MODEL CBR BOILERS
125 - 800 HP

CONTENTS

ILLUSTRATIONS

TABLES

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 ^{0}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	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.

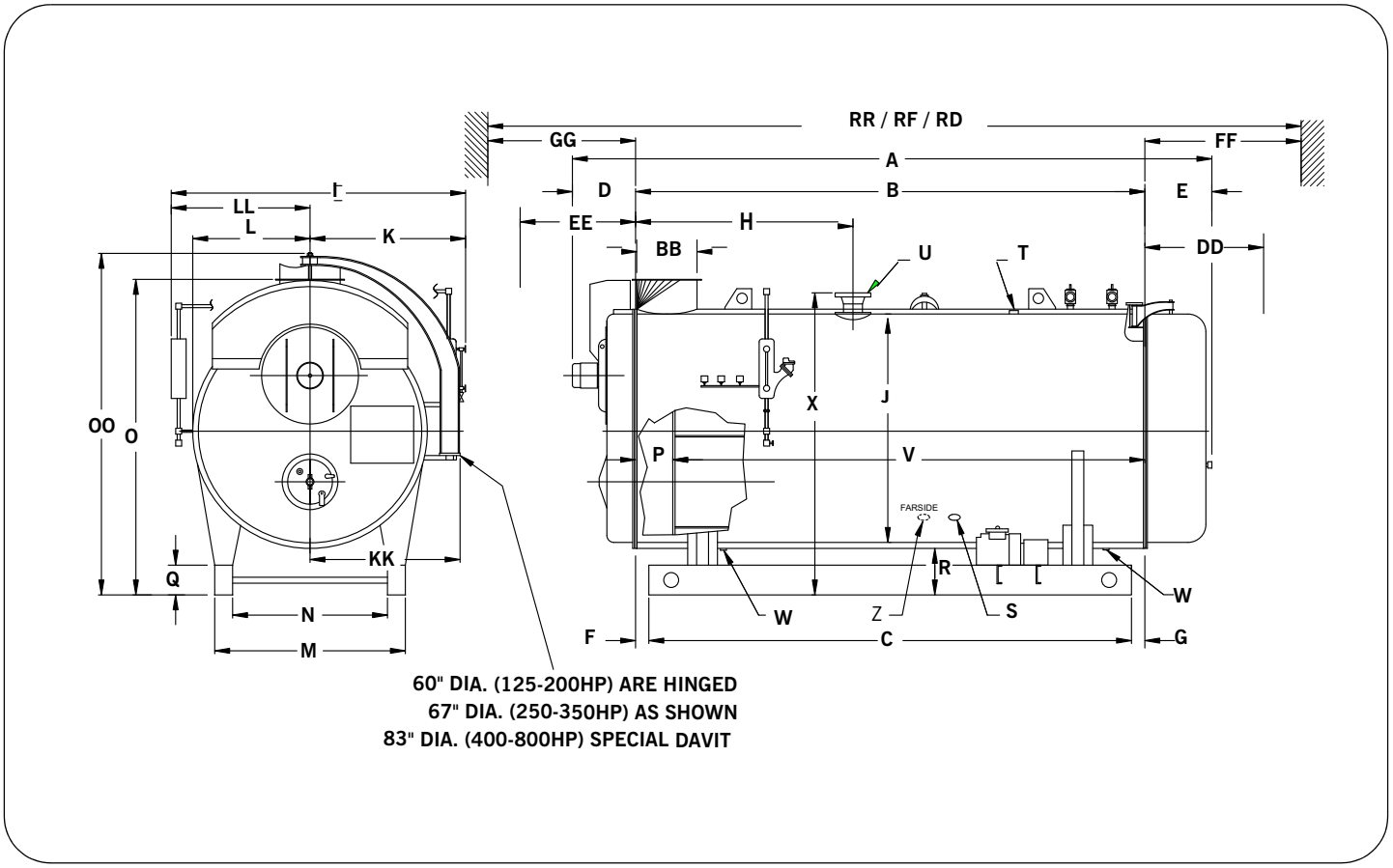


Figure A10-1. Model CBR Steam Boiler Dimensions and Weights - Sheet 1 of 2

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	167.75	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	87	87	87	102.5	102.5	102.5	120.5	120.5	120.5	120.5	120.5
Base to Vent Outlet	O	87	87	87	94.5	94.5	94.5	112	112	112	112	112
Height of Base Frame	Q	12	12	12	12	12	12	14	14	14	14	14
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	12	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

