function of water temperature. Lowering the dissolved oxygen content below what is naturally present, based on mixed water temperature at atmospheric pressure, requires the addition of a chemical treatment program. The most common oxygen scavenger used is sodium sulfite. Sodium sulfite reacts with dissolved oxygen as follows:



Theoretically, it takes approximately 8 ppm of sodium sulfite as Na_2SO_3 to scavenge 1 ppm of dissolved O_2

Makeup Water

Increased make-up water is required because of lost flash steam, lost exhaust steam, and additional surface blowdown. This additional makeup water can be associated to a cost. Makeup water cost should be a combination of the utility charge plus pretreatment equipment consumable costs.

Sewer

Utilities often base a sewer charge on make-up water usage. Increased makeup water usage with an associated increase in surface blowdown can affect these costs.

Intangibles

Some cost savings are difficult to calculate - in general, best practices in deaeration will prolong the life of boiler room equipment, reducing repair and maintenance costs.

*SAMPLE SPECIFICATIONS***CONTENTS**

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1.1	DEAERATOR SPECIFICATION.....	H1a-12
PART 2	PRODUCTS.....	H1a-12
2.1	HARDWARE.....	H1a-12
A.	Deaerator.....	H1a-12
B.	Make Up Valve and Controller.....	H1a-14
C.	Steam Pressure Reducing Station.....	H1a-15
D.	Boiler Feedwater Pump And Motor Set.....	H1a-16
E.	Control Panel.....	H1a-16

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

PART 1 GENERAL

1.1 DEAERATOR SPECIFICATION

1. Provide one Cleaver-Brooks Model _____ spray type, pressurized, horizontal deaerator rated at _____ pounds per hour. The system shall be of the single tank design and shall guarantee oxygen removal to not more than 0.005 ccs/liter in the effluent throughout all load conditions between 5 and 100 percent. Two-compartment designs are not acceptable. The deaerator shall be designed for operation at 5 psig, but shall be suitable for use from 2 to 15 psig. Atmospheric operating designs are not acceptable.

PART 2 PRODUCTS

2.1 HARDWARE

A. Deaerator

1. Feedwater and condensate shall be admitted to the deaerator through a single spring-loaded, self-cleaning, adjustable stainless steel spray valve, which shall provide proper internal vent condensing and water distribution at any load between 5 and 100 percent of rated capacity. The water temperature in the primary heating and vent concentrating section is to be raised within 2 or 3 °F of steam temperature and most of the gases released. The water is then to be collected in a conical water collector. From there, it is to flow to an atomizing valve where high velocity steam strikes it, breaks it down into a fine mist, and heats it to a full steam saturation temperature. The mixture is to strike a deflecting baffle, which separates water and steam. Hot, gas-free water is to then drop to the storage compartment to complete the cycle. The steam and non-condensables are to flow upward, through the primary heating spray, into the internal vent concentrating section, where they contact the cold influent water. Here, the steam is to be condensed to continue the cycle. Released gasses are discharged to atmosphere through the vent outlet. All internal surfaces, which come in contact with un-deaerated water, shall be constructed of Type 316 stainless steel.
2. Automatic vent valve shall be thermostatically controlled to provide a fast means of venting when a sudden buildup of gases occurs, such as seen at start up. The manual vent valve shall have an orifice for continuous minimum venting. Venting rate shall not exceed 0.1 of 1% of the rated deaerator capacity at 5 psig.

3. The deaerated water storage tank shall have _____ minutes of storage and have a capacity of _____ gallons measured to overflow. The tank shall be _____ diameter x _____ long. An _____ manhole shall be provided for access. All nozzles 3" and under shall be 3000 lbs forged steel couplings and over 3" shall be 150 lbs flat face flanges. Heads to be ASME torispherical type constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches. The tank shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 psig at 650 °F and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per Table UW-12, which does not require stress relieving or nondestructive examination.
4. The deaerator loads shall be as specified in the table below.
Low temperature returns are defined as condensate with a temperature below that of the deaerator operating temperature. High temperature returns are defined as condensate with a temperature above that of the deaerator operating temperature.

LOAD SPECIFICATIONS				
LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Make up		GPM		25 psig Minimum
Pumped Low Temp Returns				10 psig Minimum
High Temp Returns	Not To Exceed 30%			

5. Optional - The tank shall be factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. Block-type insulation is not acceptable. The blanket insulation is to be fiberglass, 2" thick, 1 lb/cu-ft, and have a rating of R5. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 18 gauge (0.0478") minimum and head thickness of 18 gauge (0.0478") minimum.
6. Optional - The magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed. Linings shall not be acceptable in this application.
7. Optional - The high temperature diffuser or sparge tube shall be located beneath the normal tank water level. The tube shall be constructed of 2-1/2 inch pipe. This tube shall provide even distribution and blending of high-temperature condensate returns.
8. Optional - The chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.
9. Optional - The basic deaerator shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

B. Make Up Valve and Controller

1. Option (Mechanical) - _____ " inlet water regulating lever valve with _____ body and _____ connections. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. The pressure drop across the valve shall not exceed a delta-P of 10 psig. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____, Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____, Model _____.
2. Option (Electronic) - _____ " inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional, with a permanently lubricated gear train, and be directly coupled to the valve stem. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psi inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Cleaver-Brooks Model TW82. A solenoid valve and float switch are not acceptable. (Available only in the U.S.)
3. Option (Pneumatic) - _____ " inlet water diaphragm actuated regulating valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for 3 - 15 psig operating signal. The valve shall be normally open on loss of air. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____ Model _____. A filter regulator is to be provided to reduce 50 psig instrument air supply to 3 - 15 psig for proper operation.
4. Optional - The make up valve shall include a ANSI Class 125 lb three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

C. Steam Pressure Reducing Station

1. Option (Mechanical) - _____" steam pressure reducing valve with cast iron body and _____ connections. The valve shall be a self-contained unit capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. The valve shall be 250 lb class with stainless steel trim and an adjustable pilot. The valve manufacturer shall be _____, Model _____.
2. Option (Pneumatic) - _____" diaphragm actuated steam pressure reducing valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for _____ psig operating signal. The valve shall be normally closed on loss of air. The valve shall be capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. This valve shall be 250 lb class and have stainless steel trim. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external transmitter. The transmitter set pressure shall be adjustable. The transmitter manufacturer shall be _____, Model _____.
3. Optional - The steam pressure reducing valve shall include a three valve bypass with Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.
4. Optional - Quantity _____, _____" relief valves sized to relieve full capacity of the pressure reducing valve in the event of its failure. Valves to meet Paragraph UG-125 of ASME Unfired Pressure Vessel Code, Section VIII. Valve body to be of bronze construction. Relieving set pressure to be 50 psig. Relief valve manufacturer to be _____, Model _____.
5. Optional - High level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
6. Optional - Low level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
7. Optional - _____" overflow drainer sized to relieve full capacity at the operating pressure of the deaerator. The overflow drainer shall be a float type trap. The construction is to be a steel housing with stainless steel float ball. The overflow drainer manufacturer shall be _____, Model _____.
8. Optional - Suction piping for pumps shall consist of a gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 lb class construction. The vortex breaker shall be located in the tank nozzle. Manifold suction lines are not acceptable.

D. Boiler Feedwater Pump And Motor Set

1. Option (Intermittent) - Quantity _____, turbine type boiler feedwater pump and motor set. Centrifugal type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non- overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____".
2. Option (Continuous) - Quantity _____, centrifugal type boiler feedwater pump and motor set. Turbine type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosed motor. Motor to be non- overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____". A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.
3. Optional - The stand shall elevate the deaerator tank to provide the net positive suction head required by the pump at the rated condition to prevent cavitation plus a 1-1/2 foot safety factor. The stand shall be constructed of heavy square steel tubing for the legs and 1/4" steel plate covering the floor.

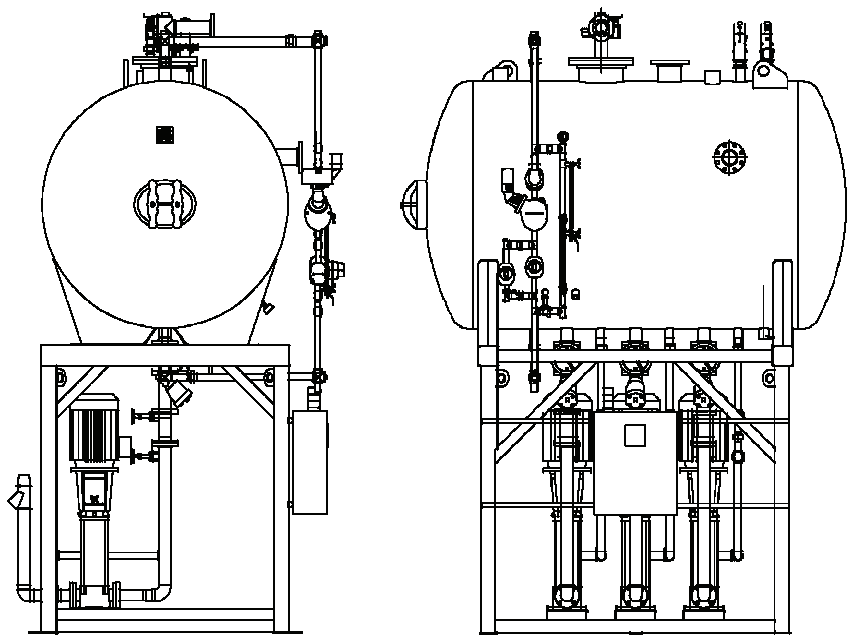
E. Control Panel

1. Optional (Base) - Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.
2. Optional (Electric Components) - Audible and visual high and low water alarm function shall be provided by a bell or horn with silence switch and individual red oil-tight lights. Control circuit transformer to supply 110-120 Volts, single-phase power supply. The transformer shall be mounted, wired and fused. Auxiliary contacts shall be furnished for chemical feed pump initiation. Contacts shall be normally open.
3. Standard - The deaerator shall have a gauge glass assembly that covers the entire tank diameter. The gauge glass shall be quartz, 0.625 inch diameter by 24 inch maximum length. Each length of glass shall be furnished with a bronze gauge cock set and protector rods. The deaerator shall be supplied with a pressure gauge that has a 4-1/2 inch dial with a 0-60 psig range and a thermometer with a 50 to 300 °F range. Packaged units are required to have both gauges bracket- mounted at eye level. The deaerator is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with an enamel paint to not less than 1 mil thick prior to shipment. Unit is to be knocked down for shipment. Piping is to be

matched marked. Three, bound, Operating and Maintenance manuals to be provided. Warranty period to be twelve months after start-up or eighteen months after shipment, whichever comes first.

Notes

SPRAYMASTER SIGNATURE SERIES
DEAERATORS (SINGLE TANK)



CONTENTS

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PRODUCT OFFERING H1b-4

DIMENSIONS AND RATINGS H1b-7

RETURN ON INVESTMENT H1b-10

SAMPLE SPECIFICATIONS H1b-11

ILLUSTRATIONS

Figure H1-1. Spraymaster Signature Series Tank Supports, Details and Dimensions H1b-7

Figure H1-2. Spraymaster Signature Series Deaerator Dimensions and Ratings (Single Tank) – Sheet 1 of 2...H1b-8

TABLES

Table H1-1. Spraymaster Signature Deaerator Product Offering H1b-4

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed water. Thus, it is the answer to maintaining long-lasting boiler equipment for industrial and commercial boiler users. The Cleaver-Brooks deaerator is constructed of corrosion-resistant alloys for a long lifetime of service. The deaerator design employs those basic principles of gas removal that have proven to be the most effective and economical means of proper operation. Contact your local Cleaver-Brooks authorized representative for component sizing information.

FEATURES AND BENEFITS

Low Profile Design:

- Low elevation and small footprint allows installation in space restricted areas.

Two-Stage Deaeration in a Common Vessel:

- Recycle pumps are not required.
- Packaged assembly for easy installation and maintenance.

ASME Code Design (Section VIII):

- Assures deaerator vessel quality in materials and fabrication to meet safety requirements.

Internal Stainless Steel Vent Condenser:

- Protects deaerator vessel against corrosive gases while providing a means for removal of these corrosive gases from boiler feedwater.

Self-Cleaning Water Spray Valve:

- Angles associated with the water spray valve assembly and water spray pattern allow deposit-free surfaces to be maintained.
- Reduces maintenance requirements.

Internal Automatic Check Valves Prevent Back Flooding:

- Both the water spray valve and steam atomizing valve are in the normally closed position under no flow conditions.
- Prevents steam back-flow through the water spray valve and water back flow through the steam atomizing valve.

Removable Water Spray Inlet Assembly:

- Flanged assembly allows easy access for maintenance and/or inspections.

Stainless Steel Deaeration Assembly:

- Ensures a longer life of all wetted materials in intimate contact with corrosive liquids and the released corrosive gases.

Pressurized Tank Reduces Flashing and Minimal Venting:

- Recovery of flash steam exhaust and turbine steam.
- Saves BTU's that would normally be exhausted to atmosphere. This in turn improves overall system and plant efficiency.

Auto Vent Valve Eliminates Dissolved Gases at Start-Up:

- Atmospheric contamination virtually eliminated for incoming water.

Exceeds ASME Recommendations for Oxygen Level:

- Guaranteed to remove oxygen concentrations to 0.005 cc/liter while operating between 5% and 100% capacity.
- Carbon dioxide concentrations are practically reduced to zero.

Capacity Not Affected by Mixed Inlet Temperature:

- Consistent performance under variable loads and conditions.

Integral Level Control Automatically Introduces Cold Water Make-Up to Supplement Condensate Only When Necessary to Meet Boiler Demand:

- Saves BTU's by accepting condensate before cold make-up water. Maintains a minimal water level within the deaerator vessel to prevent damage to the boiler feedpumps, and to maintain system operation.

Variety of Tank Sizes to Handle Volume-Swings in Condensate Return:

- Provides flexibility for selecting a tank for specific applications, limiting the loss of hot condensate to drain (minimum offering available is 10 minutes of storage).

Packaged Units for Cost Effective Installation:

- Complete packages are pre-fabricated in the manufacturing facility to ensure piping alignment and control wiring function. The unit is partially disassembled, and match marked for efficient field re-assembly.

Available in Horizontal Configuration:

- Provides adaptability for installation in space restricted areas.

Internal Pump Suction Vortex Breakers:

- Eliminates the problems of loss in NPSHA and cavitation associated with the creation of vortices within pump suction piping.

PRODUCT OFFERING

Information in this section applies directly to Cleaver- Brooks packaged Spraymaster Signature Deaerators ranging from 7,000 to 100,000 pounds/hour. For larger capacities contact your local Cleaver-Brooks authorized representative. The product offering for Spraymaster Signature Series Deaerators is shown in Table H1-1.

Table H1-1. Spraymaster Signature Deaerator Product Offering

MODEL NO.	RATING (LBS/H)	Typical TANK CAPACITY	STORAGE CAP. (MIN)
SS-15	15000	415	10
SS- 30	30000	610	10
SS- 45	45000	1105	10
SS -70	70000	1400	10
SS-100	100000	2485	10

NOTE: Model number designation (example, SM-7) is: SS = Spraymaster Signature Series Deaerator. 7 = 7,000 lbs/hr rating. Storage capacities greater than 10 minutes are available. Please contact your local Cleaver-Books authorized representative.

The Spraymaster Signature Deaerator is a pressurized low-headroom spray-type deaerator system designed to remove dissolved oxygen in boiler feedwater to 0.005 cc per liter, or less, and eliminate carbon dioxide. A typical deaerator package includes the deaerator tank mounted on a stand of appropriate height along with all operating controls, feed pumps assembled and piped (typically knocked down for shipment and field assembly). The tank conforms to section VIII of the ASME code.

The main deaerating portion is located internally and consists of a water collector cone and steam atomizing valve. Built into a flange on top of the tank is a spring loaded water spray nozzle which includes an automatic and manual vent valve.

Packaged Spraymaster Signature Deaerator systems offer substantial advantages through, lower cost installation and simplified operation and maintenance. Spraymaster Signature Spraymaster Signature Deaerators arrive on site ready for installation and hookup to your water, steam, and electric power connections.

The deaerator stand comes with feed pump/motor set mounted on a base. The base is specially reinforced to prevent vibration wear on vital system components. Rugged square structural tubing combines lasting strength with generous working space for inspection or routine servicing.

Control Panel The control panel, complete with starters, fuse protection, switches, lights and pre-wired terminal blocks is mounted on the stand assembly. Wiring to feed pump motor and all controls is standard.

Deaerator Tank ASME construction - certified to 50 psig. All tanks provided with manhole, individual pump suction tapplings and other openings as required. Legs are standard on all sizes. Storage in the vessels is designed for a minimum of 10 minutes.

Piping Pump and motor sets are mounted directly on the base channel.

Individual suction piping (including strainer, shutoff valve, flexible connector) is standard and provided for all feed pumps.

Standard Equipment

- Spraymaster Signature deaerator.
- Deaerator storage tank.
- Deaerator water inlet atomizing valve.
- Deaerator steam inlet atomizing valve.
- Deaerator manual and automatic vent.
- Gauge glass.
- Steam pressure gauge.
- Water temperature thermometer.
- Required tapplings.
- Steam pressure reducing valve.
- Optional three valve bypass and strainer (PRV).
- Water level controller with make-up valve.

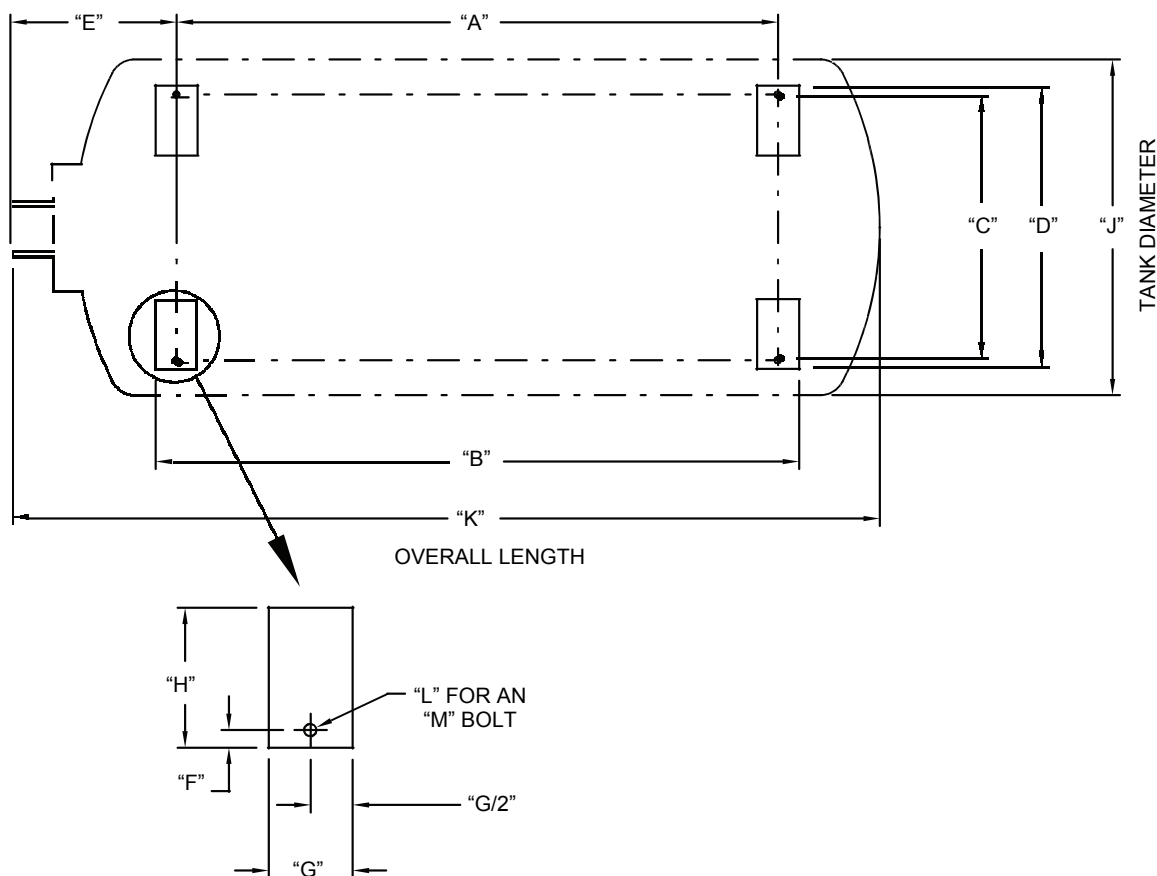
- Optional three valve bypass and strainer (MUV).
- Steam relief valves.
- High water alarm.
- Low water alarm.
- Low water pump cut off.
- Boiler feed pump and motor sets.
- Recirculation orifice.
- Suction shutoff valve.
- Suction strainer.
- Suction flexible fitting.
- Optional discharge check valve.
- Optional discharge shutoff valve.
- Optional discharge pressure gauge.
- Optional discharge manifold.
- Overflow drainer.
- Control panel.
- Optional chemical feed quill.
- Optional vacuum breaker.
- Optional insulation and jacket.
- Sentinel relief valve.
- Optional tank drain valve.
- Optional magnesium anode.
- Stand.

Packaging

- Fully packaged, factory piped and wired.

DIMENSIONS AND RATINGS

Dimensions and ratings for Spraymaster Signature Deaerators are shown in Figure H1-1 and Figure H1-2.



TANK CAPACITY (GALLONS)							
	260	415	610	840	1105	1400	2485
A	47	86	86	86	86	86	110
B	53	92	92	92	92	92	116
C	38	38	44.75	44.75	50	52	62
D	40.5	40.5	47.25	48.25	53	55	65.5
E	22.31	22.78	23.59	24.84	25.91	26.78	29.59
F	1.25	1.25	1.25	1.75	1.5	1.5	1.75
G	6	6	6	6	6	6	6
H	10	10	14.37	16	18.25	21.25	23.12
J	48	48	54	60	66	72	84
K	83.31	123.33	124.93	127.36	129.56	131.23	160.58
L	0.87	0.87	0.87	1.12	1.12	1.12	1.12
M	0.75	0.75	0.75	1	1	1	1

Figure H1-1. Spraymaster Signature Series Tank Supports, Details and Dimensions

Spraymaster Deaerators (Single Tank)



1. Packaged units only. Mounted on side stand.
2. Suction piping includes strainer, gate valve and flexible connection.
3. All couplings are 3000# F.S.
4. All flanges are 150# F.F. except as noted.
5. Customer to plug all fittings not being used.
6. Mount tank above pump at elevation necessary for static head including safe allowance for piping friction as approved by pump manufacturer.
7. Deaerator tank is built to SAME Code.
8. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
9. Add Suffix "P" to Model No. for packaged units (SSP-45).
10. Dimension "B" will change depending on controls required - contact your local Cleaver-Brooks authorized representative.

1. No interconnecting piping or wiring furnished on non-packaged units unless specified, contact your local Cleaver-Brooks representative for specific piping or wiring furnished on packaged assemblies.
12. Weights shown are without controls or packaging - contact your local Cleaver-Brooks representative for additions.
13. Capacities other than shown as standard available by proper selection of controls - contact your local Cleaver-Brooks authorized representative.
14. Optional tank sizes and ratings available - contact your local authorized Cleaver-Brooks representative.
15. Lifting lugs are for lifting EMPTY tanks only.
16. For zone IIB Stand dimensions - contact your local Cleaver-Brooks representative.

RATINGS FOR SPRAYMASTER MODEL	Conn. 3 Steam Inlet	Conn. 4 Water Inlet
SS-7	6"-150# FF Flg	1" NPT.
SS-15	6"-150# FF Flg	1.5"-150# RF Flg
SS-30	6"-150# FF Flg	2"-150# RF Flg
SS-45	6"-150# FF Flg	2"-150# RF Flg
SS-70	6"-150# FF Flg	2.5"-150# RF Flg
SS-100	6"-150# FF Flg	3"-150# RF Flg

Figure H1-2. Spraymaster Signature Series Deaerator Dimensions and Ratings (Single Tank) – Sheet 1 of 2

OVERALL DIMENSIONS (TANK AND STAND)								
X	Overall Package Width	81	81	95	98	101	99	117
Y	Overall Package Height	157	157	163	169	175	181	205
Z	Overall Package Length	87	123.5	125	127.5	129.5	131.5	160.5
TANK DIMENSIONS								
A	Overall Tank Height	73	73	80	85	91	97	109
B	Overall Tank Width	70	68	70.5	76.5	82.5	88.5	100.5
C	Front Head	12.31	12.31	13.13	14.37	15.44	16.31	18.81
D	High Temperature Return	49	8	8	8	8	8	20
E	Level Control	6	18	18	18	18	18	30
F	Water Inlet	17.5	37.5	37.5	37.5	37.5	37.5	49.5
G	Steam Inlet	37.5	57.5	57.5	57.5	57.5	57.5	69.5
H	Relief Valve	49	70	70	70	70	70	82
J	Relief Valve	N/A	78	78	78	78	78	90
K	Spare	N/A	86	86	86	86	86	98
	Spare	N/A	N/A	N/A	N/A	N/A	N/A	106
L	Drain	46	85	85	85	85	85	97
M	Overflow	REAR HEAD	75	75	75	75	75	87
N	Overflow	1.56	1.59	4.62	7.62	10.87	13.81	18.25

STAND DIMENSIONS -FOR ZONE IV- see note 16.								
	Capacity (Gal. to Overflow)	260	415	610	840	1105	1400	2485
A1	Overall Length	52	91	91	91	91	91	116
B2	C/L to C/L Bolt Holes	47	86	86	86	86	86	110
C3	Overall Width	72.75	72.75	72.75	72.75	78	80	91
D4	C/L to C/L Bolt Holes	68.25	68.25	68.25	68.25	73.5	75.5	86.5
E5	Hole Size	1.37	1.37	1.37	1.37	1.37	1.37	1.37
F6	Anchor Bolt Size	1.25	1.25	1.25	1.25	1.25	1.25	1.25

CONNECTIONS AND TRIM								
1	Relief Valve Size / Quantity	Contact Your Local Cleaver-Brooks Authorized Representative						
2	Overflow Size	3" NPT	3" NPT	3" NPT	3" NPT	4"-150# FF	4"-150# FF	4"-150# FF
3	Steam Inlet Size	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF
4	Water Inlet Size	8"-150# FF	8"-150# FF	8"-150# FF	12"-150# FF	12"-150# FF	12"-150# FF	12"-150# FF
5	High Temperature Return Size	1 1/2" NPT	2" NPT	2" NPT	2" NPT	3" NPT	3" NPT	3" NPT
6	Drain Size	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT
7	Suction Size	2.5" NPT	2.5" NPT	2.5" NPT	2.5" NPT	3"-150# FF	3"-150# FF	4"-150# FF
8	Thermometer	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT
9	Sample	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT
10	Chemical Feed	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT
11	Recirculation	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	2" NPT
12	Gauge Glass Assembly							
13	Level Controller	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT
14	Make-Up Valve							
15	Pressure Gauge	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT
16	Control Panel	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design
17	Feed Pump/Motor	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design
18	Suction Piping	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design
19	Manway Size - SSP 15-70	12" x 16"	12" x 16"	12" x 16"	12" x 16"	12" x 16"	12" x 16"	N/A
20	Manway Size - SSP 100	N/A	N/A	N/A	N/A	N/A	N/A	14" x 18"
21	Level Alarms	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT
22	Overflow Drainer	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design

Figure H1-2. Spraymaster Signature Deaerator Dimensions and Ratings (Single Tank) – Sheet 2 of 2

RETURN ON INVESTMENT

Payback for a pressurized deaerator versus an atmospheric boiler feed system is based on an additional capital expenditure required divided by the yearly operating cost savings. The differential in yearly operating costs are in the following areas:

- Flash steam
- Exhaust steam
- Blowdown
- Chemical treatment
- Sewer
- Intangibles

Flash Steam	A percentage of the high-pressure condensate returns will flash to steam and be lost in an atmospheric vessel application. This flash steam loss can result in an energy loss and associated fuel cost. Returning condensate to a pressurized vessel decreases the amount of flash steam created and reduces losses to atmosphere.
Exhaust Steam	Exhaust steam cannot be recovered in an atmospheric vessel application. This exhaust steam loss can be converted to energy loss and associated fuel cost. An example would be steam turbine exhaust.
Surface Blowdown	Increased makeup water is required because of lost flash and exhaust steam. This increase in makeup water requires an increase of surface blowdown. This is directly related to cycles of concentration in the boiler. The additional blowdown loss can result in an energy loss and associated fuel cost. The additional surface blowdown may also result in an increase in capital expenditure for a larger blowdown heat recovery system.
Chemical Treatment	Dissolved oxygen content in an atmospheric boiler feedwater system is a function of water temperature. Lowering the dissolved oxygen content below what is naturally present, based on mixed water temperature at atmospheric pressure, requires the addition of a chemical treatment program. The most common oxygen scavenger used is sodium sulfite. Sodium sulfite reacts with dissolved oxygen as follows: $2\text{Na}_2\text{SO}_3 + \text{O}_2 \rightarrow 2\text{Na}_2\text{SO}_4$ Theoretically, it takes approximately 8 ppm of sodium sulfite as Na₂SO₃ to scavenge 1 ppm of dissolved O₂
Makeup Water	Increased make-up water is required because of lost flash steam, lost exhaust steam, and additional surface blowdown. This additional makeup water can be associated to a cost. Makeup water cost should be a combination of the utility charge plus pretreatment equipment consumable costs.
Sewer	Utilities often base a sewer charge on make-up water usage. Increased makeup water usage with an associated increase in surface blowdown can affect these costs.
Intangibles	Some cost savings are difficult to calculate - in general, best practices in deaeration will prolong the life of boiler room equipment, reducing repair and maintenance costs.