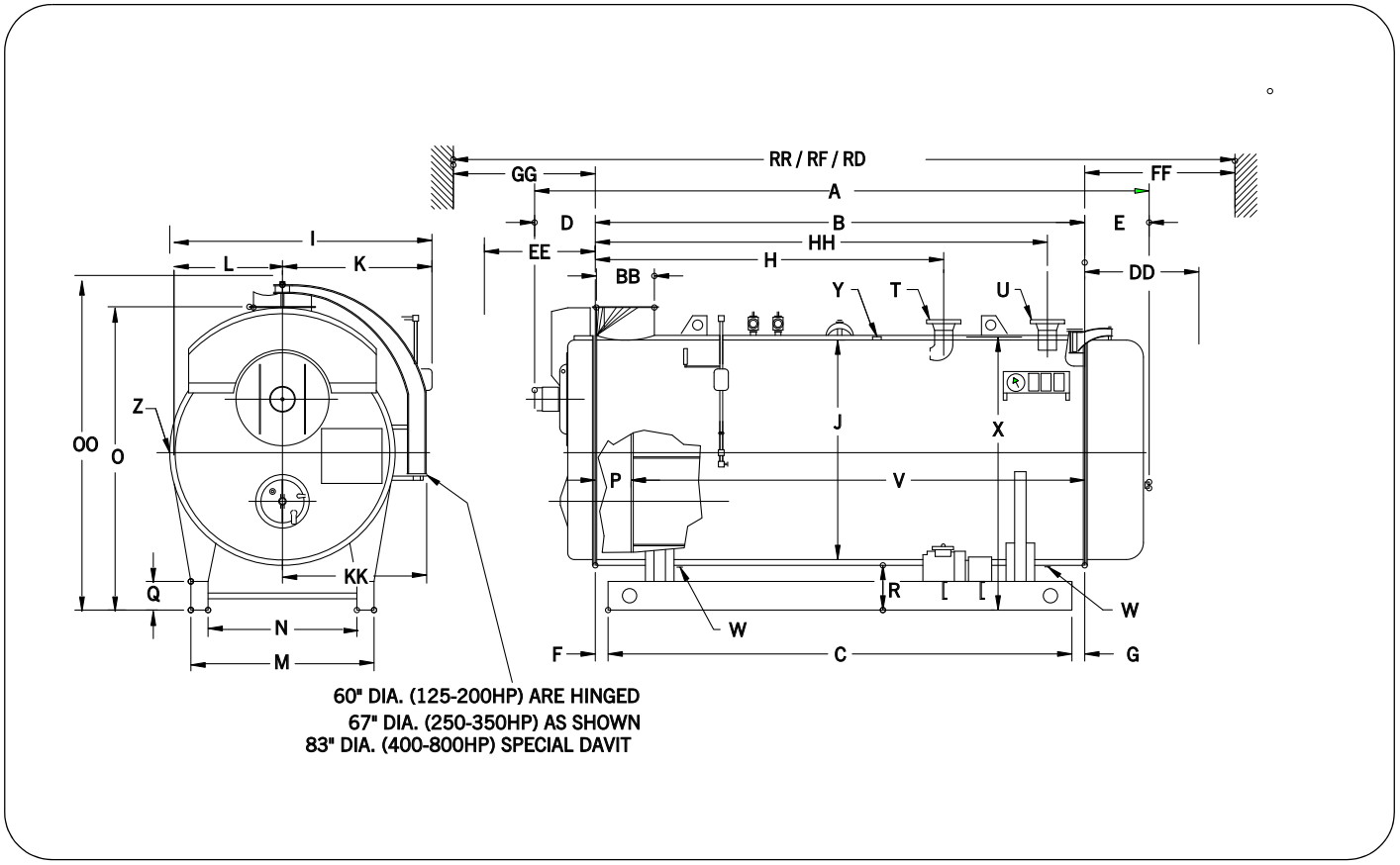


Figure A10-2. Model CBR Hot Water Boiler Dimensions - Sheet 1 of 2

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 H ead Ex tension (60 PPM system)	D	28	31	32	28	32	34	29	30	34	35	36
Front H ead 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 Bas e	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 R eturn	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 Tubes heets	V	137	137	168	141	156	186	146	151	183	216	216
W ID THS												
Overall W idth	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
C enter 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
C enter to O utsi de Davit/Hinge	KK	35	35	35	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5
C enter to Lagging	L	33	33	33	36.5	36.5	36.5	44.5	44.5	44.5	44.5	44.5
Base Outs ide	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	87	87	87	102.5	102.5	102.5	120.5	120.5	120.5	120.5	120.5
Base to Vent Outlet	O	87	87	87	94.5	94.5	94.5	112	112	112	112	112
H ei ght of Base Fram e	Q	12	12	12	12	12	12	14	14	14	14	14
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 CON NEC TION S												
W ater Return (See Note "A")	T	6	6	6	8	8	8	10	10	12	12	12
W ater Outlet (See Notes "A & B")	U	6	6	6	8	8	8	10	10	12	12	12
D rain-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 Stac k Diameter (Flanged)	BB	16	16	16	20	20	20	24	24	24	24	24
MINIMUM CLEARAN CES												
R ear Door Swing	DD	32	32	32	36	36	36	45	45	45	45	45
Front D oor 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 ALLOW ING FO R DOOR SW ING AN D TUBE R EMOVAL FROM:												
Thru Window or Door	RD	248	248	279	267	282	312	288	293	325	358	358
Front of Boi ler	RF	308	308	370	320	349	409	338	348	412	478	478
R ear of Boiler	RR	355	355	417	374	403	463	390	400	464	530	530
W EIGHTS IN LBS												
N ormal Water W eight		10,800	10,800	13,050	11,750	12,750	15,000	16,900	17,150	20,500	23,250	23,250
Approx. Shipping W eight - (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 W eight - (125 psig)		13,200	13,200	15,100	18,350	18,400	20,700	29,400	28,150	31,900	37,050	37,050

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

Figure A10-2. Model CBR Hot Water Boiler Dimensions - Sheet 2 of 2

Table A10-3. Steam Boiler Safety Valve Openings

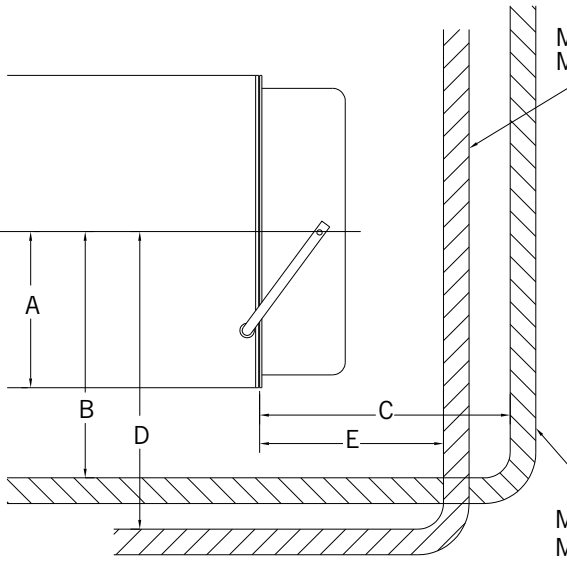
VALVE SETTING	15 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
125	1	2-1/2	1	2	1	1-1/2	1	1-1/2
150	1	3	2	(1) 1-1/2 (1) 1-1/4	2	(1) 1-1/4 (1) 1	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) 1-1/2	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 revised 04/2012.

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.