SAMPLE SPECIFICATIONS

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3.1	Deaerator Manuals and Warranty	H1b-16

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

PART 1 GENERAL

1.1 Packaged Deaerator Specification

- A. Provide one (1) Cleaver-Brooks Model SSP _____ Signature Series spray type, pressurized, horizontal deaerator rated at _____ pounds per hour. The system shall be a single tank design. Performance is guaranteed to remove oxygen to not more than 0.005 ccs/liter in the effluent throughout all load conditions between 5 and 100 percent with a 20:1 turndown ratio. The deaerator shall be designed for operation at 5 PSIG, but shall be suitable for use from 2 to 15 PSIG. Feedwater, low and medium temperature condensate shall be admitted to the deaerator through a single spring-loaded, self-cleaning, adjustable stainless steel spray valve, which shall provide proper internal vent condensing and water distribution at any load between 5 and 100 percent of rated capacity.

PART 2 PRODUCTS

2.1 Deaerator

- A. The water temperature in the primary heating and vent concentrating section is to be raised within 2 to 3 °F of steam saturation temperature causing the majority of non-condensable gases to be released. The water is then to be collected in a stainless steel conical water collector. From the collector, it shall flow to an atomizing valve where high velocity steam shall contact the water stream and break it into a fine mist. At this stage, the water shall be heated to full steam saturation temperature. The mixture is to strike a deflecting baffle, which separates water and steam. Hot, gas-free water shall then drop to the storage compartment of the pressure vessel to complete the deaeration process. The non-condensable gases released during the process and steam shall flow upward, through the primary heating spray portion, into the internal vent concentrating section, where they contact the cold influent water. Here, the steam is to be condensed to continue the cycle. Released gasses are discharged to atmosphere through the vent outlet.
- B. All internal surfaces, which come in contact with un-deaerated water, shall be constructed of Type 316 stainless steel. An automatic vent valve shall be thermostatically controlled to provide a swift means of venting during a sudden buildup of gases. This condition is most typically seen at start up. The manual vent valve shall contain a fixed orifice for continuous venting. Venting rate shall not exceed 0.1 of 1% of the rated deaerator capacity at 5 PSIG.

2.2 Deaerator Vessel

- A. The deaerated water storage tank shall have a minimum of 10 minutes of storage and have a capacity of _____ gallons measured to overflow. The tank shall be _____ diameter x _____ long. A 12 x 16 inch elliptical manway shall be provided for access to the deaerator. All nozzles 3" and under shall be 3000 lbs. forged steel couplings. All nozzles over 3" shall be 150 lbs. flat face flanges. Heads to be ASME torispherical type constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches. The tank shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 PSIG at 650 °F and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per Table UW-12, which does not require stress relieving or nondestructive examination.

- B. A quantity of two (2), ½ inch tapings for water sampling and chemical injection shall be provided under the water line.

2.3 Deaerator Load Specification

Load Specifications

LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Raw Make up		GPM		25 psig Minimum
Low Temperature Returns (Less than 200 °F)				10 psig Minimum
Med. Temp Returns (200 - 230 °F)				10 psig Minimum
High Temp Returns (greater than 230 °F)	Not To Exceed 25%			

2.4 Deaerator Standard Trim and Accessories

- A. The basic deaerator shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

2.5 Deaerator Make-Up Valve and Controller

- A. A _____ " inlet make-up water regulating valve with bronze body and threaded NPT connections that is electronically actuated. The valve shall be a globe style Siemens Flowrite VF 599 Series two-way valve designed to operate with an electronic actuator with a 3/4-inch (20 mm) stroke. The electronic actuator shall be the Siemens Flowrite EA 599 Series SKB/C Electronic Valve Actuator. The actuator shall receive a 0 to 10 Vdc or a 4 to 20 mA control signal to proportionally control the valve. The valve shall be rated for _____ GPM at _____ PSIG inlet pressure. The valve shall meet ANSI leakage class IV (0.01% of Cv) shutoff standards. The valve shall be normally closed, with stainless steel trim, linear control, include Teflon V-ring packing and be suitable for temperatures up to 330°F.
- B. A McDonnell & Miller 93-7B level controller shall electronically control the make-up valve.
- C. The make-up valve shall **optionally** be included in an assembly using an ANSI Class 125 LB three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

2.6 Deaerator Steam Pressure Reducing Valve (PRV) Station

- A. A _____ " steam pressure reducing valve with cast iron body and _____ connections. The valve shall be a self-contained unit capable of reducing _____ PSIG saturated steam to the operating pressure of the deaerator at a flow rate of _____ LBS./HR. The valve shall be 250 lb. class with stainless steel trim and an adjustable pilot. The valve manufacturer shall be Spence, Model _____.
- B. The steam pressure reducing valve shall **optionally** be included in an assembly using a three valve bypass with Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

2.7 Deaerator Safety Relief Valve(s) (SRV)

- A. Include a quantity of _____, _____" relief valves sized to relieve full capacity of the pressure reducing valve in the event of its failure. Valves to meet Paragraph UG-125 of ASME Unfired Pressure Vessel Code, Section VIII. Valve body to be of _____ construction. Relieving set pressure to be 50 PSIG. Relief valve manufacturer to be Kunkle, Model _____.

2.8 Deaerator Water Level Alarms

- A. A NEMA 1 high water alarm shall be an externally mounted float type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron.
- B. A NEMA 1 low water alarm shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron.
- C. A NEMA 1 low-water cutout alarm and switch shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron. The cutout will protect the pumps from a dry-run condition.

2.9 Deaerator Overflow Drainer

- A. A _____" overflow drainer sized to relieve full capacity at the operating pressure of the deaerator. The overflow drainer shall be a float type trap. The construction is to be a steel housing with stainless steel float ball. The overflow drainer manufacturer shall be Warren Model _____.

2.10 Deaerator Suction Piping

- A. Suction piping for pumps shall consist of a _____ gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 LB class construction. The vortex breaker shall be located in the tank nozzle.

2.11 Boiler Feedwater Pump and Motor Set

Pumps may be selected to run either on/off or intermittent.

Intermittent

- A. Quantity _____, vertically oriented, multistage centrifugal type boiler feedwater pump and motor set. Pump to be rated for _____ GPM at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have mechanical seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate channel and flexibly coupled with an OSHA type coupling guard to a _____ HP, _____ phase, _____ Hz, _____ Volt, _____ RPM, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be Grundfos Model _____k.

Continuous

- B. Quantity _____, vertically oriented, multistage centrifugal type boiler feedwater pump and motor set. Pump to be rated for _____ GPM at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have mechanical seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate channel and flexibly coupled with an OSHA type coupling guard to a _____ HP, _____ phase, _____ Hz, _____ Volt, _____ RPM, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be Grundfos Model _____ k. A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.

2.12 Deaerator Support Stand

- A. The _____ feet high stand shall elevate the deaerator tank to provide the net positive suction head required by the pump at the rated condition to prevent cavitation plus a 2 foot safety factor. The stand shall be constructed of heavy square steel tubing.
- B. The stand shall be designed for Seismic Zone 2B.
- C. Calculations for Seismic Zone 2B or a design upgrade to Seismic Zone 4 may be provided optionally.

2.13 Deaerator Control Panel

- A. Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.

2.14 Electric Components

- A. Audible and visual high, low-water and low-water cutout alarm functions shall be provided by a bell, horn or electronic sounder with silence switch and individual oil-tight lights. Control circuit transformer to supply 110-120 Volts, single-phase power supply. The transformer shall be mounted, wired and fused. Auxiliary contacts shall be optionally furnished per customer's requirements. Contacts shall be normally open.
- B. The deaerator shall have a gauge glass assembly that covers the operating range of the unit. The gauge glass shall be quartz, 0.625 inch diameter by 24 inch maximum length. Each length of glass shall be furnished with a bronze gauge cock set and protector rods. The deaerator shall be supplied with a pressure gauge that has a 4-1/2 inch dial with a 0-60 PSIG range and a thermometer with a 50 to 300 °F range.

2.15 Deaerator Preparation and Packaging

- A. The deaerator is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with enamel paint to not less than 1 mil thick prior to shipment.

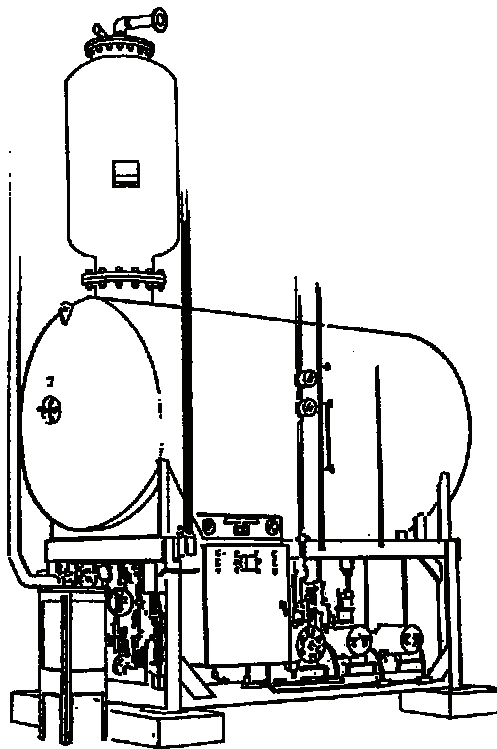
- B. The deaerator vessel, stand, controls and piping shall be packaged together as a complete system. The unit is to be disassembled for shipment. Piping is to be matched marked for ease of reassembly.

PART 3 EXECUTION

3.1 Deaerator Manuals and Warranty

- A. All units shall include three (3) bound, Operating and Maintenance manuals. The warranty period to be not less than twelve months after start-up or eighteen months after shipment, whichever comes first.
- B. Deaerator Options for Trim and Accessories
 - 1. The tank shall be optionally factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. The blanket insulation is to be fiberglass, 2" thick, 1 LB/CU-FT, and have a rating of R3.85. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 22 gauge (0.299") minimum and head thickness of 12 gauge (0.1046") minimum.
 - 2. The optional magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed.
 - 3. The optional chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.
 - 4. Additional discharge piping, manifold piping and recirculation piping may be provided optionally.

SECTION H4
BOILERMATE DEAERATORS



CONTENTS

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ILLUSTRATIONS

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Figure H4-2. Boilermate Deaerator Dimensions and Ratings – Sheet 1 of 2.....H4-8

Figure H4-3. Boilermate Tank Supports and Saddles, Details and Dimensions.....H4-10

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long-lasting boiler equipment for industrial and commercial boiler users. Built of corrosion-resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proven most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component and sizing information.

FEATURES AND BENEFITS

The following features and benefits apply to the Boilermate Deaerator product line. The Boilermate design uses a packed column to deaerate the water.

Less Mechanical Movement of Deaerator Components:

- The water spray valve is the only internal moving component within the deaerator vessel.

Two-Stage Deaeration in a Common Vessel:

- Recycle pumps are not required.
- Packaged for easy maintenance.

ASME Code Design (Section VIII):

- Assures deaerator vessel quality in materials and fabrication to meet safety requirements.

Internal Stainless Steel Vent Condenser:

- Protects deaerator vessel against corrosive gases while providing a means for removal of corrosive gases from boiler feedwater.

Self-Cleaning Water Spray Valve:

- Maintains deposit-free surface.
- Reduces maintenance requirements.

Internal Automatic-Check Valve Prevents Steam Back-Flow:

- The water spray valve is normally closed at no flow.
- Prevents steam back flow through the water spray valve at no flow conditions.

Removable Water Spray Inlet Assembly:

- Flanged assembly allows easy access for maintenance and/or inspections.

Stainless Steel Deaeration Assembly:

- Ensures a longer life of wetted materials in intimate contact with corrosive liquids and released corrosive gases.

Pressurized Tank Reduces Flashing and Minimal Venting:

- Recovery of exhaust and turbine steam.
- Saves Btu's that would normally be exhausted to atmosphere.
- Improves plant efficiency.

Auto Vent Valve Eliminates Gases at Start-Up:

- Atmospheric contamination virtually eliminated for incoming water.

Exceeds ASME Recommendations for Oxygen Level:

- Cleaver-Brooks deaerator is guaranteed to remove oxygen concentrations to 0.005 cc/liter while operating between 5 and 100% capacity.
- Carbon dioxide concentration is practically reduced to a zero.

Integral Level Control Automatically Introduces Cold Water Make-Up to Supplement Condensate Only When Necessary to Meet Boiler Demand:

- Saves Btu's by accepting condensate before cold make-up water. Maintains a minimal water level within the deaerator vessel to prevent damage to the boiler feedpumps, and to maintain system operation.

Variety of Tank Sizes to Handle Volume-Swings in Condensate Return:

- Provides flexibility for selecting a tank for specific applications to limit the loss of hot condensate to drain.

Packaged Units for Cost Effective Installation:

- Complete packages are pre-fabricated in the Cleaver- Brooks manufacturing facility to ensure piping alignment and control wiring function. The unit is partially disassembled, match marked for efficient field re-assembly.

Internal Pump Suction Vortex Breakers:

- Eliminates the problems of loss in NPSHA and cavitation associated with the creation of vortices within pump suction piping.

PRODUCT OFFERING

Information in this section applies directly to Cleaver-Brooks packaged boilermate deaerators ranging from 1,500 lbs/hr at 50 °F makeup to 135,000 lbs/hr at 200 °F make-up. Larger capacities can be obtained by using two columns. The Boilermate deaerator product offering is shown in Figure H4-1.

The Boilermate deaerator is a pressurized packed column, low maintenance system designed to remove dissolved oxygen in boiler feed water to 0.005 cc per liter or less and eliminate carbon dioxide. A typical deaerator package includes the packed column and storage tank mounted on a stand of appropriate height along with all operating controls, feed pumps assembled and piped (typically knocked down for shipment and field assembly). The tank conforms to Section VIII of the ASME Code.

The packed column design is best for handling high-temperature returns. The column is constructed of a carbon steel casing with a stainless steel liner. Built into a flange on top of the column is a spring loaded self-cleaning water spray nozzle and an automatic and manual vent valve.

From experience, large industrial plants and utilities have learned that the most practical and economical way to remove oxygen from feedwater is through mechanical deaeration. The Boilermate deaerator economically effects oxygen removal through a design that is trouble free in performance.

Raw water, untreated and not deaerated, contains as much as ten cubic centimeters of corrosion-causing oxygen per liter. Oxygen in water corrodes and shortens the life of boiler feed lines, boilers and condensate return lines.

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long-lasting boiler equipment for industrial and commercial boiler users. Built of corrosion-resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proved to most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component and sizing information.

The design of the Boilermate deaerator offers simplicity in both operation and service. The exchange packing, the heart of the deaerator, requires no maintenance. There are no moving parts to adjust or maintain. Installation is simple and quick.

Standard Equipment

- Boilermate column.
- Deaerator storage tank.
- Stainless steel exchange packing.
- Deaerator water inlet atomizing valve.
- Gauge glass.
- Deaerator manual and automatic vent valve.
- Steam pressure gauge.
- Feed water thermometer.
- Required tapings.

Optional Equipment

- Steam pressure reducing valve.
- Three valve bypass and strainer (PRV).
- Water level controller with make-up valve.
- Three valve bypass and strainer (MUV).
- Steam relief valves.
- High water alarm.
- Low water alarm.
- Low water pump cut off.
- High-temperature condensate diffuser tube (over 227 °F).
- Boiler feed pump and motor sets.
- Recirculation orifice or relief valve.
- Suction shutoff valve.
- Suction strainer.
- Suction flexible fitting.
- Discharge check valve.
- Discharge shutoff valve.
- Discharge pressure gauge.
- Discharge manifold.

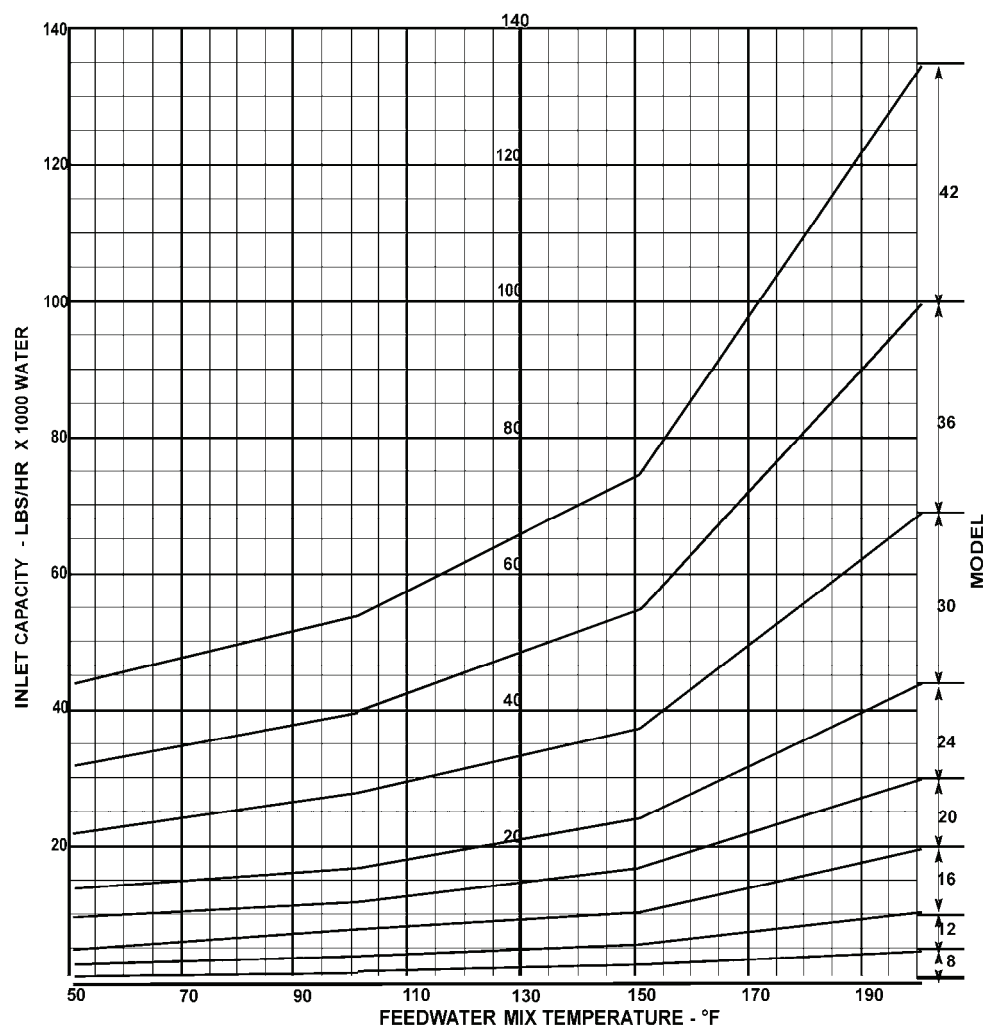
- Overflow drainer.
- Control panel.
- Chemical feed quill.
- Vacuum breaker.
- Insulation and lagging.
- Sentinel relief valve.
- Tank drain valve.
- Back pressure relief valve.
- Magnesium anode (not available with lined tanks).
- Stand.

Packaging

- Fully packaged, factory piped and wired.
- Half packaged, suitable for field erection with interconnecting piping and wiring by others.

DIMENSIONS AND RATINGS

Dimensions and ratings for BoilerMate Deaerators are shown in Figure H4-2 and Figure H4-3.

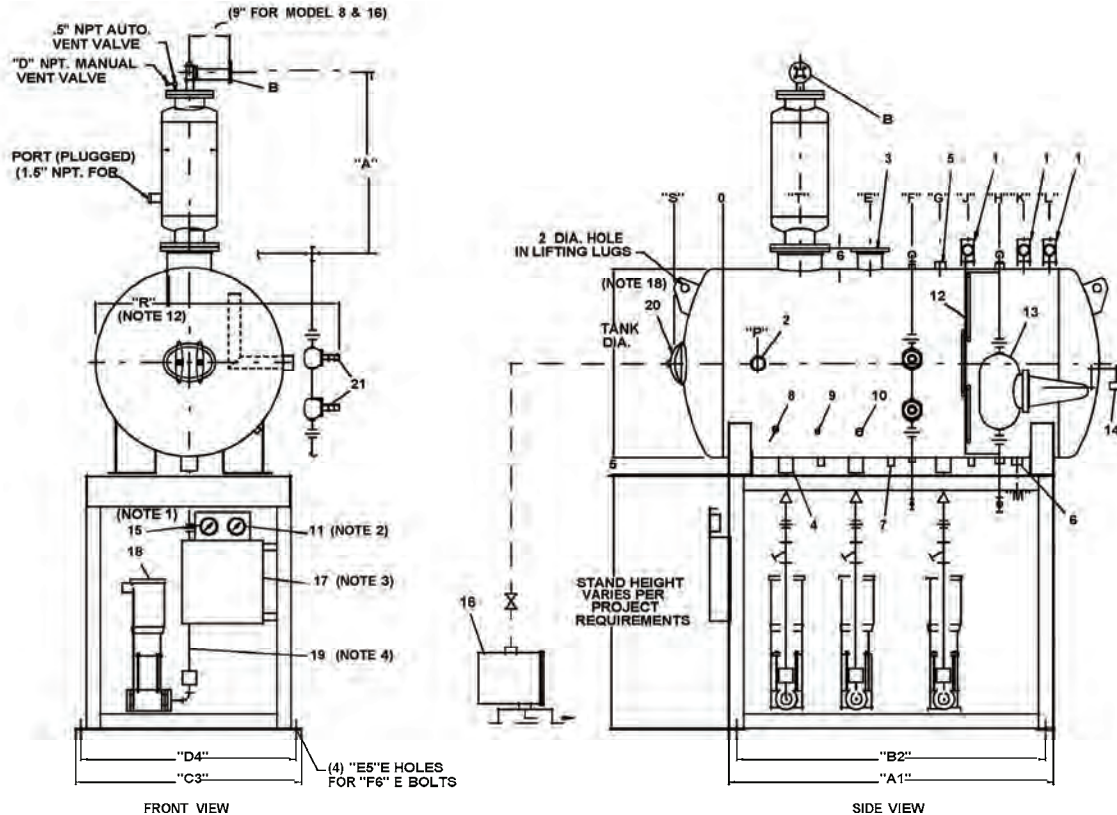


MODEL NO	*DEARERATOR CAPACITY LBS/HR							
	BM-8	BM-12	BM-16	BM-20	BM-24	BM-30	BM-36	BM-42
50°F	1,500	3,500	6,000	10,000	15,000	23,000	33,000	45,000
100°F	2,000	4,500	8,000	12,500	18,000	28,000	40,000	54,000
150°F	2,700	6,000	11,000	17,000	24,000	38,000	55,000	75,000
200°F	5,000	11,000	20,000	30,000	44,000	69,000	100,000	135,000
Weight (lbs) Including Packing	250	350	410	560	960	1,275	1,810	2,390

NOTE: Model Designation (example BM-8) is: BM = Boilermate Deaerator. 8 = size of packed column. Ratings for each column size vary with makeup water temperature.

* Capacities may be doubled by using two columns.

Figure H4-1. Cleaver-Brooks Boilermate Deaerator Selection Guide



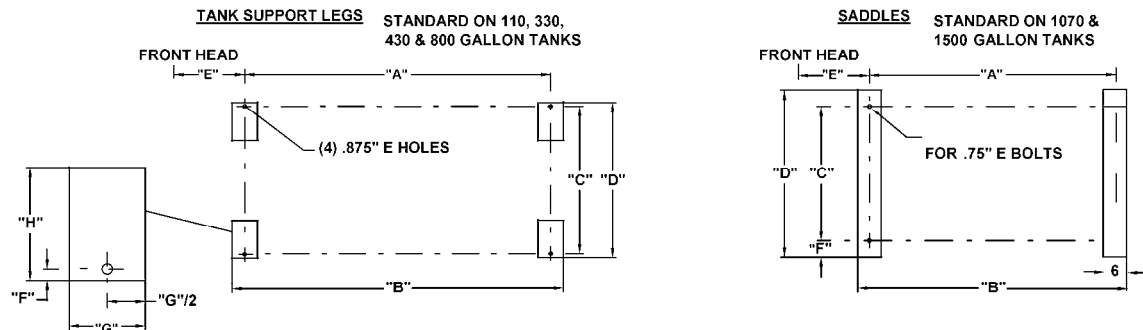
1. Mounted at dim. "M" (top of tank) on non-packaged units.
2. Tank mounted on non-packaged unit.
3. Packaged units only. Mounted on left end, right side of stand on 48" dia. 1070 gal 54" dia. 1500 gal as shown.
4. Suction piping includes strainer, gate valve and flexible connector.
5. All couplings are 3000# F.S.
6. All flanges are 150# F.F. except as noted.
7. Customer to plug all fittings not being used.
8. Mount tank above pump at elevation necessary for static head including safe allowance for piping friction as approved by pump manufacturer.
9. Tank is built to ASME Code.
10. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
11. Add suffix "P" to Model no. for packaged units (BMP-24).
12. Dimension "R" will change depending on controls required- contact your local Cleaver-Brooks authorized representative.
13. No interconnecting piping or wiring furnished on non-packaged units unless specified, contact your local Cleaver-Brooks authorized representative for specific piping or wiring furnished on packaged assemblies.
14. Weights shown are without controls or packaging - contact your local Cleaver-Brooks authorized representative for additions.
15. Capacities other than shown as standard available by using two columns - contact your local Cleaver-Brooks authorized representative.
16. Optional tank sizes available - contact your local Cleaver-Brooks authorized representative.
17. Lifting lugs are for lifting empty tank only.
18. Manway is standard. Manufacturing may require a larger manway for fabrication. See dimensional diagram for actual size.