BOILER H.P.	DIMENSIONS (INCHES)				
	A	B	C	D	E
125-200	33"	55"	45"	68"	32"
250-350	36.5"	65"	51"	83"	35"
400-800	44.5"	86"	64"	99"	57"

Figure A10-3. Space Required to Open Rear Head on Model CBR Boilers Equipped with Davits

Boiler HP	Motor HP	Hole Number
400-800	10	1
	20-30	2
	50-75	3

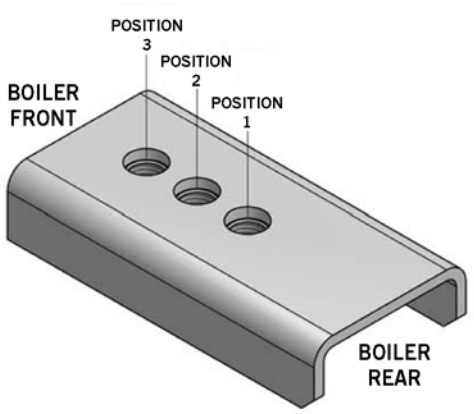
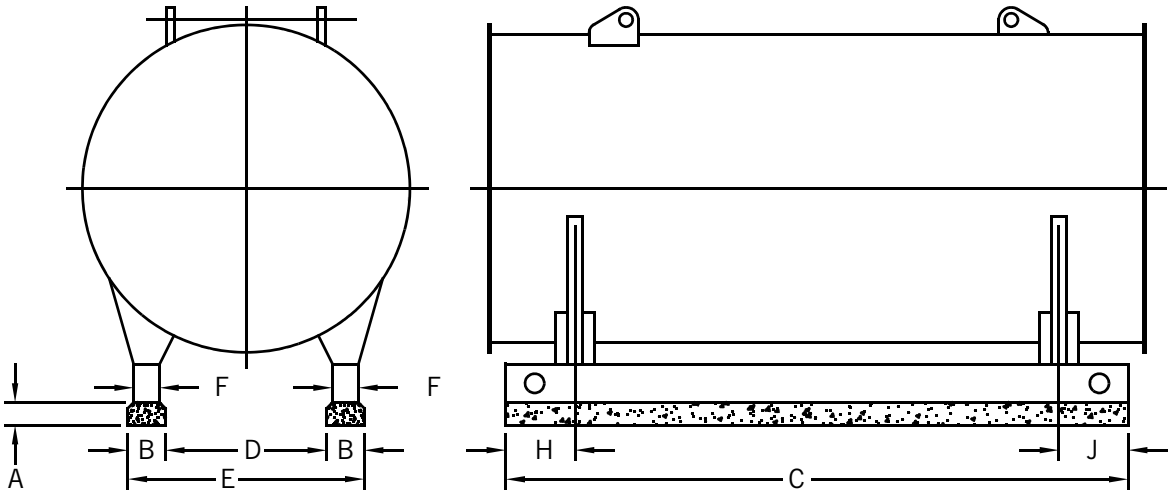