COLUMN DETAILS AND DIMENSIONS									
BOILERMATE MODEL NO.		8	12	16	20	24	30	36	42
A	Height	46	48.5	58	62	64	71.5	78.5	80
B	Water Inlet (150# RF Flg)	1.25	1.5	1.5	2	2	2.5	3	4
C	Column Outside Diameter	8.63	12.8	16	20	24	30	36	42
D	Manual Vent Valve Size	.5" NPT	.5" NPT	.75" NPT	.75" NPT	.75" NPT	1" NPT	1.5" NPT	2" NPT
	2" NPT Column Weight (lb)	250	350	450	600	750	850	1050	1300
	Volume Packing (Cu ft)	0.7	1.6	3.0	5.0	8.0	12.0	18.0	29.0
	Packing Weight (lb)	25	50	150	200	300	450	650	1050

Figure H4-2. BoilerMate Deaerator Dimensions and Ratings – Sheet 1 of 2

RATINGS						
Cap (Gal to Overflow)	110	330	430	800	1070	1500
Tank Weight (Dry) (lb)	750	1200	1400	1900	2500	2750
Tank Weight (Flooded) (lb)	1850	4250	5300	9100	12700	15600
Tank Size (Dia x Length)	24 x 70	36 x 86	36 x 110	48 x 114	54x 127	60 x 129
TANK DIMENSIONS						
E	Steam Inlet	29	33	53	60	
F	Level Alarm	23	26	45	50	
G	High Temp Return	35	21	39	43	
H	Level Control	42	41	61	69	
J	Relief Valve	48	50	69	77	
K	Relief Valve	N/A	60	79	86	
L	Relief Valve	N/A	N/A	N/A	95	
M	Drain	36	47	76	93	
P	Overflow	Rear Hd	60	10	10	
R	Overall Width	39	51	51	63	75
S	Front Head	6	8	8	10	11
T	Column	8.5	8.5	22	12	
STANDARD DIMENSIONS						
A1	Overall Length	54	61	86	101	
B2	C/L to C/L Bolt Holes	49	56	80	95	
C3	Overall Width	42	49	64	71	
D4	C/L to C/L Bolt Holes	39	46	61	68	
E5	Hole Size	0.75	1	1	1.125	
F6	Anchor Bolt Size	0.625	0.875	0.875	1	
CONNECTIONS & TRIM						
1	Relief Valve Size	Contact your local Cleaver-Brooks authorized representative				
2	Overflow Size	1.25" NPT	2" NPT	3" NPT	3" NPT	
3	Steam Inlet Size	2" NPT	3" NPT	4"-150# FF	6"-150# FF	6"-150# FF
4	Suction Size	3" NPT	3" NPT	3" NPT	4"-150# FF	
5	High Temp Return Size	1" NPT	1.5" NPT	2" NPT	3" NPT	
6	Drain Size	2" NPT	2" NPT	2" NPT	2" NPT	
7	Recirc (1" NPT)					
8	Thermometer (.75" NPT)					
9	Sample (.5" NPT)					
10	Chem Feed (1" NPT)					
11	Thermometer					
12	Gauge Glass Assy					
13	Level Controller					
14	Make-Up Valve					
15	Pressure Gauge					
16	Overflow Drainer (Opt)					
17	Control Panel (Opt)					
18	Feed Pump/Motor (Opt)					
19	Suction Piping, (Opt)					
20	Manway, 12 x 16					
21	Level Alarms (Opt)					

Figure H4-2. Boilermate Deaerator Dimensions and Ratings – Sheet 2 of 2



TANK CAPACITY (GAL.)						
MODEL	110	330	430	800	1070	1500
	LEGS	SADDLES				
A	48.5	55.5	80		95	
B	54	61	85.5	86.5	101	
C	22.5	29.5	29.5	38	44.75	
D	24.25	31.25	31.25	40	51.5	57
E	11	15	15	17	16	17
F	0.875	0.875	0.875	1	3.38	6.13
G	5.5	5.5	5.5	6.5	N/A	
H	7	7	7	9.75	N/A	

Figure H4-3. Boilermate Tank Supports and Saddles, Details and Dimensions

RETURN ON INVESTMENT

Payback for a pressurized deaerator verses an atmospheric boiler feed system is based on an additional capital expenditure required divided by the yearly operating cost savings. The differential in yearly operating costs are in the following areas:

- Flash steam
- Exhaust steam
- Blowdown
- Chemical treatment
- Makeup water
- Sewer
- Intangibles

Flash Steam	A percentage of the high-pressure condensate returns will flash to steam and be lost in an atmospheric vessel application. This flash steam loss can be converted to an energy loss and associated fuel cost.
Exhaust Steam	Exhaust steam cannot be recovered in an atmospheric vessel application. This exhaust steam loss can be converted to energy loss and associated fuel cost. An example would be steam turbine exhaust.
Surface Blowdown	Increased makeup water is required because of lost flash and exhaust steam. This increase in makeup water requires an increase of surface blowdown. This is directly related to cycles of concentration in the boiler. The additional blowdown loss can be converted to an energy loss and associated fuel cost. The additional surface blowdown may also result in an increase in capital expenditure for a larger blowdown heat recovery system.
Chemical Treatment	Dissolved oxygen content in an atmospheric boiler feedwater system is a function of water temperature. Lowering the dissolved oxygen content below what is naturally present, based on mixed water temperature at atmospheric pressure, requires the addition of a chemical treatment program. The most common oxygen scavenger used is sodium sulfite. Sodium sulfite reacts with dissolved oxygen as follows: Theoretically, it takes approximately 8 ppm of sodium sulfite as Na_2SO_3 to scavenge 1 ppm of dissolved O_2 $2\text{Na}_2\text{SO}_3 + \text{O}_2 \rightarrow 2\text{Na}_2\text{SO}_4$
Makeup Water	Increased make-up water is required because of lost flash steam, lost exhaust steam, and additional surface blowdown. This additional makeup water can be associated to a cost. Makeup water cost should be a combination of the utility charge plus pretreatment equipment consumable costs.
Sewer	Utilities often base a sewer charge on make-up water usage. Increased makeup water usage with an associated increase in surface blowdown can affect these costs.
Intangibles	Some cost savings are difficult to calculate - in general, best practices in deaeration will prolong the life of boiler room equipment, reducing repair and maintenance costs.

Notes

SECTION H4
BOILERMATE DEAERATORS

SAMPLE SPECIFICATIONS

PART 1 GENERAL.....H4-14

 1.01 General H4-14

PART 2 PRODUCTS.....H4-14

 2.01 Hardware H4-14

 A. Deaerator H4-14

 B. Make Up Valve and Controller.....H4-15

 C. Steam Pressure Reducing Station H4-16

 D. Boiler Feedwater Pump and Motor Set H4-17

 E. Control Panel H4-17

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

PART 1 GENERAL

1.01 General

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application

PART 2 PRODUCTS

2.01 Hardware

A. Deaerator

1. Cleaver-Brooks Model _____ packed column type, pressurized, horizontal deaerator is rated at _____ pounds per hour at _____ °F mixed inlet water temperature. The system shall be of the single tank design and guarantee oxygen removal to not more than 0.005 CCS/liter in the effluent throughout all load conditions between 5 and 100 percent. Tray-type designs are not acceptable. The deaerator shall be designed for operation at 5 psig, but shall be suitable for use from 2 to 15 psig. Atmospheric operating designs are not acceptable.
2. Feedwater and condensate shall be admitted to the deaerator through a single spring-loaded, self-cleaning, adjustable stainless steel spray valve, which shall provide proper internal vent condensing and water distribution at any load between 5 and 100 percent of rated capacity. The water temperature in the primary heating and vent concentrating section is to be raised within 2 or 3 °F of steam temperature and most of the gases released. The water is then to drop down through the column's stainless steel exchange packing counterflow to the steam, which enters at the top of the storage tank and rises up through the column. The column is to be _____" in length and _____" in diameter. The column shall have a stainless liner and grid support. Hot, gas-free water is to then drop to the storage compartment to complete the cycle. The steam and non-condensables are to flow upward, through the primary heating spray, into the internal vent concentrating section, where they contact the cold influent water. Here, the steam is to be condensed to continue the cycle. Released gases are discharged to atmosphere through the vent outlet. All internal surfaces, which come in contact with un-deaerated water, shall be constructed of Type 316 stainless steel.
3. Automatic vent valve shall be thermostatically controlled to provide a fast means of venting when a sudden buildup of gases occurs, such as seen at start up. The manual vent valve shall have an orifice for continuous minimum venting. Venting rate shall not exceed 0.1 of 1% of the rated deaerator capacity at 5 psig.

Load Specifications

LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Make up				25 psig Minimum
Pumped Low Temp Returns				10 psig Minimum
High Temp Returns	Not To Exceed 30%			

4. The deaerated water storage tank shall have _____ minutes of storage and have a capacity of _____ gallons measured to overflow. The tank shall be _____ diameter x _____ long. An 11" x 15" elliptical manhole shall be provided for access. All nozzles 3" and under shall be 3000 lbs forged steel couplings and over 3" shall be 150 lbs flat face flanges. Heads to be ASME torispherical type constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches. The tank and column shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 psig at 650 °F and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per table UW-12, which does not require stress relieving or nondestructive examination.
5. The deaerator loads shall be as specified in the table below. Low temperature returns are defined as condensate with a temperature below that of the deaerator operating temperature. High temperature returns are defined as condensate with a temperature above that of the deaerator operating temperature.
6. Optional - The tank and column shall be factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. Block-type insulation is not acceptable. The blanket insulation is to be fiberglass, 2" thick, 1 lb/cubic foot, and have a rating of R3.85. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 22 gauge (0.299") minimum and head thickness of 12 gauge (0.1046") minimum.
7. Optional - The magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed. Linings shall not be acceptable in this application.
8. Optional - The high temperature diffuser or sparge tube shall be located beneath the normal tank water level. The tube shall be constructed of 2 inch pipe. This tube shall provide even distribution and blending of high-temperature condensate returns.
9. Optional - The chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.
10. Optional - The basic deaerator shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

B. Make Up Valve and Controller

1. Option (Mechanical) - _____ " inlet water regulating lever valve with _____ body and _____ connections. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. The pressure drop across the valve shall not exceed a delta-P of 10 psig. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____ Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____, Model _____.
2. Option (Electronic) - _____ " inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional type with a permanently lubricated gear train, and be directly coupled to the valve stem. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have

teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Cleaver-Brooks Model TW82. A solenoid valve and float switch are not acceptable. (Available only in the U.S.)

3. Option (Pneumatic) - _____ " inlet water diaphragm actuated regulating valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for 3 – 15 psig operating signal. The valve shall be normally open on loss of air. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____, Model _____. A filter regulator is to be provided to reduce 50 psig instrument air supply to 3 - 15 psig for proper operation.
4. Optional - The make up valve shall include a ANSI Class 125 lb three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

C. Steam Pressure Reducing Station

1. Option (Mechanical) - _____ " steam pressure reducing valve with cast iron body and _____ connections. The valve shall be a self-contained unit capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. The valve shall be 250 lb class with stainless steel trim and an adjustable pilot. The valve manufacturer shall be _____ Model _____.
2. Option (Pneumatic) - _____ " diaphragm actuated steam pressure reducing valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for _____ psig operating signal. The valve shall be normally closed on loss of air. The valve shall be capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. This valve shall be 250 lb class and have stainless steel trim. The diaphragm actuated valve manufacturer shall be _____ Model _____. This valve shall be pneumatically controlled by an external transmitter. The transmitter set pressure shall be adjustable. The transmitter manufacturer shall be _____, Model _____.
3. Optional - The steam pressure reducing valve shall include a three valve bypass with Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.
4. Optional - Quantity _____, _____ " relief valves sized to relieve full capacity of the pressure reducing valve in the event of its failure. Valves to meet Paragraph UG-125 of ASME Unfired Pressure Vessel Code, Section VIII. Valve body to be of bronze construction. Relieving set pressure to be 50 psig. Relief valve manufacturer to be _____, Model _____.

5. Optional - High level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
6. Optional - Low level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
7. Optional - _____" overflow drainer sized to relieve full capacity at the operating pressure of the deaerator. The overflow drainer shall be a float type trap. The construction is to be a steel housing with stainless steel float ball. The overflow drainer manufacturer shall be _____, Model _____.
8. Optional - Suction piping for pumps shall consist of a gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 lb class construction. The vortex breaker shall be located in the tank nozzle. Manifold suction lines are not acceptable.

D. Boiler Feedwater Pump and Motor Set

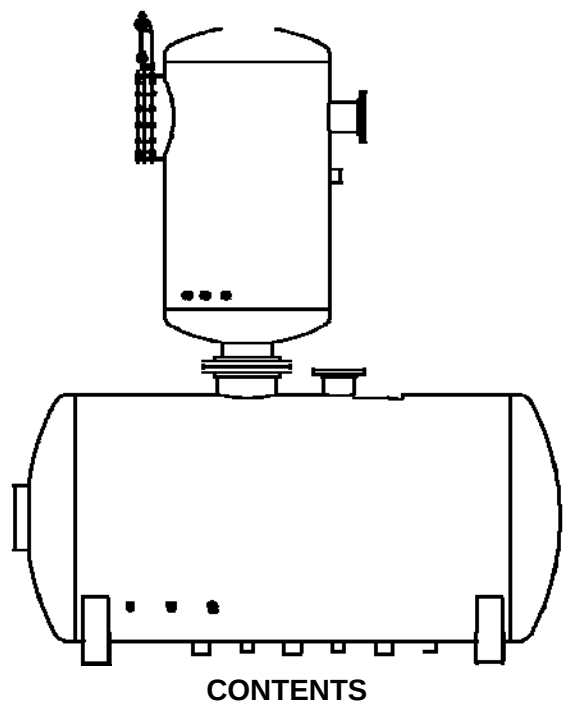
1. Option (Intermittent) - Quantity _____, turbine type boiler feedwater pump and motor set. Centrifugal type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____".
2. Option (Continuous) - Quantity _____, centrifugal type boiler feedwater pump and motor set. Turbine type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____". A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.
3. Optional - The stand shall elevate the deaerator tank to provide the net positive suction head required by the pump at the rated condition to prevent cavitation plus a 1-1/2 foot safety factor. The stand shall be constructed of heavy square steel tubing for the legs and 1/4" steel plate covering the floor.

E. Control Panel

1. Optional (Base) - Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.

2. Optional (Electric Components) - Audible and visual high and low water alarm function shall be provided by a bell or horn with silence switch and individual red oil-tight lights.
 - a. Control circuit transformer to supply 110-120 volts, single-phase power supply. The transformer shall be mounted, wired and fused.
 - b. Auxiliary contacts shall be furnished for chemical feed pump initiation. Contacts shall be normally open.
3. Standard
 - a. The deaerator shall have a gauge glass assembly that covers the entire tank diameter. The gauge glass shall be quartz 0.625 inch diameter by 24 inch maximum length. Each length of glass shall be furnished with a bronze gauge cock set and protector rods.
 - b. The deaerator shall be supplied with a pressure gauge that has a 4-1/2 inch dial with a 0-60 psig range and a thermometer with a 50 to 300 °F range. Packaged units are required to have both gauges bracket-mounted at eye level.
 - c. The deaerator is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with an enamel paint to not less than 1 mil thick prior to shipment.
 - d. Unit is to be knocked down for shipment. Piping is to be matched marked. Three bound Operating and Maintenance manuals to be provided. Warranty period to be twelve months after start-up or eighteen months after shipment, whichever comes first.

TRAYMASTER DEAERATORS



FEATURES AND BENEFITS H3-2

PRODUCT OFFERING H3-3

DIMENSIONS AND RATINGS H3-6

RETURN ON INVESTMENT H3-10

SAMPLE SPECIFICATIONS H3-11

ILLUSTRATIONS

Figure H3-1. Traymaster Deaerator Dimension Diagram.....H3-6

Figure H3-2. Storage Tank Saddle Footprint H3-9

FEATURES AND BENEFITS

The following features and benefits apply to the Traymaster Deaerator product line.

Less Mechanical Movement of Deaerator Components:

- The water spray valve is the only internal moving component within the deaerator vessel.

Two-Stage Deaeration in a Common Vessel:

- Recycle pumps are not required.
- Packaged for easy maintenance.

ASME Code Design (Section VIII):

- Assures deaerator vessel quality in materials and fabrication to meet safety requirements.

Internal Stainless Steel Vent Condenser:

- Protects deaerator vessel against corrosive gases while providing a means for removal of corrosive gases from boiler feedwater.

Self-Cleaning Water Spray Valve:

- Maintains deposit-free surface.
- Reduces maintenance requirements.

Internal Automatic-Check Valve Prevents Steam Back-Flow:

- The water spray valve is normally closed at no flow.
- Prevents steam back flow through the water spray valve at no flow conditions.

Stainless Steel Deaeration Assembly:

- Ensures a longer life of wetted materials in intimate contact with corrosive liquids and released corrosive gases.

Pressurized Tank Reduces Flashing and Minimizes Venting:

- Recovery of exhaust and turbine steam.
- Saves BTUs that would normally be exhausted to atmosphere.
- Improves plant efficiency.

Auto Vent Valve Eliminates Gases at Start-Up:

- Atmospheric contamination virtually eliminated for incoming water.

Exceeds ASME Recommendations for Oxygen Level:

- Cleaver-Brooks deaerator is guaranteed to remove oxygen concentrations to 0.005 cc/liter while operating between 5 and 100% capacity.
- Carbon dioxide concentration is practically reduced to zero.

Integral Level Control Automatically Introduces Cold Water Make-Up to Supplement Condensate Only When Necessary to Meet Boiler Demand:

- Saves BTUs by accepting condensate before cold make-up water. Maintains a minimal water level within the deaerator vessel to prevent damage to the boiler feedpumps, and to maintain system operation.

Variety of Tank Sizes to Handle Volume-Swings in Condensate Return:

- Provides flexibility for selecting a tank for specific applications to limit the loss of hot condensate to drain.

Packaged Units for Cost Effective Installation:

- Complete packages are pre-fabricated in the Cleaver- Brooks manufacturing facility to ensure piping alignment and control wiring function. The unit is partially disassembled, match marked for efficient field re-assembly.

Internal Pump Suction Vortex Breakers:

- Eliminates the problems of loss in NPSHA and cavitation associated with the creation of vortices within pump suction piping.

PRODUCT OFFERING

Information in this section applies directly to Cleaver-Brooks packaged Traymaster deaerators ranging from 30,000 lbs/hr to 500,000 lbs/hr at 50 °F makeup.

The Traymaster deaerator is a pressurized low maintenance system designed to remove dissolved oxygen in boiler feed water to 0.005 cc per liter or less and eliminate carbon dioxide. A typical deaerator package includes the tray column and storage tank mounted on a stand of appropriate height along with all operating controls, feed pumps assembled and piped (typically knocked down for shipment and field assembly). The tank conforms to Section VIII of the ASME code.

The tray column design is best for handling high-temperature returns. The column is constructed of carbon steel. Built into the top of the tray box is a spring loaded self-cleaning water spray nozzle. Automatic and manual vent valves are built into the top of the vent condenser.

From experience, large industrial plants and utilities have learned that the most practical and economical way to remove oxygen from feedwater is through mechanical deaeration. The Traymaster deaerator economically effects oxygen removal through a design that is trouble free in performance.

Raw water, untreated and not deaerated, contains as much as ten cubic centimeters of corrosion-causing oxygen per liter. Oxygen in water corrodes and shortens the life of boiler feed lines, boilers and condensate return lines.

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long- lasting boiler equipment for industrial and commercial boiler users. Built of corrosion-resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proved to most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component and sizing information.

The design of the Traymaster deaerator offers simplicity in both operation and service. The tray section, the heart of the deaerator, requires no maintenance. There are no moving parts to adjust or maintain. Installation is simple and quick.

Standard Equipment

- Tray column.
- Deaerator storage tank.
- Stainless steel trays of riveted construction.
- Deaerator water inlet atomizing valve.
- Gauge glass.
- Deaerator manual and automatic vent valve.
- Steam pressure gauge.
- Feed water thermometer.
- Required tapings.

Optional Equipment

- Steam pressure reducing valve.
- Three valve bypass and strainer (PRV).
- Water level controller with make-up valve.
- Three valve bypass and strainer (MUV).
- Steam relief valves.
- High water alarm.
- Low water alarm.
- Low water pump cut off.
- High-temperature condensate diffuser tube (over 227 °F).
- Boiler feed pump and motor sets.
- Recirculation orifice or relief valve.
- Suction shutoff valve.
- Suction strainer.
- Suction flexible fitting.
- Discharge check valve.
- Discharge shutoff valve.
- Discharge pressure gauge.
- Discharge manifold.
- Overflow drainer.
- Control panel.
- Chemical feed quill.
- Vacuum breaker.
- Insulation and lagging.

- Sentinel relief valve.
- Tank drain valve.
- Back pressure relief valve.
- Magnesium anode.
- Stand.

Packaging

- Fully packaged, factory piped and wired.
- Half packaged, suitable for field erection with interconnecting piping and wiring by others.

DIMENSIONS AND RATINGS

Dimensions and ratings for Traymaster Deaerators are shown in the following figures and tables.

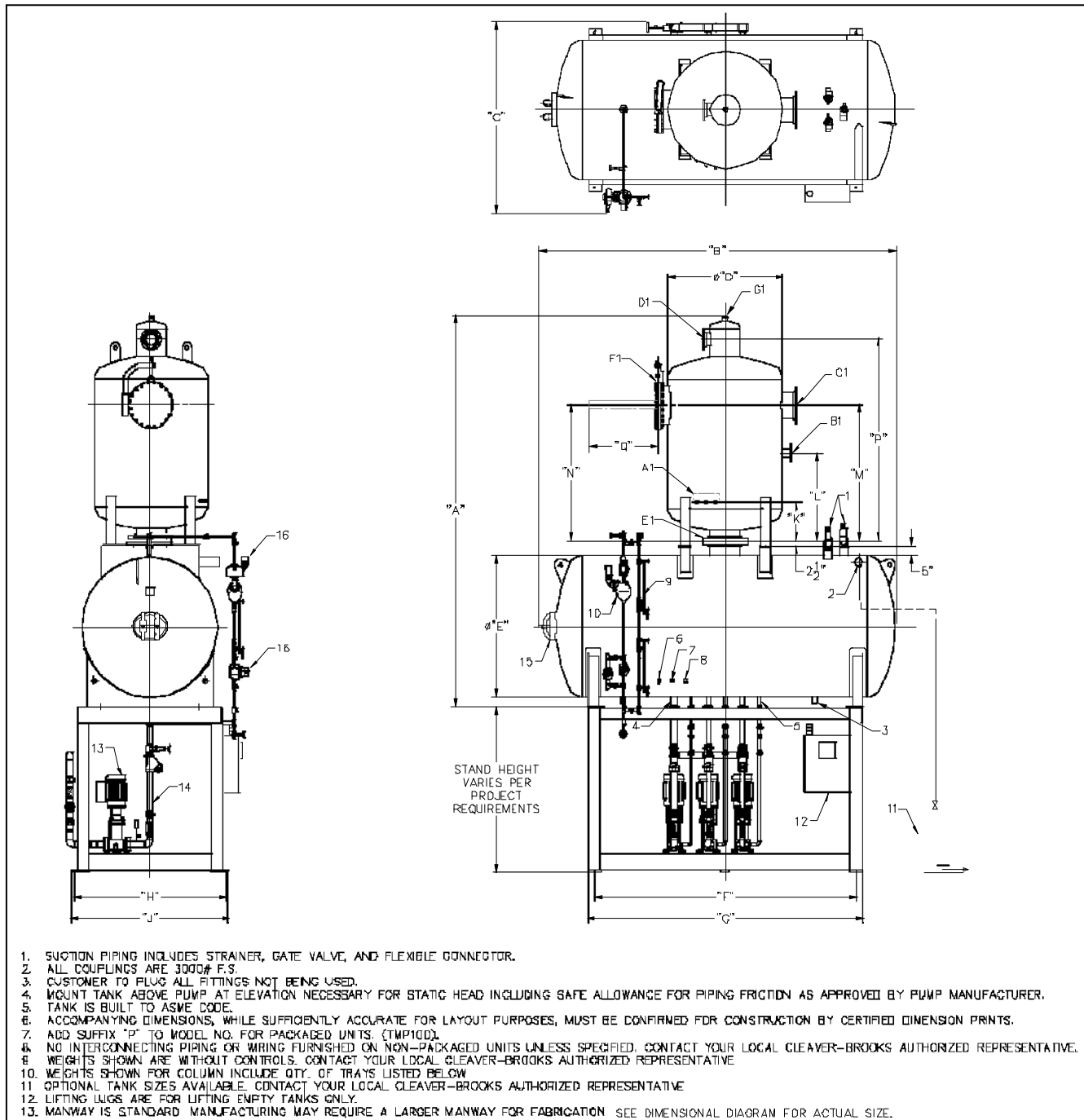


Figure H3-1. Traymaster Deaerator Dimension Diagram

Table H31. Dimensions, TM030-TM125

TRAYMASTER DETAILS AND DIMENSIONS						
MODEL NUMBER		TM030	TM045	TM070	TM100	TM125
A	HEIGHT ABOVE STAND	143	154	169	179-1/2	197-1/2
B	OVERALL LENGTH	120-1/2	133	137	160	168
C	OVERALL WIDTH	75	78	85	91	97
D	COLUMN DIAMETER	36	36	48	54	54
E	STORAGE TANK DIA.	42	48	60	66	72
F	C/L TO C/L BOLT HOLES	79-1/2	95	95	112-1/2	112-1/2
G	STAND LENGTH	84-1/2	101	101	119-1/2	119-1/2
H	C/L TO C/L BOLT HOLES	55	59	68	73	80
J	STAND WIDTH	58	62	71	76	83
K	TEMP./PRESS. SENSOR	15-5/8	15-5/8	18	23-7/8	18-7/8
L	HIGH TEMP. RETURN	41-5/8	39-5/8	40	40-7/8	52-3/4
M	STEAM INLET	54-5/8	52-5/8	55	55-7/8	67-3/4
N	DAVITED MANWAY	54-5/8	52-5/8	55	55-7/8	67-3/4
P	WATER INLET	SEE "A"	81-3/8	84-1/4	87-1/8	99-1/8
Q	TRAY CLEARANCE	18	24	36	36	36
TRAY QTY.		20	20	20	30	36
COLUMN WEIGHT (LB)		1600	1800	2300	3000	3300
STORAGE TANK CAPACITY (GAL.)		600	900	1400	2000	2500
STORAGE TANK WEIGHT (DRY) (LB)		1500	1800	2400	3800	4300
STORAGE TANK WEIGHT (FLOODED) (LB)		6500	9300	14000	20500	25100
COLUMN CONNECTIONS						
MODEL NUMBER		TM030	TM045	TM070	TM100	TM125
A1	TEMP./PRESS. SENSOR	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT
B1	HIGH TEMP. RETURN	2" NPT	2" NPT	2-1/2" NPT	3" NPT	3" NPT
C1	STEAM INLET	6"-150# RFSO	8"-150# RFSO	8"-150# RFSO	10"-150# RFSO	10"-150# RFSO
D1	WATER INLET	2-1/2"-150# RFSO	3"-150# RFSO	3"-150# RFSO	4"-150# RFSO	4"-150# RFSO
E1	DOWNCOMER	10"-150# FFSO	12"-150# FFSO	14"-150# FFSO	16"-150# FFSO	16"-150# FFSO
F1	MANWAY	16"	18"	18"	20"	20"
G1	VENT PIPE	3/4" NPT	1-1/2" NPT	1-1/2" NPT	2" NPT	2" NPT

Table H32. Dimensions, TM140-TM250

TRAYMASTER DETAILS AND DIMENSIONS						
MODEL NUMBER		TM140	TM175	TM200	TM225	TM250
A	HEIGHT ABOVE STAND	200	218-1/2	218-1/2	232	232
B	OVERALL LENGTH	186	188	197	190-1/2	195-1/2
C	OVERALL WIDTH	97	107-1/2	107-1/2	119	119
D	COLUMN DIAMETER	60	72	72	72	72
E	STORAGE TANK DIA.	72	84	84	96	96
F	C/L TO C/L BOLT HOLES	137	135-1/2	137	127-1/2	137
G	STAND LENGTH	144	142-1/2	144	134-1/2	144
H	C/L TO C/L BOLT HOLES	80	88-1/2	88-1/2	99	99
J	STAND WIDTH	83	91-1/2	91-1/2	102	102
K	TEMP./PRESS. SENSOR	20	21-7/8	21-7/8	21-7/8	24-3/8
L	HIGH TEMP. RETURN	45	44-7/8	44-7/8	44-7/8	47-3/8
M	STEAM INLET	69-1/2	69-7/8	69-7/8	69-7/8	72-3/8
N	DAVITED MANWAY	69-1/2	69-7/8	69-7/8	69-7/8	72-3/8
P	WATER INLET	103-1/4	107-1/8	107-1/8	108-1/8	109-5/8
Q	TRAY CLEARANCE	36	36	36	36	36
TRAY QTY.		42	42	56	65	70
COLUMN WEIGHT (LB)		3700	3700	5600	5800	6000
STORAGE TANK CAPACITY (GAL.)		2800	3500	4000	4500	5000
STORAGE TANK WEIGHT (DRY) (LB)		4700	6600	6900	7900	8100
STORAGE TANK WEIGHT (FLOODED) (LB)		28000	35800	40200	45400	49800
COLUMN CONNECTIONS						
MODEL NUMBER		TM140	TM175	TM200	TM225	TM250
A1	TEMP./PRESS. SENSOR	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT
B1	HIGH TEMP. RETURN	4"-150# RFSO	6"-150# RFSO	6"-150# RFSO	6"-150# RFSO	8"-150# RFSO
C1	STEAM INLET	12"-150# RFSO	14"-150# RFSO	14"-150# RFSO	16"-150# RFSO	16"-150# RFSO
D1	WATER INLET	6"-150# RFSO	6"-150# RFSO	6"-150# RFSO	6"-150# RFSO	6"-150# RFSO
E1	DOWNCOMER	16"-150# FFSO	18"-150# FFSO	18"-150# FFSO	18"-150# FFSO	20"-150# FFSO
F1	MANWAY	20"	24"	24"	24"	24"
G1	VENT PIPE	2" NPT	2-1/2" NPT	2-1/2" NPT	3" NPT	3" NPT

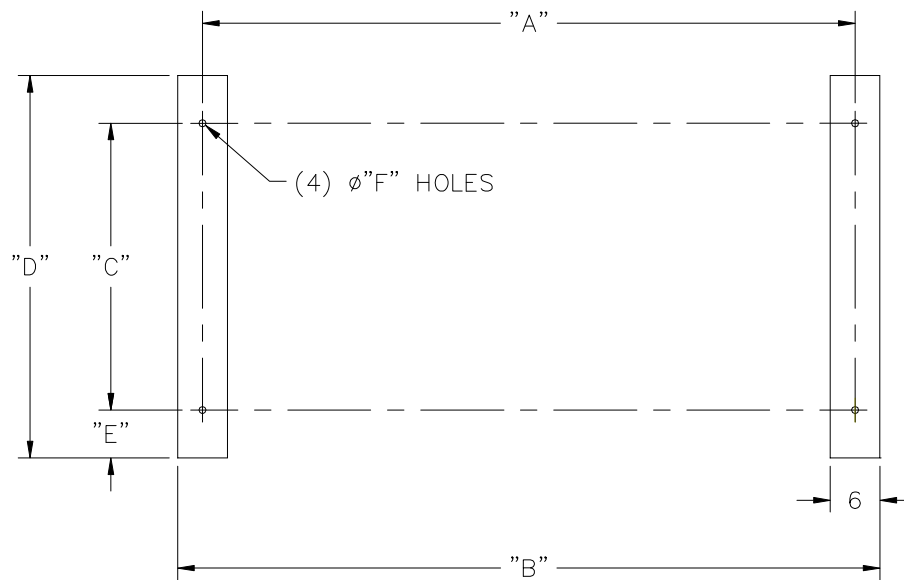
Table H33. Dimensions, TM300-TM500

TRAYMASTER DETAILS AND DIMENSIONS						
MODEL NUMBER		TM300	TM350 TM400	TM450 TM500		
A	HEIGHT ABOVE STAND	252	259	260-1/2	262-1/2	262-1/2
B	OVERALL LENGTH	198	205-1/2	246	258-1/2	304
C	OVERALL WIDTH	130	130 130 130	130		
D	COLUMN DIAMETER	84	96	108	108 108	
E	STORAGE TANK DIA.	108	108 108 108	108		
F	C/L TO C/L BOLT HOLES	137	144 185 197	243		
G	STAND LENGTH	144	151 192 204	250		
H	C/L TO C/L BOLT HOLES	110	110 110 110	110		
J	STAND WIDTH	113	113 113 113	113		
K	TEMP./PRESS. SENSOR	24-1/4	27-1/2	28-3/4	28-3/4	28-3/4
L	HIGH TEMP. RETURN	41-1/4	43	44-1/4	40-1/4	40-1/4
M	STEAM INLET	68-1/4	70	71-1/8	71-1/4	71-1/8
N	DAVITED MANWAY	68-1/4	70	69-1/4	69-1/4	69-1/4
P	WATER INLET	112-3/8	119-3/8	102-5/8	120-5/8	119-5/8
Q	TRAY CLEARANCE	36	36 36 36 36			
TRAY QTY.		84	98	120	132 144	
COLUMN WEIGHT (LB)		7300	8500	10700	10900	11100
STORAGE TANK CAPACITY (GAL.)		6000	7000 8000 9000			10000
STORAGE TANK WEIGHT (DRY) (LB)		11000	11400	13200	13700	15700
STORAGE TANK WEIGHT (FLOODED) (LB)		61000	69700	79900	88700	99000
COLUMN CONNECTIONS						
MODEL NUMBER		TM300	TM350 TM400	TM450 TM500		
A1	TEMP./PRESS. SENSOR	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT
B1	HIGH TEMP. RETURN	8"-150# RFSO	8"-150# RFSO	10"-150# RFSO	10"-150# RFSO	10"-150# RFSO
C1	STEAM INLET	18"-150# RFSO	18"-150# RFSO	20"-150# RFSO	20"-150# RFSO	22"-150# RFSO
D1	WATER INLET	8"-150# RFSO	8"-150# RFSO	8"-150# RFSO	8"-150# RFSO	10"-150# RFSO
E1	DOWNCOMER	24"-150# FFSO	30"-150# FFSO	36"-150# FFSO	36"-150# FFSO	36"-150# FFSO
F1	MANWAY	28"	28" 36" 36" 36"			
G1	VENT PIPE	3" NPT	3" NPT	3" NPT	4" NPT	4" NPT

Table H34. Connections and Trim

CONNECTIONS AND TRIM		
MODEL NUMBER		TM030 - TM500
1	RELIEF VALVE SIZE	CONTACT YOUR LOCAL CLEAVER-BROOKS AUTHORIZED REPRESENTATIVE
2	OVERFLOW SIZE	
3	DRAIN SIZE	
4	SUCTION SIZE	
5	RECIRC.	
6	THERMOMETER (3/4" NPT)	
7	SAMPLE (1/2" NPT)	
8	CHEM. FEED (1" NPT)	
9	GAUGE GLASS ASSEMBLY	
10	LEVEL CONTROLLER	
11	OVERFLOW DRAINER (OPT)	
12	CONTROL PANEL (OPT)	
13	FEED PUMP/MOTOR (OPT)	
14	SUCTION PIPING (OPT)	
15	MANWAY 12" X 16"	
16	LEVEL ALARMS (OPT)	
17	VACUUM BREAKER	

Figure H3-2. Storage Tank Saddle Footprint



TANK CAPACITY (GAL.)															
	600	900	1400	2000	2500	2800	3500	4000	4500	5000	6000	7000	8000	9000	10000
TANK DIA.	42	48	60	66	72	72	84	84	96	96	108	108	108	108	108
A	79	94	95	113-1/2	113-1/2	138	136-1/2	138	128	138	138	145	186	198	244
B	84-1/2	100	101	119-1/2	119-1/2	144	142-1/2	144	134	144	144	151	192	204	250
C	34-1/2	38	44-3/4	50	70	70	62	62	72	72	83	83	83	83	83
D	46	48	57	66	52	52	82	82	92	92	104	104	104	104	104
E	5-3/4	5	6-1/8	8	9	9	10	10	10	10	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2
F	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8

RETURN ON INVESTMENT

Payback for a pressurized deaerator versus an atmospheric boiler feed system is based on an additional capital expenditure required divided by the yearly operating cost savings. The differential in yearly operating costs are in the following areas:

- Flash steam
- Exhaust steam
- Blowdown
- Chemical treatment
- Makeup water
- Sewer
- Intangibles

Flash Steam	A percentage of the high-pressure condensate returns will flash to steam and be lost in an atmospheric vessel application. This flash steam loss can be converted to an energy loss and associated fuel cost.
Exhaust Steam	Exhaust steam cannot be recovered in an atmospheric vessel application. This exhaust steam loss can be converted to energy loss and associated fuel cost. An example would be steam turbine exhaust.
Surface Blowdown	Increased makeup water is required because of lost flash and exhaust steam. This increase in makeup water requires an increase of surface blowdown. This is directly related to cycles of concentration in the boiler. The additional blowdown loss can be converted to an energy loss and associated fuel cost. The additional surface blowdown may also result in an increase in capital expenditure for a larger blowdown heat recovery system.
Chemical Treatment	Dissolved oxygen content in an atmospheric boiler feedwater system is a function of water temperature. Lowering the dissolved oxygen content below what is naturally present, based on mixed water temperature at atmospheric pressure, requires the addition of a chemical treatment program. The most common oxygen scavenger used is sodium sulfite. Sodium sulfite reacts with dissolved oxygen as follows: Theoretically, it takes approximately 8 ppm of sodium sulfite as Na_2SO_3 to scavenge 1 ppm of dissolved O_2 $2\text{Na}_2\text{SO}_3 + \text{O}_2 \rightarrow 2\text{Na}_2\text{SO}_4$
Makeup Water	Increased make-up water is required because of lost flash steam, lost exhaust steam, and additional surface blowdown. This additional makeup water can be associated to a cost. Makeup water cost should be a combination of the utility charge plus pretreatment equipment consumable costs.
Sewer	Utilities often base a sewer charge on make-up water usage. Increased makeup water usage with an associated increase in surface blowdown can affect these costs.
Intangibles	Some cost savings are difficult to calculate - in general, best practices in deaeration will prolong the life of boiler room equipment, reducing repair and maintenance costs.

SECTION H3
TRAYMASTER SERIES DEAERATORS

SAMPLE SPECIFICATIONS

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PART 2 PRODUCTS.....H3-12

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The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer’s specific needs and application.



PART 1 GENERAL

1.1 Packaged Deaerator Specification

- A. Provide one Cleaver-Brooks Model TM _____ tray type, pressurized, deaerator rated at _____ pounds per hour. The system shall be of the two tank design and shall guarantee oxygen removal to not more than 0.005 ccs/liter (7 ppb) in the effluent throughout all load conditions between 5 and 100 percent. The deaerator shall be designed for operation at 5 PSIG, but shall be suitable for use from 2 to 15 PSIG.

PART 2 PRODUCTS

2.1 Deaerator

- A. A vertically oriented deaerator section shall be Y ft. - $Y.1$ in. x Z ft. - $Z.1$ in. shell length. The deaerator shall be of the counter flow design. Undeaerated water shall enter through the top of the column into a true Internal Direct Contact Vent Condenser. *Units not implementing a True Internal Direct Contact Vent Condenser shall not be accepted.* The water shall be evenly sprayed through a spring-loaded, self-cleaning, adjustable stainless steel spray valve(s) over the trays. The valves shall be constructed of type 304 stainless steel material. Trays shall be all riveted construction using 16 gauge type 430 Stainless Steel material. *Welded trays shall not be accepted.* Trays shall be stacked within a stainless steel tray box with a minimum thickness of 1/4". The tray box shall be constructed using type 304 Stainless Steel material. The tray box shall include a wear plate at the saturated steam inlet area to ensure durability. The tray box shall have an access door for ease of inspection of the trays. This access area to the tray box shall be through a X in. round davited manhole located on the shell of the deaerator. The tank shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 PSIG at 650 °F and stamped accordingly. Connections shall include steam inlet, vent, water inlet, high temperature return, and downcomer to the storage vessel. Unit shall provide proper internal vent condensing and water distribution at any load between 5 and 100 percent of rated capacity.
- B. All internal surfaces, which come in contact with un-deaerated water, shall be constructed of stainless steel. Automatic vent valve shall be thermostatically controlled to provide a fast means of venting when a sudden buildup of gases occurs, such as seen at start up. The manual vent valve shall have an orifice for continuous minimum venting. Venting rate shall not exceed 0.1 of 1% of the rated deaerator capacity at 5 PSIG.

2.2 Deaerator Vessel

- A. The deaerated water storage tank shall have _____ minutes of storage and have a capacity of _____ gallons measured to overflow. The tank shall be _____ diameter x _____ long. An 12 x 16 elliptical manhole shall be provided for access. All nozzles 3" and under shall be 3000 lbs forged steel couplings and over 3" shall be 150 LB. flat face flanges. Heads to be ASME torispherical type constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches. The tank shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 PSIG at 650 °F and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per Table UW-12, which does not require stress relieving or nondestructive examination.

The tank shall be factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. The blanket insulation is to be fiberglass, 2" thick, 1 LB/ CU-

FT, and have a rating of R3.85. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 22 gauge (0.299") minimum and head thickness of 12 gauge (0.1046") minimum.

The magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed.

The high temperature diffuser or sparge tube shall be located beneath the normal tank water level. The tube shall be constructed of 2-1/2 inch pipe. This tube shall provide even distribution and blending of high-temperature condensate returns.

The chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.

2.3 Deaerator Load Specification

The surge tank loads shall be as specified in the following table.

LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Make up				
Low Temp Returns (<210 °F)				
Medium Temp Returns (211 – 230 °F)				
High Temp Returns (>230 °F)				

2.4 Deaerator Standard Trim and Accessories

- A. The basic deaerator shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

2.5 Deaerator Make-Up Valve and Controller

- A. _____ " inlet water regulating lever valve with _____ body and _____ connections. Rated for _____ GPM at _____ PSIG inlet pressure. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____, Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____, Model _____. A McDonnell & Miller 93-7B level controller shall electronically control the make-up valve.
- B. _____ " inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional, with a permanently lubricated gear train, and be directly coupled to the valve stem. Rated for _____ GPM at _____ PSIG inlet pressure. This valve shall have teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Model TW82.
- C. _____ " inlet water diaphragm actuated regulating valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for 3 - 15 PSIG operating signal. The valve shall be normally open on loss of air. Rated for _____ GPM at _____ PSIG inlet pressure. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____, Model _____. A filter regulator is to be provided to reduce 50 PSIG instrument air supply to 3 – 15 PSIG for proper operation.
- D. The make up valve shall include a ANSI Class 125 LB three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

2.6 Deaerator Steam Pressure Reducing Valve (PRV) Station

- A. _____ " steam pressure reducing valve with cast iron body and _____ connections. The valve shall be a self-contained unit capable of reducing _____ PSIG saturated steam to the operating pressure of the deaerator at a flow rate of _____ LB./HR. The valve shall be 250 lb class with stainless steel trim and an adjustable pilot. The valve manufacturer shall be _____, Model _____.
- B. _____ " diaphragm actuated steam pressure reducing valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for _____ PSIG operating signal. The valve shall be normally closed on loss of air. The valve shall be capable of reducing _____ PSIG saturated steam to the operating pressure of the deaerator at a flow rate of _____ LB./HR. This valve shall be 250 LB class and have stainless steel trim. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external transmitter. The transmitter set pressure shall be adjustable. The transmitter manufacturer shall be _____, Model _____.
- C. The steam pressure reducing valve shall include a three valve bypass with Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

2.7 Deaerator Safety Relief Valve(s) (SRV)

- A. Quantity _____, _____" relief valves sized to relieve full capacity of the pressure reducing valve in the event of its failure. Valves to meet Paragraph UG-125 of ASME Unfired Pressure Vessel Code, Section VIII. Valve body to be of _____ construction. Relieving set pressure to be 50 PSIG. Relief valve manufacturer to be _____, Model _____.

2.8 Deaerator Water Level Alarms

- A. **High Level Alarm** - NEMA 1 This shall be an externally mounted float type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron.
- B. **Low Level Alarm** - NEMA 1 This shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron.

2.9 Deaerator Overflow Drainer

- A. _____" overflow drainer sized to relieve full capacity at the operating pressure of the deaerator. The overflow drainer shall be a float type trap. The construction is to be a steel housing with stainless steel float ball. The overflow drainer manufacturer shall be _____, Model _____.

2.10 Deaerator Suction Piping

- A. Suction piping for pumps shall consist of a _____" gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 LB class construction. The vortex breaker shall be located in the tank nozzle.

2.11 Boiler Feedwater Pump and Motor Set

- A. **Intermittent** - Intermittent Quantity _____, turbine type boiler feedwater pump and motor set. Pump to be rated for _____ GPM at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ HP, _____ phase, _____ Hz, _____ Volt, _____ RPM, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____".
- B. **Continuous** - Continuous Quantity _____, centrifugal type boiler feedwater pump and motor set. Pump to be rated for _____ GPM at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ HP, _____ phase, _____ Hz, _____ Volt, _____ RPM, _____ enclosed motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____".

A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.

2.12 Deaerator Support Stand

- A. The _____ feet high stand shall elevate the deaerator tank to provide the net positive suction head required by the pump at the rated condition to prevent cavitation plus a 1-1/2 foot safety factor. The stand shall be constructed of heavy square steel tubing for the legs and 1/4" steel plate covering the floor.

2.13 Deaerator Control Panel

- A. Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.

2.14 Electric Components

- A. Audible and visual high and low water alarm function shall be provided by a bell or horn with silence switch and individual red oil- tight lights. Control circuit transformer to supply 110-120 Volts, single-phase power supply. The transformer shall be mounted, wired and fused. Auxiliary contacts shall be furnished for chemical feed pump initiation. Contacts shall be normally open.
- B. The deaerator shall have a gauge glass assembly that covers the entire tank diameter. The gauge glass shall be quartz, 0.625 inch diameter by 24 inch maximum length. Each length of glass shall be furnished with a bronze gauge cock set and protector rods. The deaerator shall be supplied with a pressure gauge that has a 4-1/2 inch dial with a 0-60 PSIG range and a thermometer with a 50 to 300 °F range. Packaged units are required to have both gauges bracket-mounted at eye level.

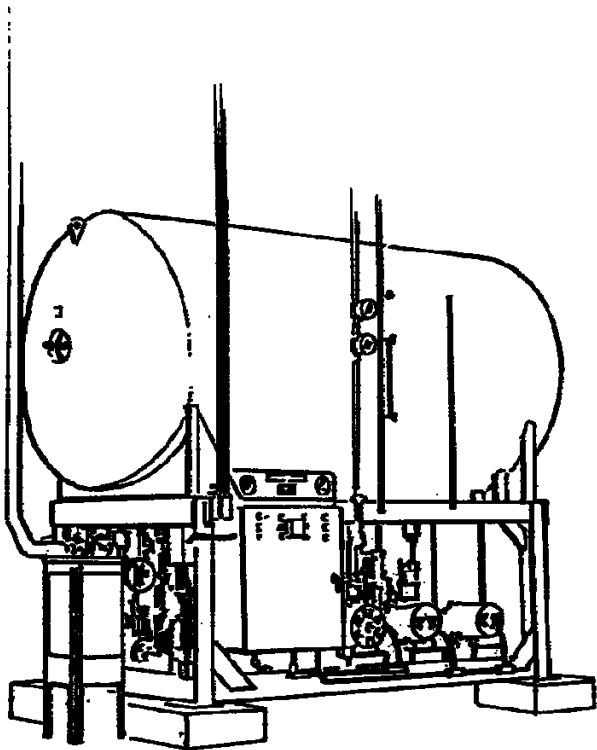
2.15 Deaerator Preparation And Packaging

- A. The deaerator is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with an enamel paint to not less than 1 mil thick prior to shipment.
- B. Unit is to be knocked down for shipment. Piping is to be matched marked.

2.16 Deaerator Manuals and Warranty

- A. Three, bound, Operating and Maintenance manuals to be provided. Warranty period to be twelve months after start-up or eighteen months after shipment, whichever comes first.

SECTION H5 SURGE TANKS



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DIMENSIONS AND RATINGS H5-6

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TABLES

Table H5-1. Surge Tank Product Offering H5-4

This section contains information on the complete line of surge tanks ranging in sizes from 300 to 3000 gallon capacities.

The Cleaver-Brooks Surge Tank products provide additional storage time and handle volume swings in condensate returns. Because condensate return volume is largely unpredictable, a surge tank provides a means to collect intermittent condensate returns and supply water at a relatively constant volume, while limiting discharge to drain. Contact your local Cleaver-Brooks authorized representative for component sizing information.

FEATURES AND BENEFITS

The following features and benefits apply to Cleaver-Brooks Surge Tank Products.

ASME Heads:

- Assures vessel quality in materials and fabrication.

1/4" Thick (Minimum) Shell:

- Quality construction.
- Longer material life.

Boosts Condensate Return Pressure:

- Acts as a collecting point for low pressure and gravity returns.
- Allows pumping of returns to a pressurized vessel.

Accepts Gravity Returns:

- Vessels are vented to atmosphere, therefore providing no pressure resistance that would inhibit gravity return.

PRODUCT OFFERING

Information in this section applies directly to Cleaver- Brooks package surge tanks ranging from 300 to 3,000 gallon capacity. Contact your local Cleaver-Brooks authorized representative for larger capacities. The product offering for surge tanks is shown in Table H5-1.

Surge tanks can reduce dependance on cold, untreated raw water to replace boiler system losses, by collecting condensate for re-use in the boiler. Dedicated surge tanks are required when intermittent peak loads of condensate can exceed the surge capacity of the deaerator.

The surge tank receives returning condensate and is supplemented by raw make-up water to maintain the desired operating level. Condensate and make-up water mix into a blend temperature as determined by the percentage of each. The surge tank is vented to atmosphere.

Surge tanks are designed to work with the deaerator. They can be packaged with transfer pumps, stand and controls of the same sturdy construction as the deaerator.

Table H5-1. Surge Tank Product Offering

MODEL NO.	FLOODED CAPACITY (GAL.)
SRG-300	300
SRG-450	450
SRG-600	600
SRG-900	900
SRG-1200	1200
SRG-1400	1400
SRG-1600	1600
SRG-2000	2000
SRG-2500	2500
SRG-3000	3000

NOTE: Model number (example, SRG-300) is: SRG = surge tank.
300 = 300 gal. capacity.

Custom arrangements are also available. Contact local Cleaver-Brooks authorized representative for component and sizing information.

Surge tanks provide additional storage time and handle volume swings in condensate return. Surge tanks are used when gravity or pumped condensate returns do not have enough pressure to enter the deaerator on their own. Water and treatment costs are reduced by recycling condensate that has already been treated.

Integral control automatically introduces cold water makeup to supplement condensate only when necessary to meet boiler demand. This translates into reduced fuel costs for heating boiler feedwater.

Standard Equipment

- Surge tank.
- Thermometer.
- Gauge glass.
- Required tapings, and manway.

Optional Equipment

- ASME code tank.
- Water level controller with make-up valve.
- Three valve bypass and strainer.
- Suction shutoff valve.
- Suction strainer.
- Suction flexible fitting.
- Discharge check valve.
- Discharge shutoff valve.
- Discharge pressure gauge.
- Discharge manifold.
- High water alarm.
- Low water alarm.
- Low water pump cut off.

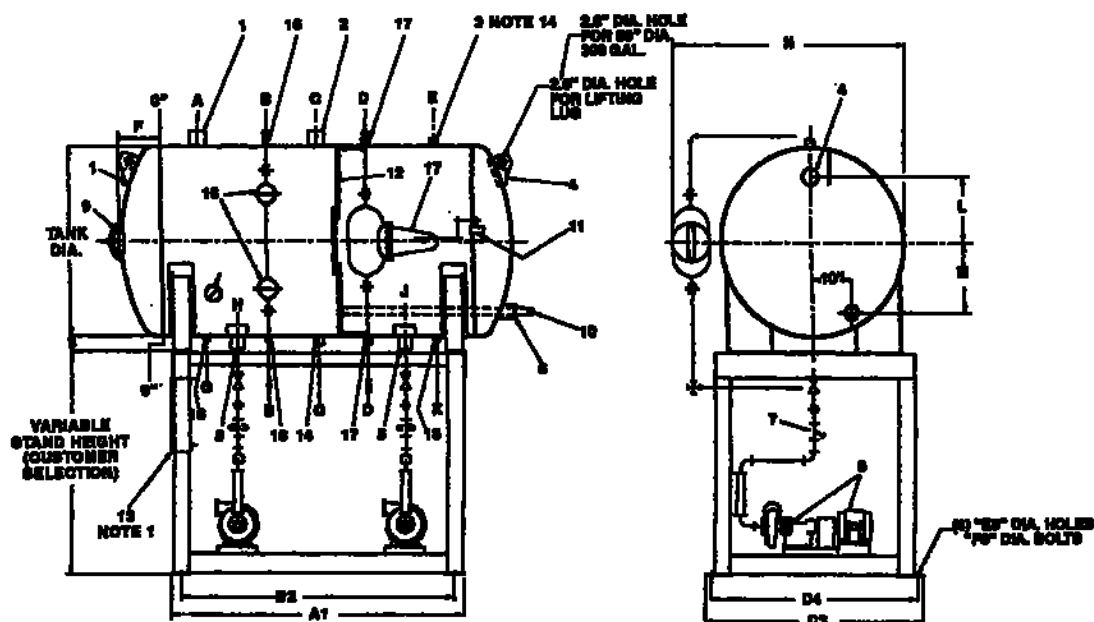
- Condensate diffuser tube.
- Control panel.
- Transfer pump and motor.
- Recirculation orifice or relief valve.
- Insulation and lagging.
- Magnesium anode (not available with lined tanks).
- Chemical feed quill.
- Drain valve.
- Stand.

Packaging

- Fully packaged, factory piped and wired.
- Half packaged, suitable for field erection with interconnecting piping and wiring by others.

DIMENSIONS AND RATINGS

Dimensions and ratings for surge tanks are shown in Figure H5-1 and Figure H5-2.



NOTES:

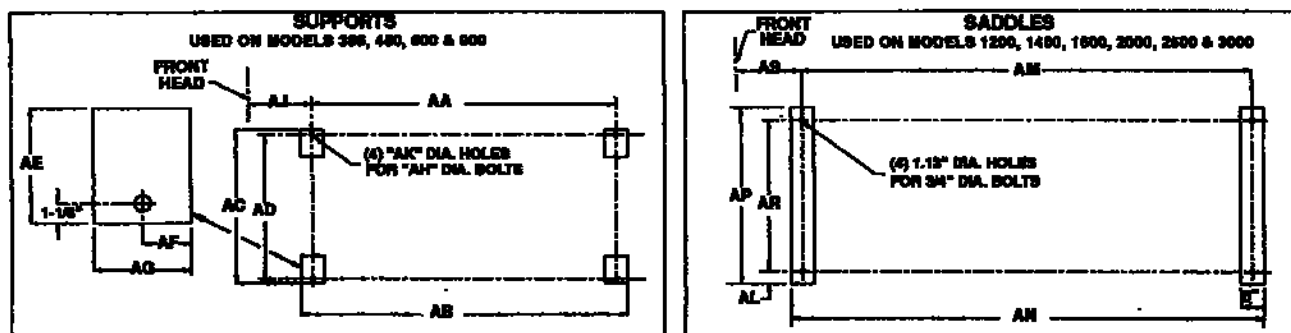
1. Mounted on packaged units only.
2. Suction piping includes strainer, gate valve and flexible connector.
3. All couplings are 3000# F.S.
4. All flanges are 150# F.F. except as noted.
5. Customer to plug all fittings not being used.
6. Mount tank above pump at elevation necessary for static head including safe allowance for piping friction as approved by pump manufacturer.
7. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
8. Add suffix "P" to Model no. for packaged units (SRG45-P).
9. Using Warren #377 float cage - dimension "N" may change with other controls - contact your local Cleaver-Brooks authorized representative.
10. No interconnecting piping or wiring furnished on non-packaged units unless specified, contact your local Cleaver-Brooks authorized representative for specific piping or wiring furnished on packaged assemblies.
11. Weights shown are without controls or packaging - contact your local Cleaver-Brooks authorized representative for additions.
12. Optional tank sizes available - contact your local Cleaver-Brooks authorized representative.
13. Lifting lugs are for lifting empty tank only.
14. Raw water make-up should first pass through a water softener if hardness is present.

STAND BASE DIMENSIONS										
	Tank Capacity (gal)	300	450	600 900	1200	1400	1600	2000	2500	3000
A1	Outside Length	61	60-1/2	84-182	100	121-3/4	94	108-1/2	95-1/2	119-1/2
B2	C _L to C _L Anchor Bolt Holes	56	55-1/2	79-1/2	95	115-3/4	88	102-1/2	89-1/2	112-1/2
C3	Outside Width	49	58	58 62		60-1/2	71	71	81	83
D4	C _L to C _L Anchor Bolt Holes	46	55	55	59	57-1/2	68	68	78	80
E5		1	1	1 1		1	1	1	1	1-1/8
FZ		7/8	7/8	7/8 7/8		7/8	7/8	7/8	7/8	1

Figure H5-1. Surge Tank Dimensions and Ratings - Sheet 1 of 2

STORAGE TANK DETAIL AND DIMENSIONS											
	Tank Capacity (gal)	300	450	600	900	1200	1400	1600	2000	2500	3000
	Tank Weight (lb)	935	1095	1330	1690	2420	2625	2765	3255	3680	4370
	Flooded Weight (lb)	3605	4905	6360	9195	12480	14595	16235	20610	24505	29240
	Tank Size (Dia X Length)	36x80	42x84	42x109	48x124	48x164	60x125	60x143	72x131	72x155	84x138
A		6	6	8	12	20	12	14	15	15	
B		23-1/2	23	30	34	52	34	43	37	41	36
C		32	32-1/2	45	52	68	50	55	51	59	52-1/2
D		40	42	60		69-1/2	91-1/2	66	75	64-1/2	84-1/2
E		57-1/2	59	82	91-1/2	123-1/2	88	104	86-1/2	110-1/2	91-1/2
F		8-1/2	9-1/2	9-1/2	10-1/2	10-1/2	12-1/2	12-1/2	14-1/2	14-1/2	16-1/2
G		9-1/2	11	14	14	28	14	21	17	19	16
H		Contact Your Local Cleaver-Brooks Authorized Representative									
J		Contact Your Local Cleaver-Brooks Authorized Representative									
K		54	54	76		89-1/2	115-1/2	86	97	84-1/2	106-1/2
L		11	14	14	16	15		20-1/2	20-1/2	25-1/2	29-1/2
M		10	10	10		12-1/2	12-1/2	19-1/2	19-1/2	25	25
N		51	57	57	63	63	75	75	87	87	99
TANK CONNECTION SIZES											
	Tank Capacity (gal)	300	450	600	900	1200	1400	1600	2000	2500	3000
1	Low Pressure Return (2)	3 NPT	3 NPT	3 NPT	3 NPT	4 NPT	4 NPT	4 NPT	4 NPT	4 NPT	4 NPT
2	Vent	3 NPT	3 NPT	3 NPT	3 NPT	4 NPT	4 NPT	4 NPT	4 NPT	4 NPT	4 NPT
3	Cold Water Inlet	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/2 NPT
4	Overflow Connection	3 NPT	3 NPT	3 NPT	3 NPT	4 NPT	4 NPT	4 NPT	4 NPT	4 NPT	4 NPT
5	Pump Suction (For Each Pump)	Contact Your Local Cleaver-Brooks Authorized Representative									
ITEM LIST											
6	High Temperature Return (3 NPT)										
7	Suction Piping (Optional) (For Each Pump) (Note 2)										
8	Pump/motor (Optional)										
9	Manway (11 X 15)										
10	Diffuser Tube (2-1/2 NPT) (Optional)										
11	Makeup Valve (Optional)										
12	Gauge Glass Assembly										
13	Control Panel (Optional)										
14	Drain (2 NPT)										
15	Thermometer (3/4 NPT)				Sizes Listed for items 15 thru 18 are for Tank Connections Only.						
16	Level Alarms (1 NPT) (Optional)										
17	Level Control (1-1/2 NPT) (Optional)										
18	Recirculating Connection (1 NPT) (For Each Pump)										

Figure H5-1. Surge Tank Dimensions and Ratings - Sheet 2 of 2



TANK CAPACITY (GALLONS)										
	300	450	600	900	1200	1400	1600	2000	2500	3000
AA	55-1/2	55	79	93-1/2	N/A	N/A	N/A	N/A	N/A	N/A
AB	59-1/2	59	83	99-1/2	N/A	N/A	N/A	N/A	N/A	N/A
AC	31-3/4	36-3/4	36-3/4	40-1/2	N/A	N/A	N/A	N/A	N/A	N/A
AD	29-1/2	34-1/2	34-1/2	38	N/A	N/A	N/A	N/A	N/A	N/A
AE	5	6-1/8	6-1/8	7-1/4	N/A	N/A	N/A	N/A	N/A	N/A
AF	2	2 2 3			N/A	N/A	N/A	N/A	N/A	N/A
AG	4	4 4 6			N/A	N/A	N/A	N/A	N/A	N/A
AH	5/8	3/4	3/4	3/4	N/A	N/A	N/A	N/A	N/A	N/A
AJ	12-1/2	14-1/2	15	15-1/2	N/A	N/A	N/A	N/A	N/A	N/A
AK	3/4	7/8	7/8	7/8	N/A	N/A	N/A	N/A	N/A	N/A
AL	N/A	N/A	N/A	N/A	4-1/4	6-1/8	6-1/8	7-1/2	7-1/2	7-3/4
AM	N/A	N/A	N/A	N/A	115-3/4	88	102-1/2	89-1/2	113-1/2	94-1/2
AN	N/A	N/A	N/A	N/A	121-3/4	94	108-1/2	95-1/2	119-1/2	100-1/2
AP	N/A	N/A	N/A	N/A	46-1/2	57	57	67	67	77-1/2
AR	N/A	N/A	N/A	N/A	38	44-3/4	44-3/4	52	52	62
AS	N/A	N/A	N/A	N/A	24-1/2	18-1/2	20-1/4	20-1/2	20-1/2	21-7/8

VENT CAPACITY CHART	
SIZE (NPT)	CAPACITY (lbs/hr)
1	175
1-1/4	350
1-1/2	525
2	1000
2-1/2	1600
3	2800
4	4800
5	10500
6	17000
8	35000

Values given based on:
 1) 50 ft. equivalent pipe length.
 2) Schedule 40 pipe
 3) 2 psi back pressure
 4) Vent capacities should be compared with anticipated venting needs. Oversized vents are available.