Figure A10-4. Front Davit Support

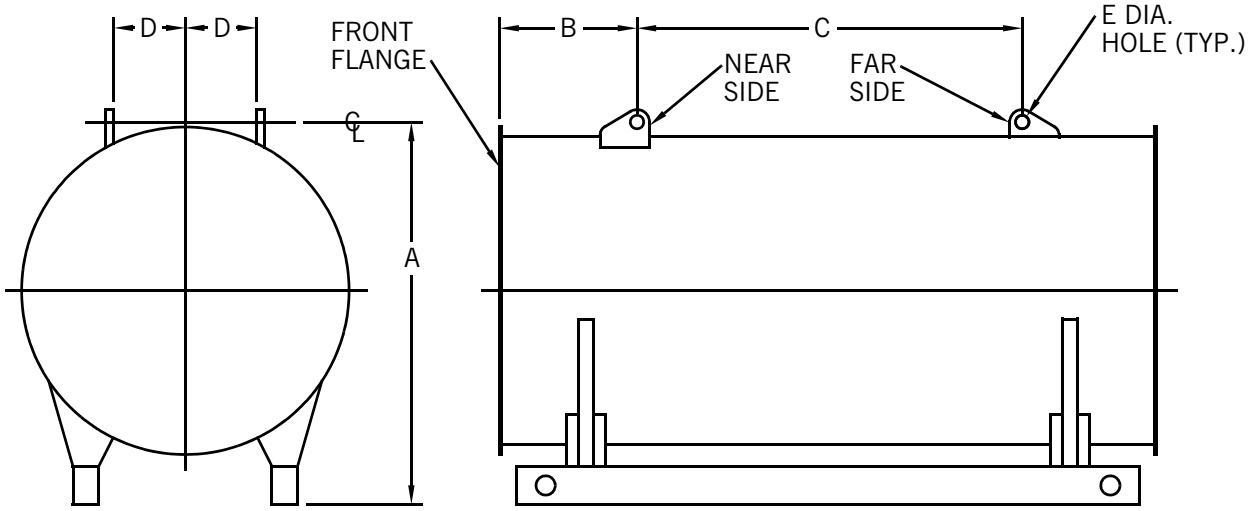


FRONT VIEW RIGHT SIDE VIEW

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 A10-5. 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 A10-6. 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

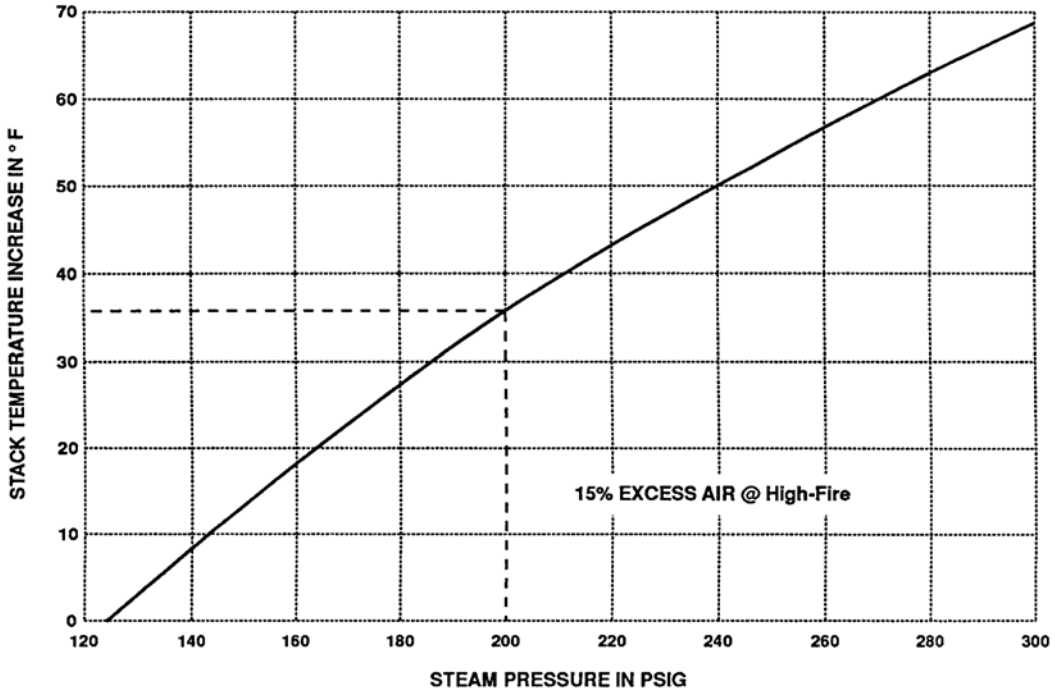


Figure A10-7. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig

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]	50/150[B]	50/150[B]	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 operqting 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	BOILER CAPACITY	OPERATING PRESSURE (PSIG)							
HP	(LBS/HR)	50	75	100	125	150	175	200	250
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 psig flanges) given in inches.								
	Standard Non-Return valve selections limited to a maximum 2 to 1turndown (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 7.5psig. 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 A10-8 and Figure A10-9 for an example of (No. 1 above) tank heating method.

See Figure A10-10 for an example of a preheating system.