Figure H5-2. Surge Tank Supports and Saddles, Details and Dimensions

SECTION H5
SURGE TANKS

SAMPLE SPECIFICATIONS

PART 1 GENERAL.....H5-10

PART 2 PRODUCTS.....H5-10

 1.1 Hardware H5-10

 A. Surge Tank H5-10

 B. Make Up Valve and Controller.....H5-11

 C. Transfer Pump and Motor Set (Optional) H5-12

 D. Control Panel.....H5-12

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer’s specific needs and application

PART 1 GENERAL

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application

PART 2 PRODUCTS

1.1 Hardware

A. Surge Tank

1. Cleaver-Brooks Model _____ shall be an atmospheric, horizontal Surge Tank.
2. The surge tank shall receive returning condensate and supplement make up water to maintain the desired operating level. Condensate and make up water mix into a blended temperature, as determined by the percentage of each. The surge tank shall be vented to atmosphere. The collected water is then transferred to the deaerator.
3. The surge tank shall have _____ minutes of storage and have a capacity of _____ gallons flooded. The tank shall be _____" diameter x _____" long. An 11" x 15" elliptical manhole shall be provided for access. All nozzles shall be 3000 lbs forged steel couplings. Heads shall be ASME torispherical type (flat heads are not acceptable) constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25". Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25".

Load Specifications

LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Make up				20 psig Minimum
Low Temp Returns				
High Temp Returns				

4. The surge tank loads shall be as specified in the following table.
5. Optional - The tank shall be designed in accordance with Section VIII of the ASME Pressure Vessel Code for _____ psig, and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per table UW-12, which does not require stress relieving or nondestructive examination.
6. Optional - The tank shall be factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. Block-type insulation is not acceptable. The blanket insulation is to be fiberglass, 2" thick, 1 lb/cu-ft, and have a rating of R3.85. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 22 gauge (0.299") minimum and head thickness of 12 gauge (0.1046") minimum.
7. Optional - The magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed. Linings shall not be acceptable in this application.

8. Optional - The high-temperature diffuser or sparge tube shall be located beneath the normal tank water level. The tube shall be constructed of 2" pipe. This tube shall provide even distribution and blending of high-temperature condensate returns.
9. Optional - The chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.
10. Optional - The basic surge tank shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

B. Make Up Valve and Controller

1. Option (Mechanical) - _____ " inlet water regulating lever valve with _____ body and _____ connections. The valve Cv shall not exceed _____, and shall be rated for _____ gpm at _____ psig inlet pressure. The pressure drop across the valve shall not exceed a delta-P of 10 psig. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____, Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____, Model _____.
2. Option (Electronic) - _____ " inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional type, with a permanently lubricated gear train, and directly coupled to the valve stem. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Cleaver- Brooks, Model TW82. A solenoid valve and float switch is not acceptable. (Available only in the U.S.)
3. Option (Pneumatic) - _____ " inlet water diaphragm actuated regulating valve with cast iron body and connections. The valve shall be globe-type with proportional control and a spring-opposed diaphragm actuator arranged for 3 - 15 psig operating signal. The valve shall be normally open on loss of air. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____, Model _____. A filter regulator is to be provided to reduce 50 psig instrument air supply to 3 - 15 psig for proper operation.
4. Optional - The make up valve shall include a ANSI Class 125 lb three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.
5. Optional - High level alarm switch. This shall be an externally mounted float-type switch. The switch shall make contact on rise and break on fall. Float cage construction shall be cast iron. (Not required with electronic make up controller.)

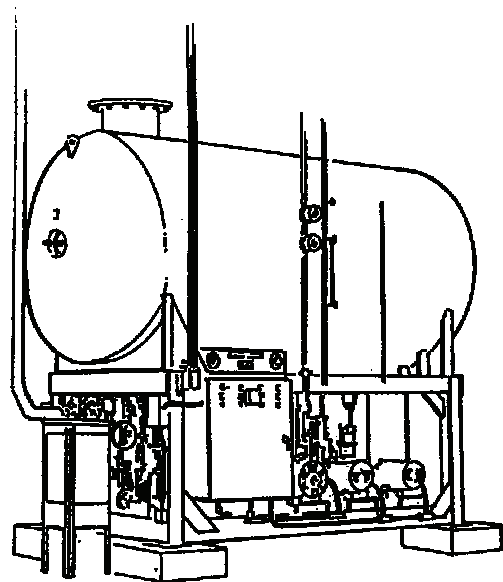
6. Optional - Low level alarm switch. This shall be an externally mounted float-type switch. The switch shall make contact on fall and break on rise. Float cage construction shall be cast iron. (Not required with electronic make up controller.)
 7. Optional - Suction piping for pumps shall consist of a gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 lb class construction. The vortex breaker shall be located in the tank nozzle. Manifold suction lines are not acceptable.
- C. Transfer Pump and Motor Set (Optional)
1. Quantity _____, centrifugal type transfer pump and motor set. Turbine type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute, and have _____ seals for a maximum water temperature of 212 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____ " x _____ ". A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.
 2. Optional - The stand shall elevate the surge tank to provide the net positive suction head required by the pump at the rated condition to prevent cavitation. The stand shall be constructed of heavy square steel tubing for the legs and 1/4" steel plate covering the floor.
- D. Control Panel
1. Optional (Base) - Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.
 2. Optional (Electric Components) - Audible and visual high and low water alarm function shall be provided by a bell or horn with silence switch and individual red oil-tight lights.
 - a. Control circuit transformer to supply 110-120 Volts, single-phase power supply. The transformer shall be mounted, wired and fused.
 - b. Auxiliary contacts shall be furnished for chemical feed pump initiation. Contacts shall be normally open.

3. Standard

- a. The surge tank shall have a gauge glass assembly that covers the entire tank diameter. The gauge glass shall be quartz 0.625 inch diameter by 24-inch maximum length. Each length of glass shall be furnished with a bronze gauge cock set and protector rods.
- b. The surge tank shall be supplied with a thermometer with a 50 to 300 °F range.
- c. The surge tank is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with an enamel paint to not less than 1 mil thick prior to shipment.
- d. Unit is to be knocked down for shipment. Piping is to be matched marked. Warranty period to be twelve months after start-up or eighteen months after shipment, whichever comes first.

Notes

SPRAYMASTER DEAERATORS (DUO-TANK)



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Figure H2-1. Spraymaster Duo-Tank Supports and Saddles, Details and Dimensions.....H2-4

Figure H2-2. Spraymaster Deaerator (Duo-Tank) Dimensions and Ratings – Sheet 1 of 3 H2-5

TABLES

Table H2-1. Spraymaster Deaerator Duo-Tank Offering.....H2-4

The Duo Tank product combines a surge tank with a Spraymaster deaerator into a single combined vessel, providing a complete engineered and packaged system.

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long-lasting boiler equipment for industrial and commercial boiler users. Built of corrosion-resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proven most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component sizing information.

FEATURES AND BENEFITS

The Duo Tank product combines a surge tank with a Spraymaster deaerator in to a single combined vessel, providing the following features and benefits in addition to the benefits of the deaerator and surge tank independently.

Double Inner Head Separates the Deaerator Pressure Vessel From Surge Tank:

- Ensures the deaerator and surge tank are two separate vessels while structurally attached for space considerations. This also limits heat transfer from the deaerator pressure vessel to the surge atmospheric vessel, preventing energy loss due to surge tank water boiling.

Vented and Insulated Gap Between the Deaerator and Surge Tank:

- Insulation is placed between the double inner head to further limit heat transfer from the deaerator pressure vessel to the surge atmospheric vessel. A vent is placed between the double inner head to allow moisture evaporation eliminating corrosion potential.

Low Profile Design:

- Low head room allows for installation in space restricted areas.

Two-Stage Deaeration in a Common Vessel:

- Recycle pumps are not required.
- Packaged for easy maintenance.

Packaged Units for Cost Effective Installation:

- Complete packages are pre-fabricated in the Cleaver-Brooks manufacturing facility to ensure piping alignment and control wiring function. The unit is disassembled, match marked for efficient field re-assembly.

PRODUCT OFFERING

Information in this section applies directly to Cleaver-Brooks packaged Spraymaster Deaerators in duo-tank arrangement ranging from 7000 to 280,000 lbs/hr.

The product offering for Duo-Tank packaging is a combination of the product offering for the Spraymaster Deaerator and the Surge Tank. The combined package product offering for Duo-Tank products is shown in Table H2-1

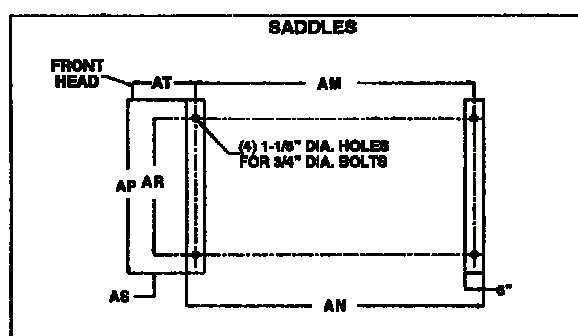
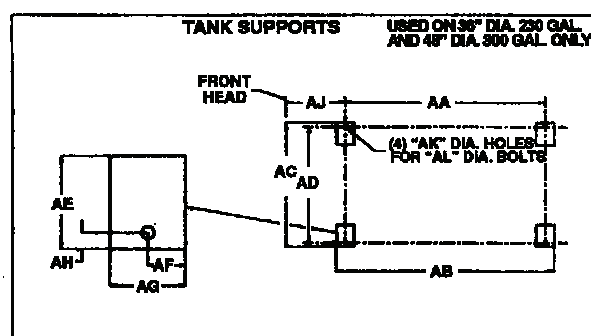
DIMENSIONS AND RATINGS

Dimensions and ratings are shown in Figure H2-1 and Figure H2-2

Table H2-1. Spraymaster Deaerator Duo-Tank Offering

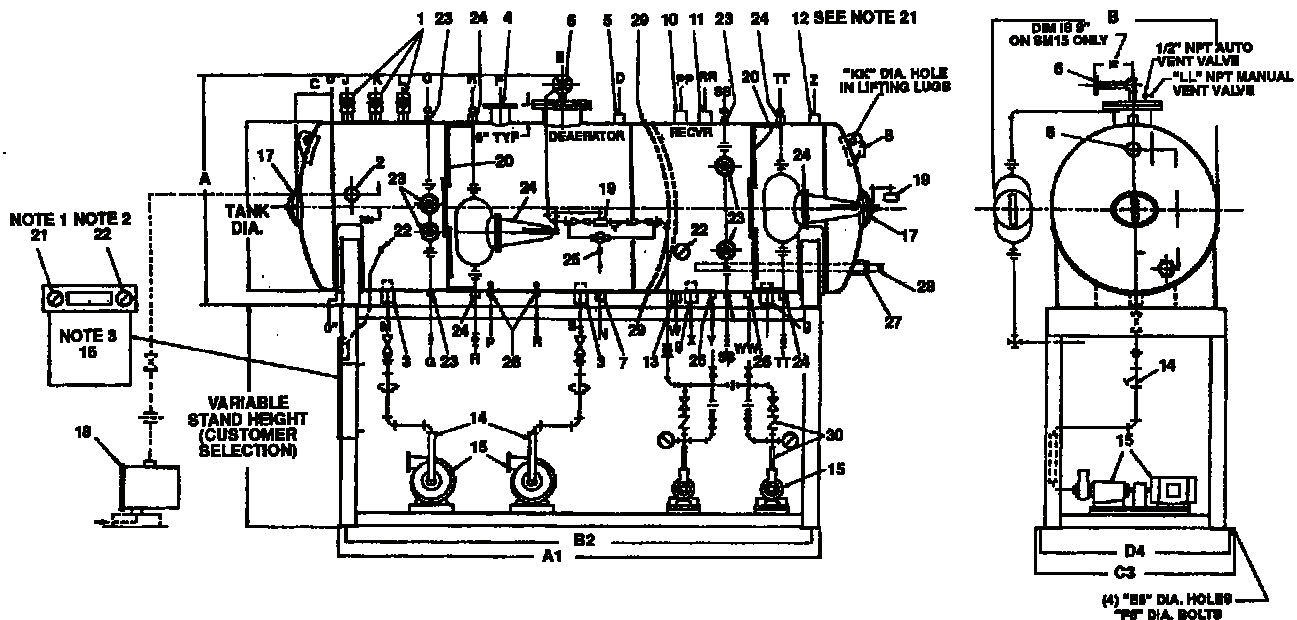
MODEL NO.	SD-7	SD-15	SD-30	SD-45	SD-70	SD-100	SD-40	SD-200	SD-280
Rating (lbs/hr)	7000	15000	30000	45000	70000	100000	140000	200000	280000
Deaerator Gallons to Overflow	230	300	600	900	1400	2000	2800	4000	5600
Deaerator Storage Capacity (min)	16	10	10	10	10	10	10	10	10
Surge Gallons to Flooded	160	300	600	900	1400	2000	2800	4000	5600
Surge Storage Capacity (Min)	11.5	10	10	10	10	10	10	10	10

NOTE: Model designation (example SD-7) is: S = Spraymaster Deaerator, D = Duo-tank, 7 = 7,000 lbs/h rating, combined deaerator and surge tank package.



TANK CAPACITY (GALLONS)									
	230	300	600	900	1400	2000	2800	4000	5600
AA	81-1/2	108-1/2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AB	875-1/2	114-1/2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AC	31-3/4	40-1/4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AD	29-1/2	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AE	6-1/8	7-3/8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AF	2	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AG	4	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AH	1-1/8	1-1/4	M/A	N/A	N/A	N/A	N/A	N/A	N/A
AJ	12-1/2	16-1/2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AK	7/8	7/8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AL	3/4	3/4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AM	N/A	N/A	148	169-1/2	231-1/2	270	257	245-1/2	281
AN	N/A	N/A	154	175-1/2	237-1/2	276	263	251-1/2	287
AP	N/A	N/A	51-1/2	57	62	67	77-1/2	88	98-3/4
AR	N/A	N/A	44-3/4	44-3/4	50	52	62	72	83
AS	N/A	N/A	3-3/8	6-18	6	7-1/2	7-3/4	8	7-7/8
AT	N/A	N/A	16-1/2	18-3/4	20	25	22-1/2	31-5/8	34

Figure H2-1. Spraymaster Duo-Tank Supports and Saddles, Details and Dimensions



NOTES:

1. Mounted at dim. "H" (top of tank) on non-packaged units.
2. Tank mounted on non-packaged unit.
3. Packaged units only. Mounted on left end, right side of stand on 48" dia. 450 gal, 66" dia. 1400 gal & 72" dia. 2000 gal units as shown.
4. Suction piping includes strainer, gate valve and flexible connector.
5. Discharge piping includes gate valve, check valve, control valve, by-pass orifice, and pressure gauge.
6. All couplings are 3000# F.S.
7. All flanges are 150# F.F. except as noted.
8. Two water and steam inlets used, one shown.
9. Customer to plug all fittings not being used.
10. Mount tank above pump at elevation necessary for static head including safe allowance for piping friction as approved by pump manufacturer.
11. Deaerator section of tank is built to ASME Code.
12. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
13. Add suffix "P" to Model no. for packaged units (SDP-45).
14. Optional tanks available for 5 minutes storage (except SDP-7 & SDP-15), other combinations of capacities as required - contact your local Cleaver-Brooks authorized representative.
15. Using Warren #377 float cage (except SM7 which uses MCD-M #51), dimension "B" may change with other controls - contact your local Cleaver-Brooks authorized representative.
16. No interconnecting piping or wiring furnished on non-packaged units unless specified, contact your local Cleaver-Brooks authorized representative for specific piping or wiring furnished on packaged assemblies.
17. Weights shown are without controls or packaging - contact your local Cleaver-Brooks authorized representative for additions.
18. Capacities other than shown as standard available by proper selection of controls - contact your local Cleaver-Brooks authorized representative.
19. Optional tank sizes and ratings available - contact your local Cleaver-Brooks authorized representative.
20. Lifting lugs are for lifting empty tank only.
21. Raw water make-up should first pass through a water softener if hardness is present.
22. All dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimensional prints.

Figure H2-2. Spraymaster Deaerator (Duo-Tank) Dimensions and Ratings – Sheet 1 of 3

STORAGE TANK DETAIL AND DIMENSIONS										
	SPRAYMASTER MODEL NO.	SM-7D	SM-15D	SM-30D	SM-45D	SM-70D	SM-100D	SM-140D	SM-200D ⁸	SM-280D ⁸
	Ratings (lb/h)	7000	15000	30000	45000	70000	100000	140000	200000	280000
	Tank Weight (lbs)	1530	2500	3650	4500	6770	8810	10760	12975	18735
	Tank Weight Flooded (lbs)	5165	10835	17720	24440	38450	52310	68045	80290	106475
	Tank Cap-Deaerator (Gal to Overflow)	230	300	600	900	1400	2000	2800	4000	5600
	Storage Cap (Min)	16	10	10	10	10	10	10	10	10
	Tank Cap-Rec Section (Gal to Flooded)	160	300	600	900	1400	2000	2800	4000	5600
	Storage Cap (Min)	11.5	10	10	10	10	10	10	10	10
	Tank Size (Dia x Length)	36 x 106-1/2	48 x 141-1/2	54 x 181	60 x 207	66 x 270-1/2	72 x 302	84 x 302-1/4	96 x 308-3/4	108 x 349
A	Overall Height	58	66-1/2	74-1/2	80-1/2	88	96-1/2	109	120-1/2	133
B	Overall Width	51	62	68	75	80	87	99	111	123
C		8-1/2	10-1/2	11-1/2	12-1/2	13-1/2	14-1/2	16-1/2	18-5/8	20-3/4
D		28-1/2	72-1/2	92-1/2	101	146	164	146	4 136	4 153
E		43	54-1/2	74	83	124	142	124	24 116	24 133
F		48-1/2	34-1/2	54	63	104	122	104	44 96	48 109
G		11	16	31	42	68	68	73	60	59
H		21	26	45	54	80	104	86	82	98
J		Contact Your Local Cleaver-Brooks Authorized Representative								
K		Contact Your Local Cleaver-Brooks Authorized Representative								
L		Contact Your Local Cleaver-Brooks Authorized Representative								
M		Contact Your Local Cleaver-Brooks Authorized Representative								
N		52	56	90	102	144	164	147	130	144
P		N/A	31	50	32	35	36	28	35	28
R		N/A	47	65	74	115	132	126	106	123
S		Consult Your Local Cleaver-Brooks Authorized Representative								
T		38	60	90	27	27	32	27	36	27
W		64	90	109	126	169	224	205	160	186
X		Consult Your Local Cleaver-Brooks Authorized Representative								
Y		69	95	120	145	198	192	177	196	196
z		85	115	155	171	230	266	258	258	249
KK		2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-3/4	2-3/4
LL		1/2	3/4	3/4	3/4	1	1-1/2	2	2 @ 1-1/2	2 @ 2
MM		3	6	6	10	6	6	8	12	12
NN		10	C _L	4	7	6-1/2	8	14-1/2	26-1/2	27-1/2
PP		68	94	112	127	180	197	173	175	191
RR		74	101	120	133	200	227	205	201-1/2	211
SS		72	95	126	138	188	214	183	190	229
TT		82	109	144	160	218	243	232	213	249
WW		75	108	132	153	208	267	249	206	279
XX		Consult Your Local Cleaver-Brooks Authorized Representative								
YY		12	16	19	22	24	27	31	36	40
ZZ		10	12-1/2	16	19-1/2	22	25	30	34-1/2	40

Figure H2-2. Spraymaster Deaerator (Duo-Tank) Dimensions and Ratings – Sheet 2 of 3

STAND BASE DIMENSIONS										
	TANK CAPACITY (GAL)	230	300	600	900	1400	2000	2800	4000	5600
A1	Outside Length	87	115	154	175-1/2	237-1/2	276	268	144	297
B2	C _L to C _L Anchor Bolt Holes	82	110	148	169-1/2	230-1/2	269	265	137	294
C3	Outside Width	49	62	66	71	76	81	86-1/2	102	112
D4	C _L to C _L Anchor Bolt Holes	46	59	63	68	73	78	79-1/2	99	101
E5		3/4	1	1	1	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8
F6		5/6	7/8	7/8	7/8	1	1	1	1	1
TANK CONNECTION SIZES										
1	Relief-Valve(s)	Contact Your Local Cleaver-Brooks Authorized Representative								
2	Overflow (Dea)	1-1/4 NPT	3 NPT	3 NPT	3 NPT	4 FLG	4 FLG	4 FLG	6 FLG	6 FLG
3	Pump Suction (Optional)	Contact Your Local Cleaver-Brooks Authorized Representative								
4	Steam Inlet (Dea Flg)	3	6	6	6	6	6	8	2 @ 6	2 @ 8
5	High Temp Return	1-1/4 NPT	1-1/2 NPT	2 NPT	2 NPT	3 NPT	3 NPT	3 NPT	2 @ 3 NPT	2 @ 3 NPT
6	Water Inlet (150# RF Flg)	1 NPT	1-1/2	2	2	2-1/2	3	4	2 @ 3	2 @ 4
7	Drain (Dea)	1-1/4 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT
8	Overflow (Rec)	2 NPT	2 NPT	2 NPT	3 NPT	3 NP	3 NPT	4 NPT	4 NPT	6 NPT
9	Pump Suction (Optional)	Contact Your Local Cleaver-Brooks Authorized Representative								
10	Vent (Rec)	3 NPT	3 NPT	3 NPT	3 NPT	4 NPT	4 NPT	4 NPT	4 NPT	6 NPT
11	Low Pressure Return (Rec)	2 NPT	2 NPT	3 NPT	3 NPT	3 NPT	3 NPT	4NPT	4 NPT	6 NPT
12	Cold Water Inlet (Rec)	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	3 NPT
13	Drain (Rec)	1-1/4 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT	2 NPT
ITEM LIST										
14	Suction Pump, (optional) (For each pump) (Note 4)									
15	Pump/Motor, (optional)									
16	Control Panel, (optional)									
17	Manway 11 x 15									
18	Overflow Drainer, (optional)									
19	Make-Up Valve, (optional)									
20	Gauge Glass Assembly									
21	Pressure Gauge									
22	Thermometer (3/4 NPT)					Sizes listed for items 22 thru 29 are for tank connections only.				
23	Level Alarms (1 NPT), (optional)									
24	Level Control (1-1/2 NPT), (optional)									
25	Sample Connection (1/2 NPT)									
26	Recirculation Connection (1 NPT), (optional) (For each pump)									
27	High Temp Return Connection-Rec (3 NPT)									
28	Diffuser Tube (2-1/2 NPT, (optional)									
29	Breather Connection (1/2 NPT -Do Not Plug)									
30	Discharge Piping, (optional) (For each pump) (NOTE 5)									

Figure H2-2. Spraymaster Deaerator (Duo-Tank) Dimensions and Ratings – Sheet 3 of 3

SAMPLE SPECIFICATIONS

PART 1 GENERAL.....H2-9

 1.1 DEAERATOR AND SURGE TANK H2-9

PART 2 PRODUCTS.....H2-11

 2.1 HARDWARE.....H2-11

 A. Make Up Valve and Controller.....H2-11

 B. Steam Pressure Reducing Station H2-11

 C. Boiler Feedwater Pump and Motor Set H2-12

 D. Make Up Valve and Controller.....H2-13

 E. Control Panel H2-14

 F. Standard H2-14

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer’s specific needs and application.

PART 1 GENERAL

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.

1.1 DEAERATOR AND SURGE TANK

- A. Cleaver-Brooks Model _____ spray type, pressurized, horizontal deaerator is rated at _____ pounds per hour. The system shall be guarantee oxygen removal to not more than 0.005 CCS/liter in the effluent throughout all load conditions between 5 and 100 percent. The deaerator shall be designed for operation at 5 psig, but shall be suitable for use from 2 to 15 psig.
- B. The surge tank shall receive returning condensate and supplement make up water to maintain the desired operating level. Condensate and make up water mix into a blended temperature, as determined by the percentage of each. The surge tank shall be vented to atmosphere. The collected water is then transferred to the deaerator.
- C. The collected water shall be admitted to the deaerator through a single spring-loaded, self-cleaning, adjustable stainless steel spray valve, which shall provide proper internal vent condensing and water distribution at any load between 5 and 100 percent of rated capacity. The water temperature in the primary heating and vent concentrating section is to be raised within 2 or 3 °F of steam temperature and most of the gases released. The water is then to be collected in a conical water collector. From there, it is to flow to an atomizing valve where high velocity steam strikes it, breaks it down into a fine mist, and heats it to a full steam saturation temperature. The mixture is to strike a deflecting baffle, which separates water and steam. Hot, gas-free water is to then drop to the storage compartment to complete the cycle. The steam and non-condensables are to flow upward, through the primary heating spray, into the internal vent concentrating section, where they contact the cold influent water. Here, the steam is to be condensed to continue the cycle. Released gasses are discharged to atmosphere through the vent outlet. All internal surfaces, which come in contact with un-deaerated water, shall be constructed of Type 316 stainless steel.
- D. Automatic vent valve shall be thermostatically controlled to provide a fast means of venting when a sudden buildup of gases occurs, such as seen at start up. The manual vent valve shall have an orifice for continuous minimum venting. Venting rate shall not exceed 0.1 of 1% of the rated deaerator capacity at 5 psig.
- E. The duo tank shall be divided into two separate sections. The deaerator water storage and condensate surge section shall be divided by a double inner head. The dead air space between the two inner heads shall be packed with a fiberglass insulation and have a breather and drain connection. The duo tank shall be _____" diameter and _____" long.
- F. The deaerated water storage tank section shall have _____ minutes of storage and have a capacity of _____ gallons measured to overflow. An _____ manhole shall be provided for access. All nozzles 3" and under shall be 3000 lbs forged steel couplings and over 3" shall be 150 lbs flat face flanges. Heads to be ASME torispherical type constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches. The tank shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 psig at 650 delta-F and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per Table UW-12, which does not require stress relieving or nondestructive examination.

- G. The surge tank section shall have _____ minutes of storage and have a capacity of _____ gallons flooded. An _____ manhole shall be provided for access. All nozzles shall be 3000 lbs forged steel couplings. Heads to be ASME torispherical type (flat heads are not acceptable) constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches.
- H. The loads shall be as specified in the table above. Low temperature returns are defined as condensate with a temperature below that of the deaerator operating temperature. High temperature returns are defined as condensate with a temperature above that of the deaerator operating temperature.
- I. Optional - The surge tank section shall be designed in accordance with Section VIII of the ASME Pressure Vessel Code for _____ psig, and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per Table UW-12, which does not require stress relieving or nondestructive examination.
- J. Optional - The duo tank shall be factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. Block-type insulation is not acceptable. The blanket insulation is to be fiberglass, 2" thick, 1 lb/cu-ft, and have a rating of R3.85. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 18 gauge (0.0478") minimum and head thickness of 18 gauge (0.0478") minimum.
- K. Optional - The magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed. Linings shall not be acceptable in this application.
- L. Optional - The high temperature diffuser or sparge tube shall be located beneath the normal tank water level. The tube shall be constructed of 2 inch pipe. This tube shall provide even distribution and blending of high-temperature condensate returns.
- M. Optional - The chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.
- N. Optional - The basic deaerator section shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

PART 2 PRODUCTS

2.1 HARDWARE

A. Make Up Valve and Controller

1. Option (Mechanical) - _____ " inlet water regulating lever valve with _____ body and _____ connections. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psi inlet pressure. The pressure drop across the valve shall not exceed a delta-P of 10 psig. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____, Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____ Model _____.
2. Option (Electronic) - _____ " inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional type with a permanently lubricated gear train, and be directly coupled to the valve stem. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Cleaver-Brooks Model TW82. A solenoid valve and float switch are not acceptable. (Available only in the U.S.)
3. Option (Pneumatic) - _____ " inlet water diaphragm actuated regulating valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for 3 - 15 psig operating signal. The valve shall be normally open on loss of air. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____, Model _____. A filter regulator is to be provided to reduce 50 psig instrument air supply to 3 - 15 psig for proper operation.
4. Optional - The make up valve shall include an ANSI Class 125 lb three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

B. Steam Pressure Reducing Station

1. Option (Mechanical) - _____ " steam pressure reducing valve with cast iron body and _____ connections. The valve shall be a self-contained unit capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. The valve shall be 250 lb class with stainless steel trim and an adjustable pilot. The valve manufacturer shall be _____, Model _____.
2. Option (Pneumatic) - _____ " diaphragm actuated steam pressure reducing valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for

- _____ psig operating signal. The valve shall be normally closed on loss of air. The valve shall be capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. This valve shall be 250 lb class and have stainless steel trim. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external transmitter. The transmitter set pressure shall be adjustable. The transmitter manufacturer shall be _____, Model _____.
3. Optional - The steam pressure reducing valve shall include a three valve bypass with Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.
 4. Optional - Quantity _____, _____" relief valves sized to relieve full capacity of the pressure reducing valve in the event of its failure. Valves to meet Paragraph UG-125 of ASME Unfired Pressure Vessel Code, Section VIII. Valve body to be of bronze construction. Relieving set pressure to be 50 psig. Relief valve manufacturer to be _____, Model _____.
 5. Optional - High level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
 6. Optional - Low level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
 7. Optional - _____" overflow drainer sized to relieve full capacity at the operating pressure of the deaerator. The overflow drainer shall be a float type trap. The construction is to be a steel housing with stainless steel float ball. The overflow drainer manufacturer shall be _____, Model _____.
 8. Optional - Suction piping for pumps shall consist of a gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 lb class construction. The vortex breaker shall be located in the tank nozzle. Manifold suction lines are not acceptable.

C. Boiler Feedwater Pump and Motor Set

1. Option - Intermittent - Quantity _____, turbine type boiler feedwater pump and motor set. Centrifugal type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____".
2. Option (Continuous) - Quantity _____, centrifugal type boiler feedwater pump and motor set. Turbine type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump

manufacturer to be _____, Model _____, size _____" x _____". A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.

3. Optional - The basic surge tank shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

D. Make Up Valve and Controller

1. Option (Mechanical) - _____" inlet water regulating lever valve with _____ body and _____ connections. The valve Cv shall not exceed _____, and shall be rated for _____ gpm at _____ psi inlet pressure. The pressure drop across the valve shall not exceed a delta-P of 10 psig. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____, Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____, Model _____.
 - 1) Option (Electronic) - _____" inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional type, with a permanently lubricated gear train, and directly coupled to the valve stem. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psi inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Cleaver-Brooks, Model TW82. A solenoid valve and float switch are not acceptable. (Available only in the U.S.)
 - 2) Option (Pneumatic) - _____" inlet water diaphragm actuated regulating valve with cast iron body and _____ connections. The valve shall be globe-type with proportional control and a spring-opposed diaphragm actuator arranged for 3 - 15 psig operating signal. The valve shall be normally open on loss of air. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psi inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____, Model _____. A filter regulator is to be provided to reduce 50 psig instrument air supply to 3 - 15 psig for proper operation.
2. Optional - The make up valve shall include a ANSI Class 125 lb three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.
3. Optional - High-level alarm switch. This shall be an externally mounted float-type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
4. Optional - Low-level alarm switch. This shall be an externally mounted float-type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron. (Not required with electronic make up controller.)

5. Optional - Suction piping for pumps shall consist of a gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 lb class construction. The vortex breaker shall be located in the tank nozzle. Manifold suction lines are not acceptable.
6. Transfer Pump and Motor Set - Quantity _____, centrifugal type transfer pump and motor set. Turbine type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute, and have _____ seals for a maximum water temperature of 212 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____". A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.
7. Optional - The duo stand shall elevate the deaerator and surge tank sections to provide the net positive suction head required by the pump at the rated condition to prevent cavitation. The stand shall be constructed of heavy square steel tubing for the legs and 1/4" steel plate covering the floor.

E. Control Panel

1. Optional (Base) - Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.
2. Optional (Electric Components) - Audible and visual high and low water alarm function shall be provided by a bell or horn with silence switch and individual red oil-tight lights.
 - a. Control circuit transformer to supply 110-120 Volts, single-phase power supply. The transformer shall be mounted, wired and fused.
 - b. Auxiliary contacts shall be furnished for chemical feed pump initiation. Contacts shall be normally open.

F. Standard

1. The deaerator and surge section shall have a gauge glass assembly that covers the entire tank diameter. The gauge glass shall be quartz 0.625 inch diameter by 24 inch maximum length. Each length of glass shall be furnished with a bronzegauge cock set and protector rods.
 - a. The deaerator section shall be supplied with a pressure gauge that has a 4-1/2 inch dial with a 0-60 psig range and a thermometer with a 50 to 300 °F range. Packaged units are required to have both gauges bracket-mounted at eye level.
 - b. The surge tank section shall be supplied with a thermometer with a 50 to 300 °F range.
 - c. The duo tank is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with an enamel paint to not less than 1 mil thick prior to shipment.

- d. Unit is to be knocked down for shipment. Piping is to be matched marked. Three, bound, Operating and Maintenance manuals to be provided. Warranty period to be twelve months after start-up or eighteen months after shipment, whichever comes first.

Load Specifications

LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Make up to Deaerator		GPM		25 psig Min.
Make up to Surge Tank		GPM		
Pumped Low Temp Returns				
Gravity Feed Low Temp Returns				
High Temp Returns				

BOILER FEED SYSTEM PRODUCT GUIDE



Overview

Cleaver-Brooks boiler feed systems help maintain peak efficiency and prolong the life of boilers where investment in a deaerator cannot be justified. Consisting of one or more feed pumps and a corrosion resistant receiver tank, the system automatically supplements condensate with makeup water to replace system losses. Cold water is heated by mixing with hot condensate and pumped to the boiler on demand.

Information in this section addresses tank size and typical offering of Boiler Feed Systems.

- Pump Run Options
 - Continuous
 - Intermittent
- Pumps are equipped with mechanical seals as standard.
 - Tungsten Carbide seals are available at additional cost - Contact PWS Sales.
- Pumps are 304 SS fitted construction with cast iron base and pump head.
 - 316 SS construction on special request - Contact PWS Sales.
- Pump dead head pressure must exceed the boiler safety valve setting by 3%.
- All units are factory assembled and include pump and receiver combinations suitable for feedwater temperatures up to 210°F at sea level and are F.O.B. Richfield, WI.
- When equipped with an automatic steam preheater, feedwater temperature can be maintained at 210°F. At this higher temperature, oxygen and carbon dioxide are released, reducing corrosion problems in the boiler. Pre-heating is recommended if return condensate constitutes 50% or less of the feedwater required.

FEATURES AND BENEFITS

The following features and benefits apply to Cleaver-Brooks Boiler Feed system products.

All Pumps Deliver the Required Capacity at 210°F:

- Guaranteed pump performance.

All Pumps Have Mechanical Seals (Standard):

- Reduces maintenance when compared to packing type seals.

Specifically Designed for Compatibility With Cleaver-Brooks Boilers:

- Quick, accurate equipment selection.
- Single source responsibility.
- Proven performance.

Provides Additional Storage Time and Handles Volume-Swings in Condensate Return:

- Feedwater tank collects intermittent condensate returns and supplies water at a relative constant volume.
- Minimizes problem from unpredictable condensate flow rates.

Boosts Condensate Return Pressure:

- Acts as a collecting point for low pressure and gravity returns
- Allows the introduction of returns to a high pressure vessel

Accepts Gravity Returns:

- Vessels are vented to atmosphere, providing no pressure resistance that would inhibit gravity return.

Internal Pump Suction Vortex Breakers:

- Eliminates the problems of loss in NPSHA and cavitations associated with the creation of vortices within pump suction piping.

Standard Signature Series

Receiver Tank

- Horizontal, ¼ inch thick, welded carbon steel receiver with heads, mounted on structural steel stand, with the following trim.
 - Float switch and solenoid operated make-up water valve.
 - Gauge glass set with shut-off valves.
 - Includes taps for sample and chemical feed.
 - Thermometer.
 - Piping between tank and pump including valve, strainer, and flexible coupling.
 - NOTE: High temperature diffuser tube not included

Feed Pumps

- Pump sets are Grundfos only complete with steel base, coupling, coupling guard and TEFC motors. Pumps are equipped with mechanical seals as standard. All motors are new NEMA rated, standard voltages are as follows:
 - Single Phase - Contact PWS Sales Department.
 - Three Phase - 230/460/3/60
 - Other voltages - If 208 or 550 volt motors are requested, 200/3/60 or 575/3/60 will be furnished. All motors 3450 or 3525 RPM.
 - The boiler load column for pump selections is calculated for a single pump.

Control Panel

- All systems using three phase motors are supplied with a NEMA Type 1 Control Panel enclosure which include magnetic starters, H-O-A selector switches, external resets, stand-by selector switches where required (dual units do not require a stand-by selector switch), 115 volt holding coils and starter overload heaters.
 - NOTE:
 - Duplex and Triplex units have transfer switches ONLY.
 - All control panels are UL listed and labeled as standard.
 - All wiring between control panel, pumps and other electrical devices provided with the will be factory completed. Simplex units panel provided unmounted. If the system must be broken down for shipment some field terminations might be required.
 - C-B nameplate attached showing model and unit number.

Packaging

- All systems up to and including 100 gallon are shipped whole. Systems larger than 100 Gallon will be shipped broken down and match marked.
- All systems are painted Cleaver Brooks blue except the control panel, wiring conduits electric motors, pumps and tanks that are either galvanized or of stainless steel construction.

Start – Up

- Individual pump throttling valves must be installed to insure the required GPM stated in the charts is not exceeded. This must be checked at start-up.

Guide

Tab 1: Model

Boiler Feed System Models

- Example: IDT - CR2-20U (460/3/60)
 - “I” – Intermittent Run Pump Operation
 - “D” – Number of Pumps:
 - S – Simplex
 - D – Duplex
 - D – Dual
 - T – Triplex
 - “T” – Tank Size
 - P – 45 Ga.
 - R – 75 Ga.
 - S – 100 Ga.
 - T – 200 Ga.
 - V – 270 Ga.
 - W – 340 Ga.
 - X – 500 Ga.
 - Y – 750 Ga.
 - Z – 1,000 Ga.
 - “CR2-20U” – Grundfos Pump/Motor Model
 - “(460/3/60)” – Current Characteristics
- Note:
 - All Systems 100 gallon and smaller with Maximum 2 Pumps are designated **Signature Series**.
 - All Systems 200 gallon through 340 gallon with 3 pumps or less are designated **Signature Series**.
 - All other Systems are considered **Custom**.
 - Custom Systems generally add an additional 2 weeks to the lead-time.

Intermittent / Simplex

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
ISP	45	18 x 43	625
ISR	75	24 X 40	675
ISS	100	24 X 55	750
IST	200	30 X 67	1125
ISV	270	36 X 63	1175
ISW	340	36 X 78	1350
ISX	500	42 X 84	1800
ISY	750	48 X 96	2050

Weights do not include pump weight.

Intermittent / Duplex

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
IDP	45	18 x 43	675
IDR	75	24 X 40	725
IDS	100	24 X 55	775
IDT	200	30 X 67	1250
IDV	270	36 X 63	1325
IDW	340	36 X 78	1450
IDX	500	42 X 84	1875
IDY	750	48 X 96	2125

Weights do not include pump weight.

Intermittent / Dual

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
IUP	45	18 x 43	675
IUR	75	24 x 40	725
IUS	100	24 X 55	775
IUT	200	24 X 55	1250
IUV	270	36 X 63	1325
IUW	340	36 X 78	1450
IUX	500	42 X 84	1875
IUY	750	48 x 96	2125
IUZ	1000	48 x 125	2475

Weights do not include pump weight.

Intermittent / Triplex

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
ITT	200	30 X 67	1375
ITV	270	36 X 63	1500
ITW	340	36 X 78	1625
ITX	500	42 X 84	1950
ITY	750	42 X 84	2275
ITZ	1000	48 X 125	2625

Weights do not include pump weight.

Continuous / Simplex

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
CSP	45	18 x 43	675
CSR	75	24 X 40	725
CSS	100	24 X 55	800
CST	200	30 X 67	1175
CSV	270	36 X 63	1225
CSW	340	36 X 78	1400
CSX	500	42 X 84	1850
CSY	750	48 X 96	2100

Weights do not include pump weight.

Continuous / Duplex

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
CDP	45	18 x 43	725
CDR	75	24 X 40	775
CDS	100	24 X 55	825
CDT	200	30 X 67	1300
CDV	270	36 X 63	1375
CDW	340	36 X 78	1500
CDX	500	42 X 84	1925
CDY	750	48 X 96	2175

Weights do not include pump weight.

Continuous / Dual

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
CUP	45	18 x 43	725
CUR	75	24 X 40	775
CUS	100	24 X 55	825
CUT	200	30 X 67	1300
CUV	270	36 X 63	1375
CUW	340	36 X 78	1500
CUX	500	42 X 84	1925
CUY	750	48 x 96	2175
CUZ	1000	48 x 125	2525

Weights do not include pump weight.

Continuous / Triplex

Model	Tank Capacity (gal)	Tank Dimensions (inches)	Approx Shipping Weight. (lbs.)
CTT	200	30 X 67	1425
CTV	270	36 X 63	1550
CTW	340	36 X 78	1675
CTX	500	42 X 84	2000
CTY	750	48 X 96	2325
CTZ	1000	48 X 125	2675

Weights do not include pump weight.

Boiler Feed Components

- Tank
 - Required if select Pump and Stand
 - For Tank Only
 - Select Tank Only
 - De-Select Trim, Stand, and Pump
- Trim (Controls)
- Stand
 - Required if Tank and Pump selected
- Pump
 - For Pumpset Only
 - Select Pump Only.
 - De-Select Tank, Trim, and Stand

Tank Design

- Required if Tank is selected
 - Options
 - Cleaver-Brooks
 - Aurora
 - Available for tank only applications

Replacement Tank

- Required for Tank Only Application
- Specify whether or not a replacement tank application

Tank Unit Number

- Required for Replacement Tank Applications

Number of Boilers

- Standard: Maximum of 3

Boiler Horsepower

- Standard: Maximum of 800HP per pump

Boiler Operating Pressure

- Minimum: 6 psi
- Maximum: 200 psi

Boiler Safety Valve Setting

- Minimum
 - Operating Pressure Less than or Equal to 12
 - Operating Pressure + 3
 - Operating Pressure equal to 13
 - 15
 - Operating Pressure Less than or Equal to 135 and greater than 13
 - Operating Pressure + 15
 - Operating Pressure Greater than 135
 - Operating Pressure x 1.11

Mode of Operation

- Options
 - Intermittent (On/Off)
 - Continuous

Additional Pressure Drop

- 15psi pressure allowance included within the pump selection for an economizer
- Only an option:
 - Continuous Mode of Operation
 - Operating Pressure is between 30 and 185

Pumpset Configuration

- Simplex
 - Available if
 - Number of Boilers = 1
 - For 1-boiler operation, consist of:
 - (1) packaged pump: (1) TEFC motor coupled to a vertical multistage pump on steel channel base with flexible coupling and coupling guard between pump and motor;
 - (1) steel receiver with extra suction and preheat tapping
 - Float switch and solenoid make-up valve
 - Gauge glass with shutoff valves and thermometer
 - Suction piping from receiver to pump is complete with isolation valve, Y-type strainer, flexible hose, gate valve, and expansion type flexible coupling.
- Duplex
 - Available if
 - Number of Boilers = 1
 - Number of Boilers = 2 and Backup Boiler = Yes
 - For 1- boiler operation with stand-by,
 - Similar to Simplex with (2) pumps;
 - (1) steel receiver
 - NEMA 1 control panel
 - Magentic starters (where required) mounted in a NEMA I Enclosure
 - H-O-A switch and manual transfer switch for standby pump.
- Dual
 - Available if
 - Number of Boilers = 2
 - Number of Boilers = 3 and Backup Boiler = Yes
 - For 2-boiler operation,
 - Similar to duplex with large receiver size for two boiler operation - individually controlled.
 - Two H-O-A switched (one for each starter).
 - Transfer switch not required.

- Triplex
 - Available if
 - Number of Boilers = 2 or 3
 - For 2-boiler operation with stand-by,
 - Similar to dual units except 3 pumps are furnished (third pump is stand-by).
 - Two selector switches are furnished to allow pumps 1 & 2, 1 & 3, or 2 & 3 to operate.
 - (If 3-boiler operation is required, it must be specified and priced accordingly.)

Triplex Boiler Adder

- Line item included for 3 boiler / 3 pump applications

Increase Tank Size

- Substitute Larger Size Tank for Standard Tank Size
- Physical dimensions of the pump and motor prohibit substitutions of smaller receivers on packaged units in most cases

Original Tank Capacity	Increase Tank Capacity (Gal)	Add Additional Weight (Lbs)
45 Gal. Tank 18 X 43	75	45
	100	195
	200	350
75 Gal. Tank 24 X 40	100	150
	200	305
	270	330
100 Gal. Tank 24 X 55	200	155
	270	180
	340	215
200 Gal. Tank 30 X 67	270	25
	340	60
	500	315
270 Gal. Tank 36 X 63	340	25
	500	290
340 Gal. Tank 36 X 78	500	255
	750	705
500 Gal. Tank 42 X 84	750	450
	1000	1000
750 Gal. Tank 48 X 96	1000	550

Storage Time Display

- Displays Final Tank Size and Actual Storage Time

Storage Time Error Display

- If Storage Time is less than 10 Mins a message will display the following
 - Actual Storage Time is less than 10 mins. A larger storage tank is required, please contact MKE PWS Sales.

Voltage

- 460/3/60
- 230/3/60
- 208/3/60
- 575/3/60
- 380-415/3/50

Pump Dead Head Pressure Display

- If Pump dead head pressure does not exceed the boiler safety valve setting by 3% the following is displayed:
 - Warning - NBIC Section I requires that the boiler feedpump must be able to produce a pressure equal to or greater than 3% above the highest boiler safety valve setting. The selected pump does not meet this requirement. This issue usually arises when the boiler operating pressure is significantly below the safety valve setting. Consider selecting a lower safety valve setting or over sizing the pump by entering a higher operating pressure.

Tab 2: Signature Series Options**Make Up Valve**

- Square D
 - Standard - Default
 - Tank mounted internal float switch and solenoid valve

Tank Size (gal)	Solenoid Size
45 – 100	½ inch
200 – 270	¾ inch
340 – 500	1 inch
750 – 1000	1 ½ inch

- Warrick
- McD-M 25 External Tank Piped
- McD-M 21 Internal Tank Mounted

Alarm Package Type

- McD-M63
 - Not an option if the Warrick Make Up Valve is selected
- Warrick

Alarm Packages

- Includes: Alarm switch, alarm horn, silence push button, alarm light and two relays
- High Water Alarm
- Low Water Alarm
- Low Water Cutoff with Alarm

Low Discharge Pump Pressure Package

- Available for Continuous Operation

Air Gap Fitting

- Option

Chemical Feed Quill

- Tapping Standard on Tank

Magnesium Anode

- Tapping Standard on Tank

Pump Discharge Pressure Gauge (4-1/2")

- Siphon and Valve

Pump Suction Pressure Gauge (4-1/2")

- Siphon and Valve

3 Valve By Pass

- Sized based on required Make Up Valve By Pass Pipe Area
- Sizes
 - 3/4"
 - 1"
 - 1-1/2"

High Temperature Diffuser Tube

- (Perforated) Schedule 40 SS pipe (not to exceed receiver length)
 - Size 2-1/2" x 37" lg (Use with 45 - 270 gal tanks)
 - Size 2 1/2" x 60" lg. (Use with 340 - 1000 gal tanks)

Additional Tapings

- Up to 5 additional tapings
 - If additional tapings are required utilize the special engineering tab
- Specify the Taping Size, Location, and function for each additional taping

Tab 3: Pressure Vessel**Tank Construction**

- Carbon Steel
 - Standard – Default
- Galvanized
 - Hot dipped galvanized tank
- Stainless Steel (304SS)
 - Not an option if an Aurora Tank
 - Tank Constructed out of grade 304 stainless steel.
 - No manway required
 - Tank has an extended 5-year warranty at no additional cost.

Manhole

- 11" X 15" (limited to sizes 200 – 1000 gallon)

Insulation and Lagging

- Special Quotation is required
- Enter the Quotation Number, Description, and Pricing in the appropriate fields

ASME Construction Tank

- Special Quotation is required
- Enter the Quotation Number, Description, and Pricing in the appropriate fields
- Receiver tanks constructed to various ASME pressure (50#, 100#, 150#)

Seismic Calculations

- Special Quotation is required
- Enter the Quotation Number, Description, and Pricing in the appropriate fields
- Calculations
- Upgrade of Stand

Special Wiring and/or Motors

- Special Quotation is required
- Enter the Quotation Number, Description, and Pricing in the appropriate fields

Tab 4: Control Panel**Nema Enclosure**

- Not Available if Trim or Pump is not selected
- Options
 - Nema 4
 - Nema 12

Main Power Disconnect

- Not available if
 - Main Circuit Breaker is selected
 - Pumps is not selected
- Options
 - Main Fused Disconnect (40 AMP)
 - Not available if
 - Voltage is 208/3/60 and Pump HP is greater than 11 HP
 - Voltage is 280/3/50 and Pump HP is greater than 20 HP
 - Main Unfused Disconnect (40 AMP)
 - Not available if
 - Voltage is 208/3/60 and Pump HP is greater than 11 HP
 - Voltage is 280/3/50 and Pump HP is greater than 20 HP
 - Pumpset Configuration is Simplex
 - Main Unfused Disconnect (80 AMP)
 - Not available if
 - Pumpset Configuration is Simplex

Pump Protection

- Not available if
 - Pumps or Trim is not selected
- Required if
 - Main Power Disconnect is Main Unfused Disconnect (40 AMP) or Main Unfused Disconnect (80 AMP) and Pumpset Configuration is Duplex
 - Main Power Disconnect is any selection and Pumpset Configuration is Dual or Triplex

- Options
 - Individual Pump Fused Disconnect (40 AMP)
 - Not available if
 - Voltage is 208/3/60 and Pump HP is greater than 11 HP
 - Voltage is 280/3/50 and Pump HP is greater than 20
 - Individual Pump Fused
 - Not available if
 - Main Power Disconnect if Main Fused Disconnect (40 AMP)
 - Pump Circuit Breaker (per Pump) with Interlock

Main Circuit Breaker with Interlock

- Not Available if
 - Pumps is not selected
 - Main Power Disconnect is selected
- Options
 - 3 Pole 380/460/575 V
 - 3 Pole 208/230 V

Fused Control Circuit Transformer including Pump Motor Fuses

- Always selected if Pump and Trim is selected

Single Point Connection

- Included if Main Power Disconnect or Main Circuit Breaker is selected

Fused Magnetic Starter

- Not available if
 - Pumps is not selected

Electric Alternator

- Available if
 - Pumps is selected
 - Pumpset Configuration is Duplex
 - Continuous operation is selected

Audible Alarm

- Options
 - Horn
 - Bell

Alarm Silence Pushbutton

- Available if Audible Alarm is selected

Additional Contacts

- Not available if
 - Trim is not selected
- Options
 - Remote Low Water Alarm
 - Available if Low Water Alarm Package is selected
 - Remote Low Water Cut-Off Alarm
 - Available if Low Water Cut-Off Alarm Package is selected
 - Remote High Water Alarm
 - Available if High Water Alarm Package is selected
 - Pump Running Status (Per Pump)

Additional Pilot Lights

- Not available if
 - Trim is not selected
- Options
 - Power On Light
 - Pump Run Light (Per Pump)

Push To Test Pilot Light

- Available if Additional Pilot Light Option is selected

Additional 3 Pole Relay

- Not available if
 - Trim is not selected
- Options
 - Chemical Feed
 - Pump (Per Pump)
 - Remote Alarm

Hour Meter

- Not available if
 - Pump is not selected

Tab 5: Preheating Equipment**Preheating Equipment**

- All standard tanks are supplied with extra openings for preheating equipment.
- Preheating systems are provided with thermostatically controlled steam pressure regulators, Sarco or equal connected to a perforated tube installed in tank by means of special bushing.
- Feed systems with preheat also include a sentinel relief valve installed on the tank.

Internal Steam Heater

- Not Available
 - Tank is not selected
 - Evaporation Rate is greater than 192.8
- Options
 - Low Pressure (5-15 psig)
 - Available if Evaporation Rate is less than 102
 - For low pressure systems (5 – 15 psi steam)
 - Operation on steam supply pressures less than 5 psig – Consult Sales
 - Thermostatic Temperature Regulating Valve without pressure reducing attachment
 - Following equipment is furnished:
 1. Perforated heater tube with special bushing.
 2. Temperature regulating valve.
 3. Strainer for temperature regulating valve.
 4. Pressure gauge.
 5. Sentinel Relief valve in tank.

Model Number	Heating Rate (GPM)			Size of Steam Control Valve & Strainer (Inches)	Min Steam Supply Line (Inches)
	50 deg. Temp Rise	100 deg. Temp Rise	150 deg. Temp Rise		
E2T14 - 1"	9.6	4.8	3.2	1"	1.25"
E2T14 - 1.5"	14.4	7.2	4.8	1.5"	2
E2T14 - 2"	25.5	12.7	8.5	2"	2.25"
E2T14 - 2.5"	39.6	19.2	12.8	2.5"	3"
E2T14 - 2.5"	51	25.5	17	2.5"	3"
E2T14 - 2.5"	72	36.2	24	2.5"	3"
E2T14 - 3"	102	51	34	3" flg	4"

- High Pressure (30-250 psig)
 - Not Applicable for Steam Pressures over 250 psi
 - Thermostatic Temperature Regulating Valve without pressure reducing attachment
 - Following equipment is furnished:
 1. Perforated heater tube with special bushing.
 2. Temperature regulating valve.
 3. Strainer for temperature regulating valve.
 4. Pressure gauge.
 5. Sentinel Relief valve in tank.

Model Number	Heating Rate (GPM)			Size of Steam Control Valve & Strainer (Inches)	Min Steam Supply Line (Inches)	Min Steam Supply Pressure	Max Steam Supply Pressure
	50 deg. Temp Rise	100 deg. Temp Rise	150 deg. Temp Rise				
ET134 1	19.3	9.6	6.4	1	1.25	30	50
ET134 .75				3/4	1	50	100
ET134 .5				1/2	3/4	100	125
ET134 .5				1/2	3/4	125	150
ET134 .5				1/2	3/4	150	200
ET134 .5				1/2	3/4	200	250

Model Number	Heating Rate (GPM)			Size of Steam Control Valve & Strainer (Inches)	Min Steam Supply Line (Inches)	Min Steam Supply Pressure	Max Steam Supply Pressure
	50 deg. Temp Rise	100 deg. Temp Rise	150 deg. Temp Rise				
ET134 1.25	28.8	14.4	9.6	1.25	1.5	30	50
ET134 1				1	1.25	50	100
ET134 .75				3/4	1	100	125
ET134 .75				3/4	1	125	150
ET134 .5				1/2	3/4	150	200
ET134 .5				1/2	3/4	200	250
ET134 1.5	48.2	24	16	1.5	2	30	50
ET134 1.25				1.25	1.5	50	100
ET134 1				1	1.25	100	125
ET134 .75				3/4	1	125	150
ET134 .75				3/4	1	150	200
ET134 .75				3/4	1	200	250
ET134 2	72	36	24	2	2.5	30	50
ET134 1.5				1.5	2	50	100
ET134 1.25				1.25	1.5	100	125
ET134 1				1	1.25	125	150
ET134 1				1	1.25	150	200
ET134 .75				3/4	1	200	250
ET134 2.5	96.4	48.2	32	2.5	3	30	50
ET134 2				2	2.5	50	100
ET134 1.2				1.25	1.5	100	125
ET134 1.2				1.25	1.5	125	150
ET134 1				1	1.25	150	200
ET134 1				1	1.25	200	250
ET134 3	144	72	48	3	4	30	50
ET134 2.5				2.5	3	50	100
ET134 1.5				1.5	2	100	125
ET134 1.5				1.5	2	125	150
ET134 1.2				1.25	1.5	150	200
ET134 1.2				1.25	1.5	200	250
ET134 4	192.8	96.4	64	4	4	30	50
ET134 2.5				2.5	3	50	100
ET134 2				2	2.5	100	125
ET134 2				2	2.5	125	150
ET134 1.5				1.5	2	150	200
ET134 1.2				1.25	1.5	200	250

Enter Steam Pressure

- Minimum
 - Low Pressure: 5 psi
 - High Pressure: 30 psi
- Maximum
 - Low Pressure: 15 psi
 - High Pressure: 250 psi

Requested Temperature Rise

- 50° F
- 100° F
- 150° F

Heating Rate

- Determined by Low or High Pressure, Entered Steam Pressure, and Requested Temperature Rise

Internal Steam Heater Model

- Selection based on Low or High Pressure, Entered Steam Pressure, Heating Rate, and Requested Temperature Rise

Tab 6: Special Engineering**Special Quotations**

- PWS List
- PWS Net

Additional Startup

- Optional

Ship Inland Freight

- Canada
- Thomasville

BOILER FEED SYSTEMS SAMPLE SPECIFICATIONS

PART 1 GENERAL

1.1 GENERAL

- A. The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application
- B. Boiler Feed System shall be Cleaver-Brooks Model _____ (Specify simplex, duplex, dual, or triplex) packaged boiler system suitable for _____gpm, at a discharge pressure of _____psig. (Refer to Table H6-2, Table H6-3, and Table H6-4.)