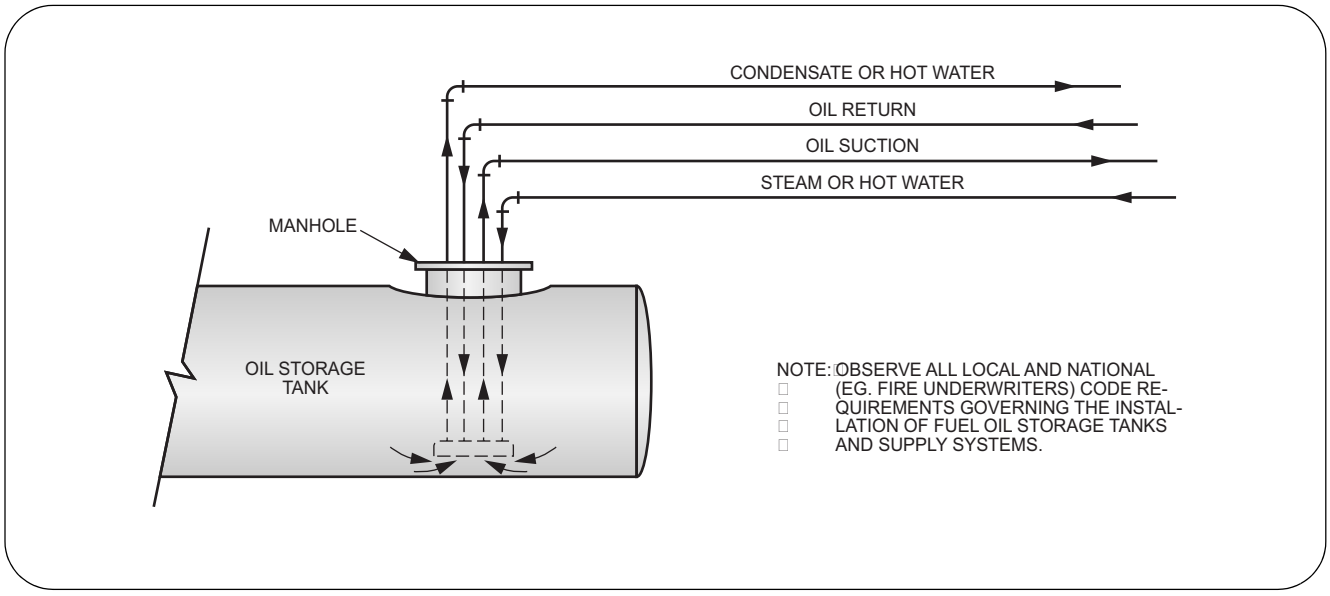
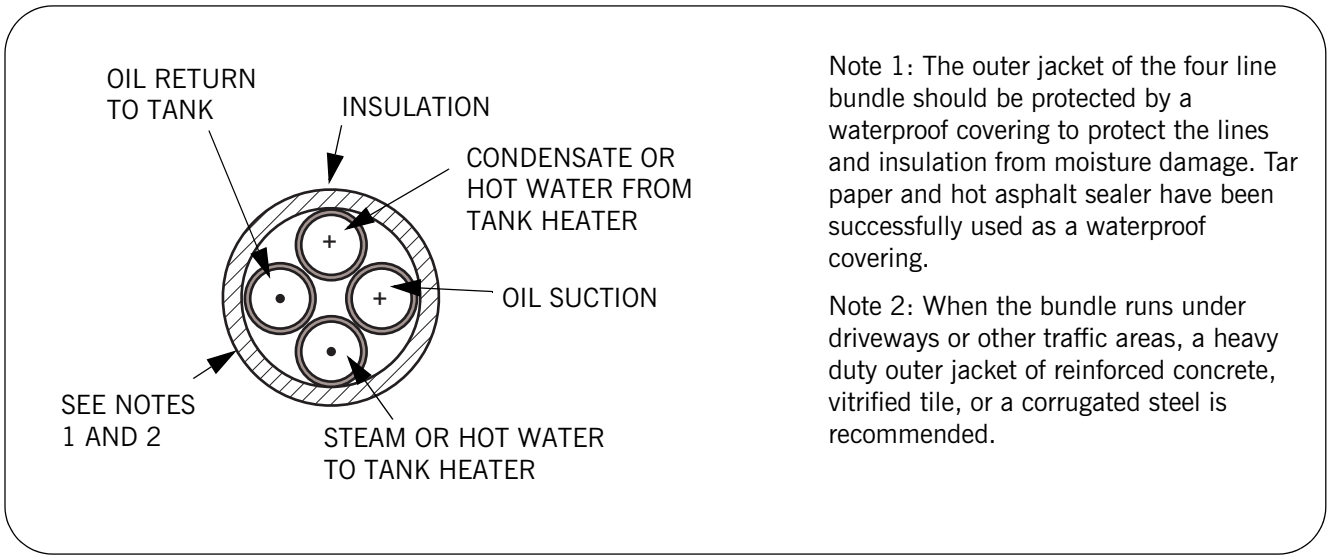