PART 2 PRODUCTS

SYSTEM COMPONENTS

- A. The unit shall consist of the following components:
 - 1. One (substitute two for duplex or dual; three for triplex) stainless steel cast iron fitted pump(s) certified by Cleaver-Brooks for a minimum of _____gpm or 212°F water at _____psig. The pump(s) shall be guaranteed for one year against defects in workmanship and material. The pump(s) shall be equipped with mechanical seals for temperatures up to 225°F.
 - 2. One non-code welded receiver made of structural grade steel.
The tank shall be furnished with integral supports and connections for inlet, outlet drain, makeup valve, thermometer, and gauge glass.
 - 3. Tank size shall be _____inches diameter with _____gallon capacity.
 - 4. One fresh water makeup valve consisting of a float switch and solenoid valve suitable for tight shutoff against 100 psig inlet pressure.
 - 5. Piping between the receiver and the pump shall consist of one (substitute two for duplex or dual; three for triplex) section(s) containing a gate valve(s), one flexible hose(s) and Y-type strainer(s) to ensure minimum pressure drop between receiver and pump.

CONDENSATE RETURN SYSTEM PRODUCT GUIDE

Standard Units Include:

- Carbon Steel Receiver Tank
- Vertical Immersion Pump(s)
- Float Switch/Mechanical Alternator

Cleaver-Brooks Vertical Immersion Pump and Motor:

Our standard system includes Vertical Immersion pumps, which do not require an isolation valve, eliminates the need to drain the system for maintenance and require a smaller footprint. These pumps are Cast Iron-Stainless Steel Construction with a wide range of pump sizes and multiple stages. Pumps operate at numerous duty points and pressures. They are built with a standard pump mounting plate for ease of removal and installation.

Condensate Return Tank Options:

- Pump Control
 - Square D: Standard
 - Warrick Probe: Optional
- Control Panel
 - 3 Phase: Standard
 - 1 Phase: Optional
 - Required with the Warrick Probe
- Thermometer
- Sight Glass
- Pump Discharge Pressure Gauge
- Pump Suction Pressure Gauge
- Inlet Y-Strainer
- Stainless Steel Tank - Special Quotation

Model Number Description: **CRS-D25-4-5**

CRS = Condensate Return System

D = Duplex

25 = Tank capacity gallons

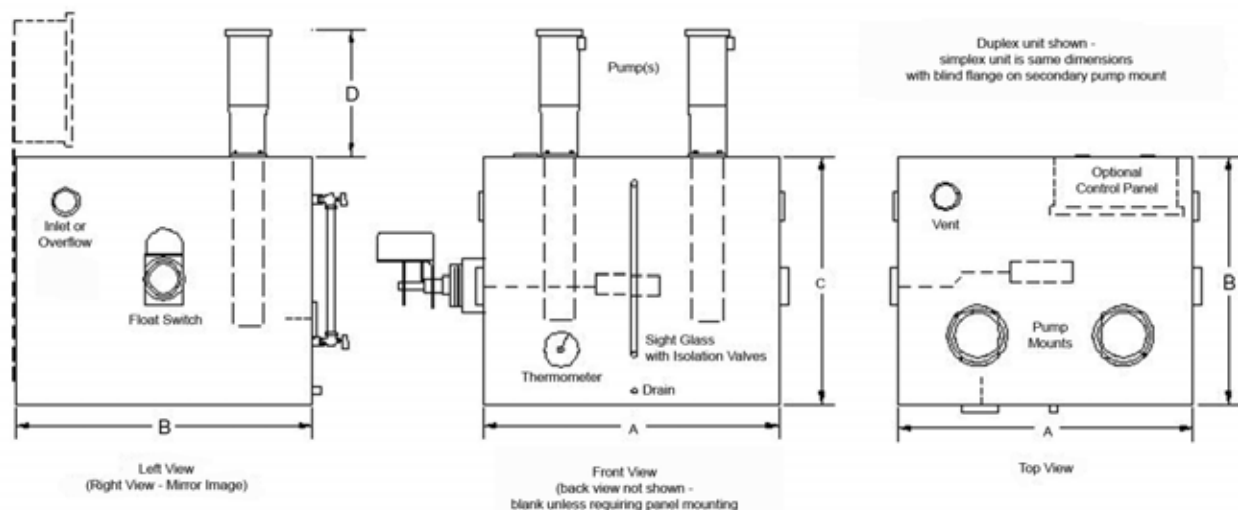
4-5 = Pump model (SPK)

Condensate System Selection Table

			PSI						
			10	15	20	25	30	35	40
GPM	EDR	Tank Cap. Gal							
5	500-3000	10	SPK1-3	SPK1-3	SPK1-3	SPK1-5	SPK1-5	SPK1-8	SPK1-8
10	4000-6000	10	SPK2-3	SPK2-3	SPK2-3	SPK2-5	SPK2-5	SPK2-8	SPK2-8
15	8000-10000	15	SPK4-3	SPK4-3	SPK4-3	SPK4-5	SPK4-5	SPK4-5	SPK4-8
20	15000	25	SPK4-3	SPK4-3	SPK4-5	SPK4-5	SPK4-8	SPK4-8	SPK4-8
25	15000	25	SPK8-1	SPK8-2	SPK8-3	SPK8-3	SPK8-5	SPK8-5	SPK8-5
30	20000	25	SPK8-2	SPK8-2	SPK8-3	SPK8-3	SKP8-5	SPK8-5	SPK8-5
35	25000	35	SPK8-2	SPK8-2	SPK8-3	SPK8-3	SKP8-5	SPK8-5	SPK8-5
40	25000	35	SPK8-2	SPK8-2	SPK8-3	SPK8-5	SKP8-5	SPK8-5	SPK8-5
45	30000	35	SPK8-2	SPK8-2	SPK8-3	SPK8-5	SKP8-5	SPK8-5	SPK8-7
50	30000	35	SPK8-2	SPK8-3	SPK8-5	SPK8-5	SPK8-5	SPK8-7	SPK8-7

Dimensions and Ratings (dimensions in inches)

Tank Size Gallons	A	B	C	D
10—T	16.00	15.50	13.00	Varies with HP
15—T	18.50	18.00	13.00	Varies with HP
25—T	23.00	22.50	15.00	Varies with HP
35—T	24.00	23.50	19.00	Varies with HP



Weights

Single Phase

Simplex System #	Simplex Weight	Duplex System #	Duplex Weight
S10-1-3	265	N/A	N/A
S10-1-5	266	N/A	N/A
S10-1-8	266	N/A	N/A
S10-2-3	265	N/A	N/A
S10-2-5	266	N/A	N/A
S10-2-8	284	N/A	N/A
S15-4-3	317	D15-4-3	364
S15-4-5	333	D15-4-5	396
S15-4-8	347	D15-4-8	424
S25-4-3	317	D25-4-3	364

Simplex System #	Simplex Weight	Duplex System #	Duplex Weight
S25-4-5	333	D25-4-5	396
S25-4-8	347	D25-4-8	424
S25-8-1	323	D25-8-1	376
S25-8-2	341	D25-8-2	412
S25-8-3	352	D25-8-3	434
S25-8-5	355	D25-8-5	440
S35-8-2	441	D35-8-2	512
S35-8-3	452	D35-8-3	534
S35-8-5	455	D35-8-5	540
S35-8-7	467	D35-8-7	564

Three Phase

Simplex System #	Simplex Weight	Duplex System #	Duplex Weight
S10-1-3	365	N/A	N/A
S10-1-5	366	N/A	N/A
S10-1-8	366	N/A	N/A
S10-2-3	365	N/A	N/A
S10-2-5	366	N/A	N/A
S10-2-8	384	N/A	N/A
S15-4-3	417	D15-4-3	514
S15-4-5	433	D15-4-5	546
S15-4-8	447	D15-4-8	574
S25-4-3	417	D25-4-3	514

Simplex System #	Simplex Weight	Duplex System #	Duplex Weight
S25-4-5	433	D25-4-5	546
S25-4-8	447	D25-4-8	574
S25-8-1	423	D25-8-1	526
S25-8-2	441	D25-8-2	562
S25-8-3	452	D25-8-3	584
S25-8-5	455	D25-8-5	590
S35-8-2	541	D35-8-2	662
S35-8-3	552	D35-8-3	684
S35-8-5	555	D35-8-5	690
S35-8-7	567	D35-8-7	714

Condensate Return System Sample Specifications

PART 1 GENERAL

1.1 GENERAL

A.The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application

B.Condensate Return Systems shall be Cleaver-Brooks Model (Specify simplex, or duplex) suitable for _____gpm, at a discharge pressure of _____psig (refer to Selection Table above).

PART 2 PRODUCTS

2.1 SYSTEM COMPONENTS

A.The unit shall consist of the following components:

1.One (substitute two for duplex) Vertical Immersion Pumps, which do not require an isolation valve. These pumps are Cast Iron-Stainless Steel Construction with a wide range of pump sizes and multiple stages. Pumps operate at numerous duty points and pressures. They are built with a standard pump mounting plate for ease of removal and installation

2.One non-code welded receiver made of carbon steel.

3.Tank size shall be gallon capacity.

4.One pump control consisting of a float switch.

CHEMICAL FEED SYSTEM PRODUCT GUIDE

STANDARD UNITS INCLUDE:

- Tank, cover*, Structural Base.
- Single Model V-10 positive displacement pump with 5/8" diameter stainless steel piston.
- 1/3 HP TEFC gearhead motor, 60RPM, 120/1/60.
- Strainer and Shutoff valve in suction piping.
- Relief valve and piping for discharge.
- Direct drive agitator with ¼ HP TENV motor 1725 RPM, 120/1/60.

*Hinged lid on steel tanks, removable cover on polyethylene tanks.

TANK MATERIALS AVAILABLE:

- Model HCS Carbon Steel (10 gauge)
- Model P Polyethylene
- Model OP Overpack (Polyethylene lined Steel tank)
- Model SS Stainless Steel

Cleaver-Brooks Model V-10 Piston Pump and Motor:

The V-10 pump is a positive displacement type with 120/1/60 TEFC motor and gearhead reducer, double stainless steel check valve and balls, 5/8" stainless steel piston

Model Number Description: 50-P-1-V-10

- 50 gallon tank capacity
- Polyethylene tank material
- One pump and motor set
- Model V-10 pump

All units are factory assembled.

STANDARD CHEMICAL FEED PACKAGES WITH V-10 PISTON PUMPS

Model	Cap Gal	Material	Ship Wgt
55-OP-1-V-10	55	Overpack	175
50-HCS-1-V-10	50	10 Ga. Carbon Stl.	175
100-HCS-1-V-10	100	10 Ga. Carbon Stl.	275
150-HCS-1-V-10	150	10 Ga. Carbon Stl.	375
200-HCS-1-V-10	200	10 Ga. Carbon Stl.	475
30-P-1-V-10	30	Polyethylene	125
55-P-1-V-10	55	Polyethylene	175
100-P-1-V-10	100	Polyethylene	225
150-P-1-V-10	150	Polyethylene	250
200-P-1-V-10	200	Polyethylene	275
50-SS-1-V-10	50	10 Ga. 304 SS	175
100-SS-1-V-10	100	10 Ga. 304 SS	275
150-SS-1-V-10	150	10 Ga. 304 SS	375
200-SS-1-V-10	200	10 Ga. 304 SS	475

SPECIAL PUMPS, MOTORS, AND ACCESSORIES

Dual - 2 Motors, 2 Pumps

Triple - 3 Motors, 3 Pumps

SPECIAL MOTORS

TEFC pump motor 240/480V 3ph 60 hz

TEFC pump 115 or 230 V 1ph 50/60 hz

1/2 HP EPFC pump motor 120 or 240 V 1ph 60 hz

SPECIAL AGITATORS

276 RPM 1/3 HP 120V 1ph 60Hz TEFC with 9" prop

276 RPM 230/460V 3ph 60 Hz TEFC with 9" prop

1725 RPM 1/4 HP EPFC 230/460/3ph motor

TENV agitator 230/460V 3ph 60 hz

1/4 EPFC agitator motor 120 or 240V 1ph 60hz

If agitator not required deduct applies

MISCELLANEOUS OPTIONS TO STANDARD PACKAGED SYSTEMS

Dissolving Basket 1/5 cu. Ft
 *Low level cutoff and alarm 115V
 304 S.S. Injection nozzle
 Electric solenoid valve 1/4" 3 way
 Timer - (Contact PWS)
 Floating cover Styrofoam
 Stainless Steel hinge on polyethylene lid
 All 316 Stainless Steel Suction piping
 *Only for units without control panels

NEMA 12 CONTROL PANELS (FOR 30 GALLON TANKS CONTACT MILWAUKEE SALES)

Simplex one ON/OFF switch for mixer one HOA switch for pump with 2 running lights (14x12x6)
 Simplex above plus audio and visual alarm (14x12x6)
 Dual one ON/OFF switch for mixer two HOA switches for pump with 3 running lights (14x12x6)
 Dual above plus audio and visual alarm (20x16x7)
 Triple one ON/OFF switch for mixer three HOA switches for pump with 4 running lights (20x16x7)
 Triple above plus audio and visual alarm (24x20x7)

Shot Feeders

Model No. Acc	Capacity (Gallons)	Price		Weight (Lbs.)		Volume Cu. Ft.
		125 PSIG	300 PSIG	125 PSIG	300 PSIG	
SF .75	3/4	\$185	\$430	21	25	0.2
SF 1	1	\$210	\$435	29	25	0.38
SF 1.5	1 1/2	\$215	\$440	35	40	0.49
SF 2	2	\$240	\$465	40	46	1.11
SF 2.5	2 1/2	\$240	\$470	45	49	1.2
SF 5	5	\$340	\$565	80	90	2.03
SF 10	10	\$415	\$640	150	205	2.84
SF 25	25	\$600	\$825	320	350	9

Standard Unit includes:

- A. Tank
- B. Funnel
- C. Inlet Valve
- D. Outlet Valve
- E. Sample Valve
- F. Screwed Connections

Bypass Feeders

Model No.	Capacity	Price	Weight	Volume
Acc.	(Gallons)	125 PSIG	(Lbs.)	Cu. Ft.
BPF .75	$\frac{3}{4}$	\$290	25	0.43
BPF 1	1	\$315	34	0.56
BPF 1.5	1 $\frac{1}{2}$	\$320	39	0.65
BPF 2	2	\$340	44	1.07
BPF 2.5	2 $\frac{1}{2}$	\$350	49	1.15
BPF 5	5	\$450	90	1.97
BPF 10	10	\$520	160	2.8
BPF 25	25	\$700	330	2.8

Standard Unit includes:

- A. Tank
- B. Funnel
- C. Funnel
- D. Sight glass with guards and valves
- E. Flow control valve
- F. Inlet and Outlet Valve
- G. Air Vent
- H. Sample Valve
- I. Screwed Connections

NOTES:

1. Feeders 5 gallons and larger include three (3) 12" support legs.
2. When ordering, specify Model No. and PSIG rating.
3. All units are shipped Berea, Ohio.

BLOWDOWN SEPARATORS PRODUCT GUIDE

Model No. *	Plate Thickness			Weight (Lbs)			Volume Cu. Ft.
	5/16"	3/8"	1/2"	5/16"	3/8"	1/2"	
A14B	Yes	N/A	N/A	85	N/A	N/A	0.81
A20B	Yes	Yes	Yes	115	130	210	1.53
A34B	Yes	Yes	Yes	155	185	235	2.66
A56B	Yes	Yes	Yes	270	340	490	4.98

*See Brochure #CBA 324-R5 for sizing chart

NOTE:

National Board stamping and "U" symbol or CRN (Canadian). Available at extra cost. See price list.

Standard Units built to ASME Code and Stamped for 250 PSIG, and Hydro tested at 375 psig

Above units supplied with screwed connections and exterior CB-Blue Paint.

Specify Model #, inlet size, drain size, vent size and plate thickness when ordering.

BLOWDOWN SEPARATORS (CODE E)

SPECIAL STATE REGULATIONS

Arkansas	Require Minimum 3/8" Plate Thickness and Pressure Gauge Connection.
District of Columbia	Requires Min. 3/8" Plate Thickness.
Kansas	All pressure vessels installed after January 1, 1999 regardless of code construction shall be registered with the National Board. Add for "U" stamp and registration.
Kentucky	Requires Minimum 3/8" Plate Thickness. "U" Symbol Stamped and Registered with National Board. Requires a Pressure Gauge. Separators and tanks should be rated and stamped for the boiler design pressure.
Michigan	Requires "U" Symbol Stamped and Registered with National Board. A pressure gauge connection is required. Separators cannot be used on boilers with a design pressure over 300 psig. Tanks should be sized according to their sizing table.
Nevada	Requires "U" Symbol Stamped and Registered with National Board.
North Dakota	All Pressure Vessels regardless of construction are required to be registered with National Board.
New Jersey	Separators cannot be used unless drain water then goes to a holding tank, pit, or sump.
Canada	All provinces require "U" Symbol Stamped and Registered with National Board. Must also be Registered with a CRN Canadian Registration Number for the Province of installation. Min. 3/8" plate thickness except the Province of Ontario which allows 5/16" min thickness. Aftercooler and TRV required on each unit. A Corrosion allowance 1/8" thk. is required. Blowdown Separators are not acceptable in Provinces of Quebec and New Brunswick. CSA B51-03 sized Blowoff Tanks must be used. British Columbia – ½" Thick heads and shell on Blowdown Separators and Blowoff Tanks. This is to meet 3/8" Minimum plate thickness of pipe and heads after forming.

BLOWDOWN SEPARATORS (CODE E)**BLOWDOWN SEPARATOR ACCESSORIES****FLANGES FOR SEPARATOR DRAIN, INLET, AND VENT FLANGES FOR AFTERCOOLER**

NOTE!!! Must be purchased along with a separator order.

Note: For 300 psig flanged Separator Inlet, Drain, and Vent, use 300 psig flanged aftercooler.
(Qty: 3 for Inlet, Drain, Vent. / Qty: 2 for Aftercooler Inlet & Outlet)

Add flange weight to separator weight.

When 150 lb. flanges are specified, Separator will be stamped 150 psig. When 300 lb. Flanges are specified, Separator will be stamped 250 psig. If "U" symbol specified, Separator will be stamped 300 psig.

Drain Size	2"	3"	4"	5"	6"	8"
150 lbs.	Yes	Yes	Yes	Yes	Yes	Yes
Weight (lbs)	15	24	39	45	57	90
300 lbs.	Yes	Yes	Yes	Yes	Yes	Yes
Weight (lbs)	21	39	66	84	117	174

DRAIN TEMPERING FITTINGS - AFTERCOOLERS

	2"	3"	4"	5"	6"	8"
5D-4" Lg x	Yes	Yes	Yes	Yes	Yes	Yes
Weight (lbs)	5	9	10	10	12	20
16DS-20"	Yes	Yes	Yes	Yes	Yes	Yes
Weight (lbs)	7	14	21	22	34	40
18DF-18" Lg	Yes	Yes	Yes	Yes	Yes	Yes
Weight (lbs)	20	30	45	55	75	92
20AO-20"	Yes	Yes	Yes	Yes	Yes	Yes
Weight (lbs)	18	22	25	35	45	65

BLOWDOWN SEPARATORS (CODE E)**BLOWDOWN SEPARATOR ACCESSORIES**

NOTE!!! Must be purchased along with a separator order.

TEMPERATURE REGULATOR VALVES

NOTE: Maximum Cooling Water Pressure 60 psig

Size	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"
Weight (lbs)	5	6	10	12	18	27	32

STRAINER, C.I.Y. TYPE: .045 SCREEN

Size	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"
Weight (lbs)	2	3	5	6	11	16	26

SOLENOID VALVE AND THERMOSTAT

Size	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"
Weight (lbs)	3	4	6	7	10	15	30

THERMOMETER 2" Dial, 6" Stem, Bimetal Thermometer for Model 16, 18 and 20 Aftercoolers

PRESSURE GAUGE 3-1/2" Dial with 1/4" syphon

FLOOR SUPPORTS (40 lbs.) 3 angle legs with floor pads to raise Separator 18" above floor.

WALL BRACKETS Model 14, 20 and 34 (40 lbs.)
Model 56 (50 lbs.)

EXHAUST HEADS (CODE E)

Model No.	Weight (Lbs)	
	Beveled	Flanged
ACC-EXP-	Inlet	Inlet
10-2	80	85
10-2- 1/2	85	90
10-3	90	95
10-4	95	105
14-5	125	140
14-6	135	160
20-8	280	310
20-10	290	330
24-12	420	485
24-14	450	525

1. Select proper exhaust head by vent size of blowdown separator.
2. Flanges are 150 lb. raised face ASTM A105.
3. Material of construction: Heads 10-20 carbon steel, shell SA53B
4. Finish is rust resistant primer exterior.
5. Beveled inlet is for butt welded seam.
6. All units are shipped F.O.B. Brookville, PA

BLOWDOWN SEPARATORS (CODE E)

1. All units are shipped F.O.B. Brookville, PA

INLAND FREIGHT & EXPORT PACKING AVAILABLE. SEE PRICE LIST.

WATER SOFTENER PRODUCT GUIDE

Model SMR – Simplex Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
150,000	1.5	721
150,000	2	754
210,000	1.5	919
210,000	2	946
300,000	2	1,428
300,000	3	1,533
450,000	2	1,753
450,000	3	1,826
600,000	2	2,460
600,000	3	2,533
750,000	2	2,833
750,000	3	2,970
900,000	2	3,340
900,000	3	3,416
1,050,000	2	3,650
1,050,000	3	3,726
1,200,000	3	5,650
1,200,000	4	5,720
1,500,000	3	6,850
1,500,000	4	6,875

Pressure gauges and test cocks (inlet/outlet) per Tank – Included

Above single system list price includes epoxy lined/painted exterior pressure vessel - non-code construction, stager controller, bypass assembly, brine tank, water softening resin, support gravel, pressure gauges, and sampling valves.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Racine, WI.

Model SMR – Twin Alternating Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
150,000	1.5	1,369
150,000	2	1,430
210,000	1.5	1,762
210,000	2	1,814
300,000	2	2,738
300,000	3	2,936
450,000	2	3,351
450,000	3	3,504
600,000	2	4,722
600,000	3	4,863
750,000	2	5,440
750,000	3	5,581
900,000	2	6,429
900,000	3	6,598
1,050,000	2	7,049
1,050,000	3	7,218
1,200,000	3	10,765
1,200,000	4	10,815
1,500,000	3	12,950
1,500,000	4	13,000

Pressure gauges and test cocks (inlet/outlet) per Tank – Included

Above twin system list price includes epoxy lined/painted exterior pressure vessels - non-code construction, metered regeneration, alternator controller, brine tank, water softening resin, support gravel, pressure gauges, and sampling valves.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Racine, WI.

*Model SMR – Accessories***ASME Pressure Tank Construction – List Price Adders (Per Tank)**

Capacity (GRAINS)	Tank Size DIA x S.S.	PSI Rating
150,000	20 x 54	100
150,000	24 x 54	100
210,000	30 x 54	100
210,000	30 x 60	100
300,000	36 x 60	100
300,000	36 x 72	100
450,000	42 x 60	100
450,000	42 x 72	100
600,000	48 x 72	100
600,000	54 x 72	100

Notes:

- (1) Interior Lining - Polyamide Epoxy applied to a sandblasted surface. Sprayed application to a dry film thickness of 10-12 mils. ANSI/NSF Standard 61 compliance.
- (2) Finish paint is a high solids, polyamide epoxy applied to an exterior lined tank. Application is 6-8 mils sprayed on sandblasted surface. The standard color is safety blue. Consult the factory for special colors and other exterior coatings.
- (3) Contact factory for prices on other tank pressure ratings and/or other tank lining requirements.

Twin Alternating – Skid Mounted / Pre-Piped / Pre-Wired Packages

Capacity (GRAINS)	Pipe Size (in.)	Header Size (in.)
150,000	1.5	1.5
150,000	2	2
210,000	1.5	1.5
210,000	2	2
300,000	2	2
300,000	3	3
450,000	2	2
450,000	3	3
600,000	2	2
600,000	3	3
750,000	2	2
750,000	3	3
900,000	2	2
900,000	3	3
1,050,000	2	2
1,050,000	3	3
1,200,000	3	3
1,200,000	4	4
1,500,000	3	3
1,500,000	4	4

Notes:

1. Steel mounting skids painted to match tank color.
2. System interconnecting piping is galvanized steel.
3. Isolation valves provided for the inlet and outlet of each tank and a system bypass valve.
4. Contact factory for alternative header sizes, material of construction etc.

Model FMR – Simplex Package

Capacity (Grains)	Pipe Size (in.)	Time Clock Shipping Wt. (lbs)	Meter Shipping Wt. (lbs)
30,000	0.75	104	---
45,000	0.75	143	---
60,000	1	178	178
60,000	1.5	187	187
90,000	1	287	287
90,000	1.5	296	296
120,000	1	366	366
120,000	1.5	374	374
150,000	1.5	463	463
150,000	2	477	477
210,000	1.5	654	654
210,000	2	667	667
300,000	1.5	929	929
300,000	2	939	939
450,000	1.5	1,365	1,365
450,000	2	1,375	1,375
600,000	2	2,035	2,035
600,000	3	2,097	2,097
900,000	3	3,421	3,421
1,200,000	3	4,395	4,395

Above “single” system list price includes FRP pressure vessel - non-code construction, top-mount control valve with automatic regeneration, hard water bypass assembly, brine tank, water softening resin, and support gravel. Metered systems include water meter and digital control valve display.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Racine, WI.

Model FMR – Twin Alternating Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
30,000	0.75	196
45,000	0.75	269
60,000	1	338
60,000	1.5	356
90,000	1	557
90,000	1.5	573
120,000	1	705
120,000	1.5	723
150,000	1.5	899
150,000	2	925
210,000	1.5	1,280
210,000	2	1,305
300,000	1.5	1,825
300,000	2	1,850
450,000	1.5	2,665
450,000	2	2,690
600,000	2	3,990
600,000	3	4,120
900,000	3	6,740
1,200,000	3	8,700

Above “twin alternating” system list price includes FRP pressure vessels - non-code construction, top-mount control valves, metered regeneration, alternating control, brine tank, water softening resin, and support gravel. Units with 3/4", 1", and 1-1/2" piping use a single control valve serving both resin tanks. Units with 2" and 3" piping have an individual control valve for each resin tank. All control valves are electronic with digital display.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Racine, WI.

*Model FMR – Accessories****Twin Alternating – Skid Mounted / Pre-Piped / Pre-Wired Packages***

Capacity (GRAINS)	Pipe Size (in.)	Header Size (in.)
30,000	0.75	0.75
45,000	0.75	0.75
60,000	1	1
60,000	1.5	1.5
90,000	1	1
90,000	1.5	1.5
120,000	1	1
120,000	1.5	1.5
150,000	1.5	1.5
150,000	2	2
210,000	1.5	1.5
210,000	2	2
300,000	1.5	1.5
300,000	2	2
450,000	1.5	1.5
450,000	2	2
600,000	2	2
600,000	3	3
900,000	3	3
1,200,000	3	3

Notes:

1. Steel mounting skids are finished with a "Safety Blue" epoxy paint coating.
2. System interconnecting piping is SCH 80 PVC.
3. Isolation valves provided for the inlet and outlet of each tank and a system bypass valve (2" & 3" only).
4. Contact factory for alternative piping header sizes, material of construction etc.

Model SSE - Simplex Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
30,000	1	150
60,000	1	285
90,000	1	395
90,000	1.5	405
120,000	1.5	560
120,000	2	605
150,000	1.5	640
150,000	2	655
210,000	1.5	980
210,000	2	995
300,000	1.5	1245
300,000	2	1275
450,000	2	1565
450,000	3	1615
600,000	2	1955
600,000	3	2015
900,000	3	2825
1,200,000	3	3660

Controls - Electronic Demand

Pressure gauges and test cocks (inlet/outlet) per Tank – Optional

Above “single” system list price includes steel epoxy lined pressure vessel.