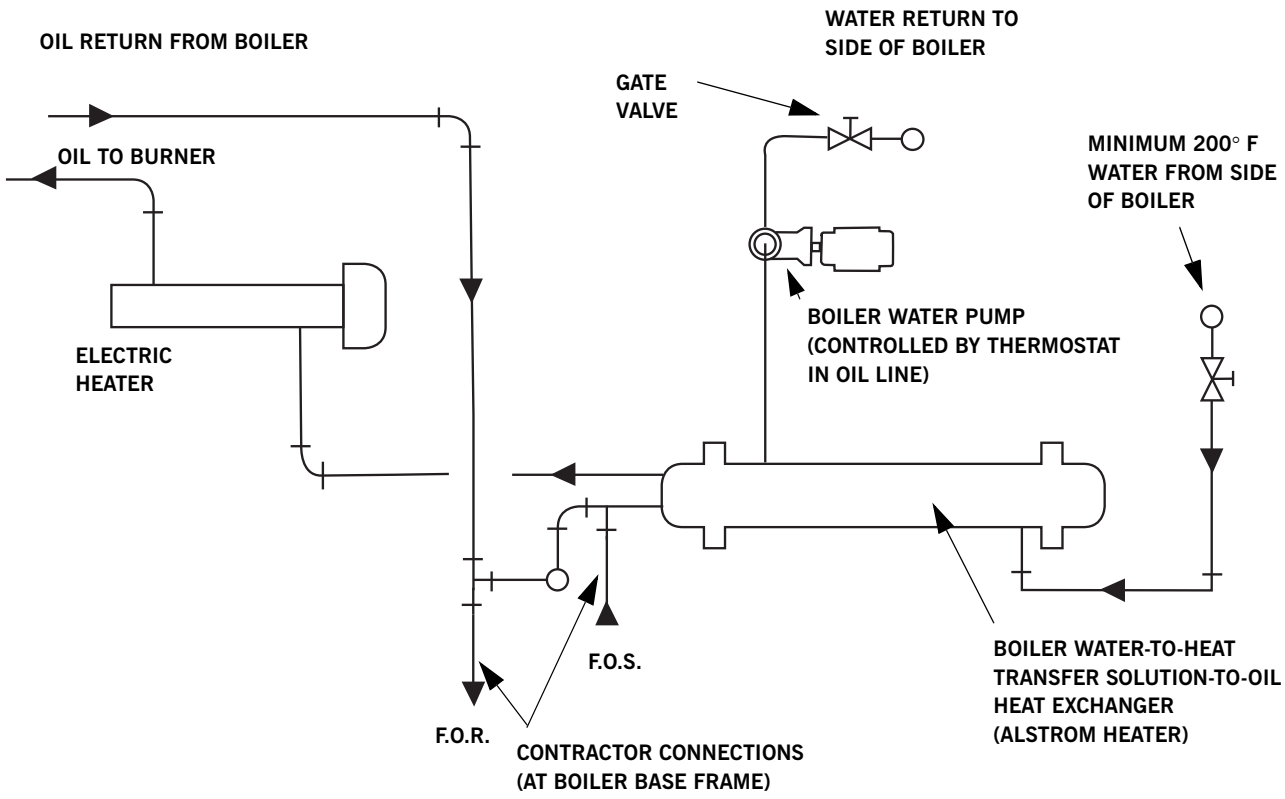
Figure A10-8. Typical Fuel Storage Tank Arrangement



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 A10-9. 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 A10-10. Schematic of Standard Alstrom Hot Water Safety-Type Preheating System