Pressure rating 100 psi. – Metered regeneration based on flow volume and inputted water hardness, standard systems will bypass hardwater during regeneration.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Naperville, IL.

Model SSE - Twin Alternating Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
30,000	1	300
60,000	1	490
90,000	1	680
90,000	1.5	700
120,000	1.5	970
120,000	2	1,060
150,000	1.5	1,130
150,000	2	1,160
210,000	1.5	1,740
210,000	2	1,770
300,000	1.5	2,270
300,000	2	2,300
450,000	2	2,980
450,000	3	3,060
600,000	2	3,760
600,000	3	3,880
900,000	3	5,670
1,200,000	3	7,340

Controls - Electronic Demand

Pressure gauges and test cocks (inlet/outlet) per Tank – Optional

Above “twin” system list price includes steel epoxy lined pressure vessel.

Pressure rating 100 psi. – Metered regeneration based on flow volume and inputted water hardness, one tank in service and the other in standby or regeneration. No hardwater bypass during regeneration.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Naperville, IL.

*Model SSE – Accessories***ASME Pressure Tank Construction – List Price Adders (Per Tank)**

Capacity (GRAINS)	Tank Size DIA	PSI Rating
30,000	10	100
60,000	12	100
90,000	14	100
120,000	18	100
150,000	18	100
210,000	24	100
300,000	24	100
450,000	30	100
600,000	36	100
900,000	42	100
1,200,000	48	100

Notes:

Carbon Steel pressure vessel rated for 100 psi with ASME code construction, a polyamide epoxy lined interior and an epoxy painted exterior

Twin Alternating – Skid Mounting Package

Capacity (Grains)	Galvanized Steel Pipe Size (in.)	Schedule 80 PVC Pipe Size (in.)	Max GPM Flow Rate
30,000	1	1	22
60,000	1	1	22
90,000	1	1	22
90,000	1.5	1.5	55
120,000	1.5	1.5	55
120,000	2	2	100
150,000	1.5	1.5	55
150,000	2	2	100
210,000	1.5	1.5	55
210,000	2	2	100
300,000	1.5	1.5	55
300,000	2	2	100
450,000	2	2	100
450,000	3	3	200
600,000	2	2	100
600,000	3	3	200
900,000	3	3	200
1,200,000	3	3	200

Notes:

1. Includes mounting the tanks on a steel skid with interconnecting piping.
2. Interconnecting piping includes inlet header with manual valve for vessel isolation, outlet header and connecting piping to each individual vessel.
3. Drain lines are to be plumbed in the field by others according to the specific site requirements.
4. Brine tanks are not mounted on the skid for greater flexibility at installation site and to reduce corrosion of the steel skid.
5. The interconnecting piping size must be an equal to or larger than the valve size.

Model FSE - Simplex Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
30,000	1	150
60,000	1	285
90,000	1	395
90,000	1.5	405
120,000	1.5	560
120,000	2	605
150,000	1.5	640
150,000	2	655
210,000	1.5	980
210,000	2	995
300,000	1.5	1245
300,000	2	1275
450,000	2	1565
450,000	3	1615
600,000	2	1955
600,000	3	2015
900,000	3	2825
1,200,000	3	3660

Controls - Electronic Demand

Pressure gauges and test cocks (inlet/outlet) per Tank – Optional

Above "single" system list price includes fiberglass reinforced pressure vessel

Pressure rating 150 psi. – Metered regeneration based on flow volume and inputted water hardness, standard systems will bypass hardwater during regeneration.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Naperville, IL.

Model FSE - Twin Alternating Package

Capacity (Grains)	Pipe Size (in.)	Shipping Wt. (lbs)
30,000	1	300
60,000	1	490
90,000	1	680
90,000	1.5	700
120,000	1.5	970
120,000	2	1,060
150,000	1.5	1,130
150,000	2	1,160
210,000	1.5	1,740
210,000	2	1,770
300,000	1.5	2,270
300,000	2	2,300
450,000	2	2,980
450,000	3	3,060
600,000	2	3,760
600,000	3	3,880
900,000	3	5,670
1,200,000	3	7,340

Controls - Electronic Demand

Pressure gauges and test cocks (inlet/outlet) per Tank – Optional

Above "twin" system list price includes fiberglass reinforced pressure vessel.

Pressure rating 150 psi. – Metered regeneration based on flow volume and inputted water hardness, one tank in service and the other in standby or regeneration. No hardwater bypass during regeneration.

For Temperatures Above 120 degrees F, Consult Cleaver-Brooks.

All units are F.O.B. Naperville, IL.

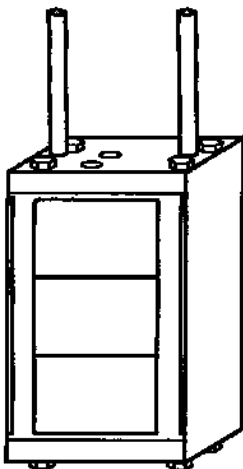
*Model FSE – Accessories****Twin Alternating – Skid Mounting Package***

Capacity (Grains)	Max GPM Flow Rate	Galvanized Steel Pipe Size (in.)	Schedule 80 PVC Pipe Size (in.)
30,000	22	1	1
60,000	22	1	1
90,000	22	1	1
90,000	55	1.5	1.5
120,000	55	1.5	1.5
120,000	100	2	2
150,000	55	1.5	1.5
150,000	100	2	2
210,000	55	1.5	1.5
210,000	100	2	2
300,000	55	1.5	1.5
300,000	100	2	2
450,000	100	2	2
450,000	200	3	3
600,000	100	2	2
600,000	200	3	3
900,000	200	3	3
1,200,000	200	3	3

Notes:

1. Price includes mounting the tanks on a steel skid with interconnecting piping.
2. Interconnecting piping includes inlet header with manual valve for vessel isolation, outlet header and connecting piping to each individual vessel.
3. Drain lines are to be plumbed in the field by others according to the specific site requirements.
4. Brine tanks are not mounted on the skid for greater flexibility at installation site and to reduce corrosion of the steel skid.
5. The interconnecting piping size must be an equal to or larger than the valve size.

SAMPLE COOLERS



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TABLES

Table H14-1. Sample Cooler Ratings.....H14-3

This section contains information on Cleaver-Brooks sample coolers. The Model SC22 and SC42 Sample Coolers are used to cool boiler water samples under pressure so that an accurate sampling can be made. When boiler water samples are taken without being properly cooled (while under boiler pressure), as much as 20% of the sample can flash to steam, causing inaccurate measurement of boiler water quality.

FEATURES AND BENEFITS

Heavy Duty All Stainless Steel Wetted Parts:

- SC-22 cools boiler water samples up to 635 °F and 2000 psig.
- SC-42 cools boiler water samples up to 1000 °F and 5000 psig.

True Counterflow Cooling:

- Effective baffling on the shell side produces full counter flow with high cooling water flow and minimum pressure drop, vibration and scaling.
- Proper temperature achieved.

Compact Design:

- SC-22 3-9/16" square x 5-1/2" long compact size. Easily mounted in cooling water piping without using brackets or special supports.
- SC-42 3-9/16" square x 11-1/4" long mounted in cooling water piping without using brackets or special supports.

Stainless Steel Coil:

- Single continuous tube with no joints assures long, maintenance free operation.

Removable Shell:

- Shell can be easily removed for inspection and/or cleaning without disconnecting sample water lines.

Lowest Cost:

- Largest heat transfer surface per unit of cost of any sample coolers.

PRODUCT OFFERING

The sample cooler is a low-pressure-drop system for monitoring boiler water quality without shutting down the boiler system. A simple, compact design cools samples with minimum disturbance to system pressure. The 316 stainless steel tubing is a continuous, jointless, coil arrangement. Tubing is maintenance-free

The design has baffling on the shell side to achieve high cooling water flow, minimizing pressure drop, vibration and scaling. The shell can be easily removed for inspection and/or cleaning without disconnecting sample or water lines.

SC-22

Rated for 635 °F at 2000 psig. Shell is 304 stainless steel, rated at 450 °F, 250 psig.

SC-42

Rated for 1000 °F at 5000 psig. Shell is 304 stainless steel, rated at 650 °F, 450 psig.

SC-22 Panel

The SC-22 is available in a pre-assembled panel mounted kit including:

- Stainless steel mounting panel
- Cooling water inlet and outlet valves
- Sample inlet metering valve and isolation valve
- Stainless steel sink with drain

DIMENSIONS AND RATINGS

Dimensions for Model SC-22 are shown in Figure H14-1, and for the SC-22 Panel in Figure H14-2. Figure H14-4 shows dimensions for Model SC-42. Ratings are shown in Table H14-1.

ENGINEERING DATA

Refer to Figure H14-3 (SC-22) and Figure H14-5 (SC-42) for performance curves. These diagrams show the relationship of outgoing sample temperature to incoming cooling water temperature for various sample temperatures (diagonal lines) and flow rates.

Example: The water sample is 1/4 gpm (946 cc/min) at 400 °F and is to be cooled to less than 100 °F and the cooling water is 95 °F. Follow the dotted line at 0.25 gpm to 400 °F inlet temperature. Read 18 °F temperature approach. Sample pressure drop will be approximately 6.5 psig. Sample will cool to 88 °F, (70 °F coolant + 18 °F approach).

Table H14-1. Sample Cooler Ratings

MODEL NO.	SHELL DESIGN	TUBE DESIGN	TUBE MATERIAL	SHELL & HEAD MATERIAL	AREA	WEIGHT
SC-22	250 psig @ 450°F	2000 psig @ 635°F	1/4" OD SS ^A	304 SS	1.2 sq-ft	9 lbs
SC-42	450 psig @ 650°F	5000 psig @ 1000°F	1/4" OD 316 SS	304 SS	2.4 sq-ft	12 lbs

A. Tubing is 300 series stainless steel with chemical and physical properties equal to, or better than T304.

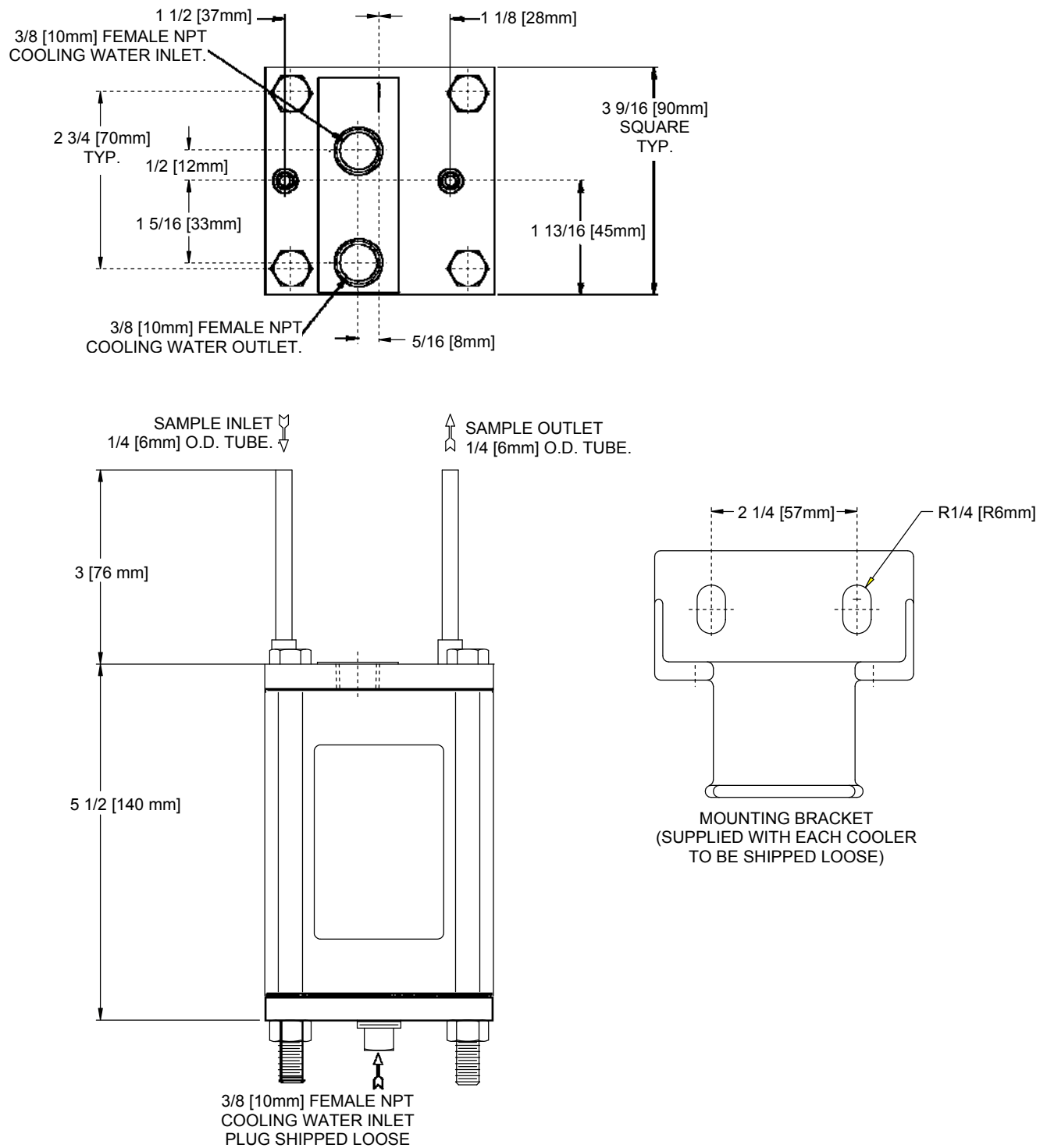


Figure H14-1. SC-22 Dimensions

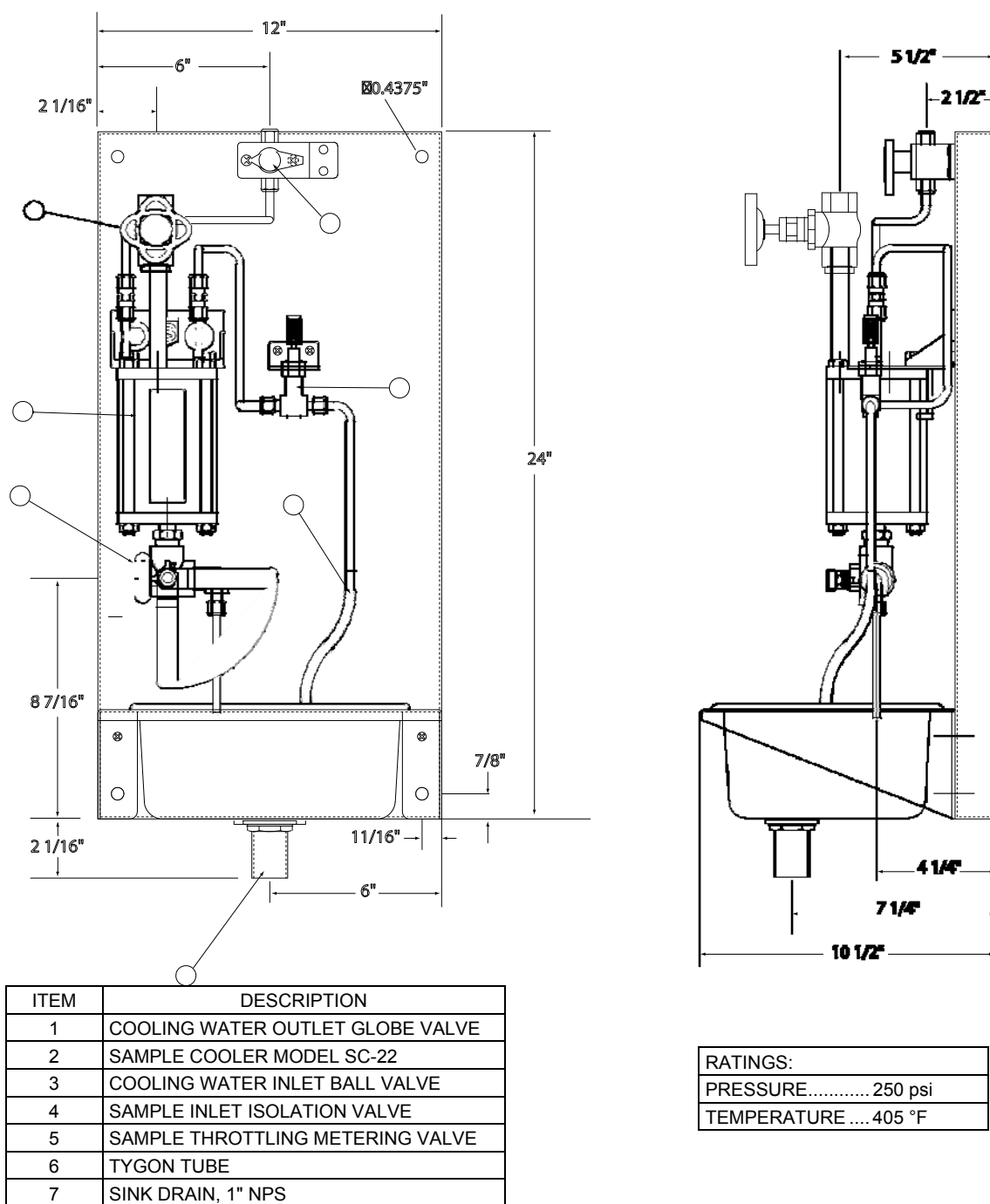


Figure H14-2. SC-22 Panel

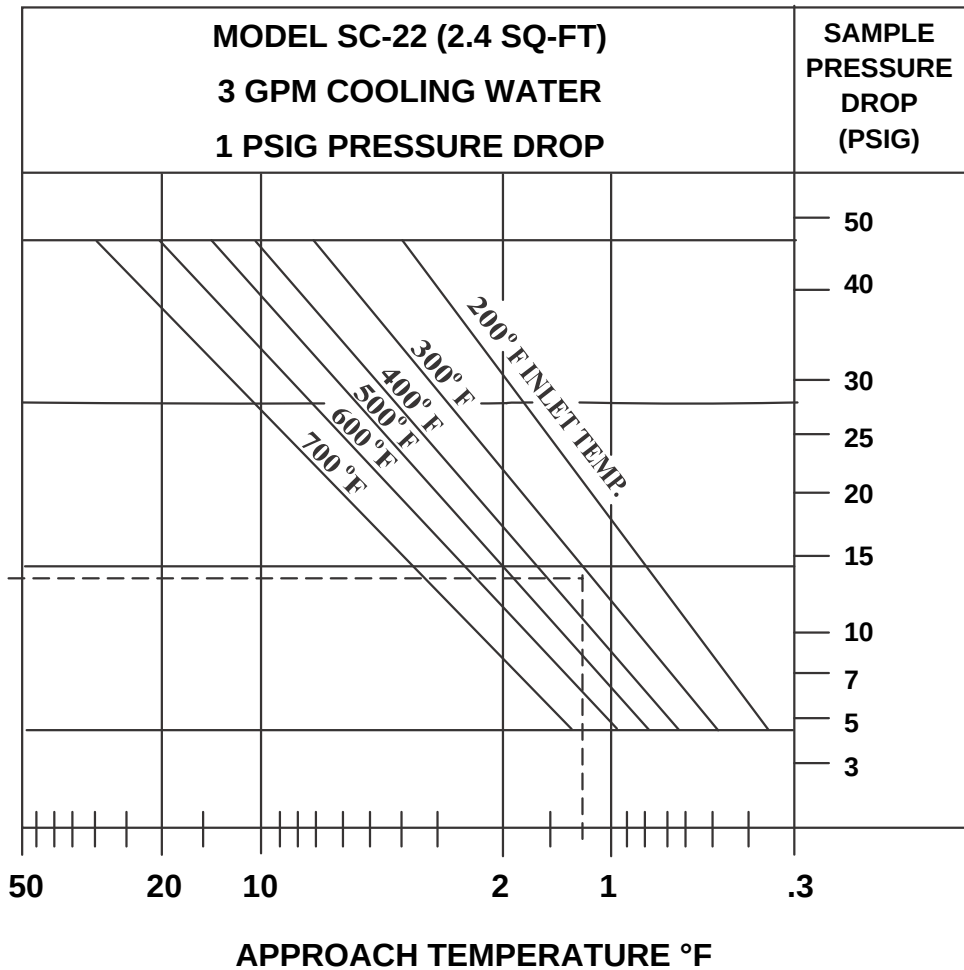


Figure H14-3. SC-22 Performance Curves

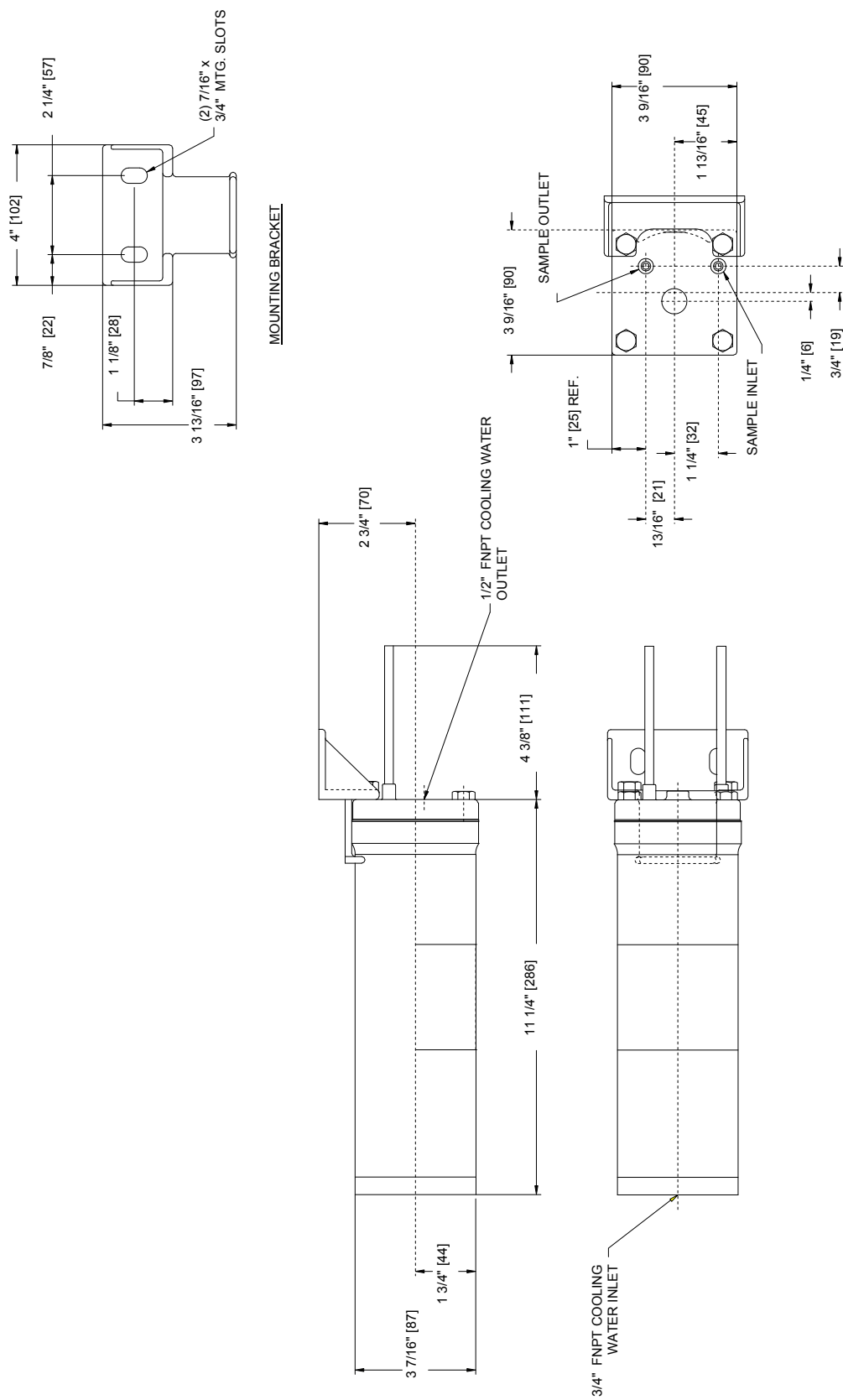


Figure H14-4. SC-42 Dimensions

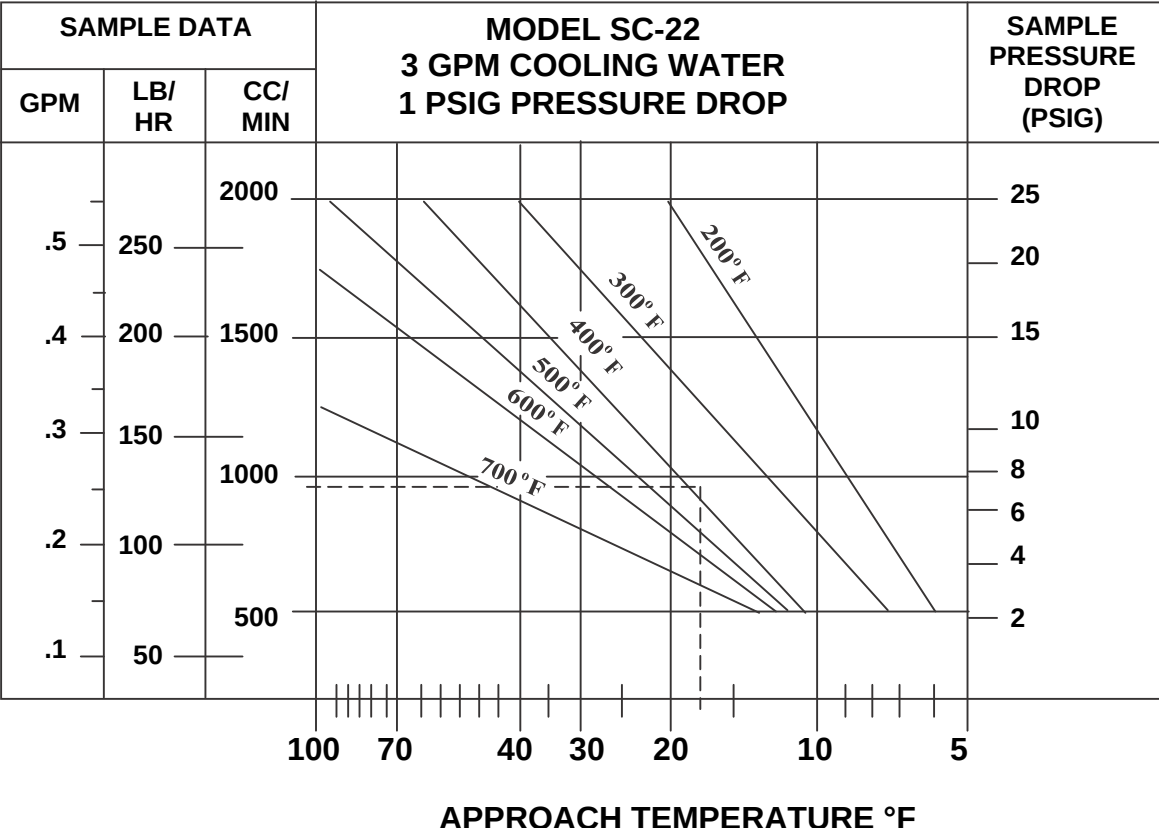


Figure H14-5. SC-42 Performance Curves

Notes

SECTION H14 SAMPLE COOLERS

SAMPLE SPECIFICATIONS

1.1 GENERAL

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's requirements.

A. SC-22

1. Furnish _____ Cleaver-Brooks Model SC-22 sample cooler(s) consisting of 304 stainless steel head and shell, jointless coiled T304 stainless steel tubing, and a carbon steel mounting bracket.
2. The sample cooler shall be of compact bolted design and shall require no larger space than 3-9/16" square x 5-1/2". The tubing and shell shall be removable for cleaning without disturbing connections. The cooling water connections shall be 3/8" FPT and the sample tube connections shall be 1/4" OD.
3. The tubing shall be rated at 2000 psig at 635 °F. The surface area shall be 1.2 sq-ft.

B. SC-22 PANEL

1. Furnish _____ Cleaver-Brooks Model SC-22 Panel pre-assembled kit. Includes Model SC-22 sample cooler as specified in Item A above, and the following additional equipment.
2. 12" x 24" stainless steel mounting panel.
3. Sample throttling metering valve and sample inlet isolation valve.
4. Cooling water outlet globe valve and inlet ball valve.
5. Stainless steel sink with 1" NPS drain fitting.

C. SC-42

1. Furnish _____ Cleaver-Brooks Model SC-42 sample cooler(s) consisting of 304 stainless steel head and shell, jointless coiled T304 stainless steel tubing, and a carbon steel mounting bracket.
2. The sample cooler shall be of compact bolted design and shall require no larger space than 3-9/16" square x 11". The tubing and shell shall be removable for cleaning without disturbing connections. The cooling water inlet connection shall be 3/4" FPT and the cooling water outlet connection shall be 1/2" FPT. The sample tube connections shall be 1/4" OD.
3. The tubing shall be rated at 5000 psig at 1000 °F. The surface area shall be 2.4 sq-ft.

Notes