Table A10-14. CBR Gas Pressure Requirements

BOILER HP	GAS TRAIN SIZE	UPSTREAM VALVE*	DOWNSTREAM*	EMISSIONS LEVEL		
				30 ppm	60 ppm	UC
125 HP	1.5 in	BB	BB	0.8 - 5.0 psi	0.7 - 5.0 psi	0.7 - 5.0 psi
125 HP	1.5 in	PC	PC	0.9 - 5.0 psi	0.8 - 5.0 psi	0.8 - 5.0 psi
125 HP	2.0 in	BB	BB	0.6 - 0.8 psi	0.5 - 0.7 psi	0.5 - 0.7 psi
125 HP	2.0 in	PC	PC	0.6 - 0.9 psi	0.6 - 0.8 psi	0.6 - 0.8 psi
125 HP	2.5 in	PC	PC	0.4 - 0.6 psi	0.4 - 0.5 psi	0.4 - 0.5 psi
150 HP	1.5 in	BB	BB	1.0 - 5.0 psi	1.0 - 5.0 psi	1.0 - 5.0 psi
150 HP	1.5 in	PC	PC	1.1 - 5.0 psi	1.1 - 5.0 psi	1.1 - 5.0 psi
150 HP	2.0 in	BB	BB	0.7 - 1.0 psi	0.7 - 1.0 psi	0.7 - 1.0 psi
150 HP	2.0 in	PC	PC	0.7 - 1.1 psi	0.7 - 1.1 psi	0.7 - 1.1 psi
150 HP	2.5 in	PC	PC	0.5 - 0.7 psi	0.5 - 0.7 psi	0.5 - 0.7 psi
200 HP	1.5 in	BB	BB	1.6 - 5.0 psi	1.6 - 5.0 psi	1.6 - 5.0 psi
200 HP	1.5 in	PC	PC	1.9 - 5.0 psi	1.8 - 5.0 psi	1.8 - 5.0 psi
200 HP	2.0 in	BB	BB	1.1 - 1.6 psi	1.1 - 1.6 psi	1.1 - 1.6 psi
200 HP	2.0 in	PC	PC	1.2 - 1.9 psi	1.1 - 1.8 psi	1.1 - 1.8 psi
200 HP	2.5 in	PC	PC	0.7 - 1.1 psi	0.7 - 1.1 psi	0.7 - 1.1 psi
200 HP	3.0 in	PC	PC	0.6 - 0.7 psi	0.6 - 0.7 psi	0.6 - 0.7 psi
250 HP	1.5 in	BB	BB	2.7 - 2.9 psi	2.7 - 2.9 psi	2.7 - 2.8 psi
250 HP	1.5 in	PC	PC	3.0 - 4.6 psi	3.0 - 4.6 psi	3.0 - 4.5 psi
250 HP	2.0 in	BB	BB	1.8 - 2.7 psi	1.8 - 2.7 psi	1.8 - 2.7 psi
250 HP	2.0 in	PC	PC	1.9 - 3.0 psi	1.9 - 3.0 psi	1.9 - 3.0 psi
250 HP	2.5 in	PC	PC	1.3 - 1.8 psi	1.3 - 1.8 psi	1.3 - 1.8 psi
250 HP	3.0 in	PC	PC	1.1 - 1.3 psi	1.1 - 1.3 psi	1.1 - 1.3 psi
300 HP	1.5 in - 2.0 in	BB	BB	3.4 - 5.0 psi	3.4 - 5.0 psi	3.4 - 5.0 psi
300 HP	1.5 in - 2.0 in	PC	PC	3.8 - 5.0 psi	3.8 - 5.0 psi	3.7 - 5.0 psi
300 HP	2.0 in	BB	BB	2.5 - 3.4 psi	2.5 - 3.4 psi	2.4 - 3.4 psi
300 HP	2.0 in	PC	PC	2.6 - 3.8 psi	2.6 - 3.8 psi	2.5 - 3.7 psi
300 HP	3.0 in	PC	PC	1.6 - 2.5 psi	1.6 - 2.5 psi	1.6 - 2.4 psi
350 HP	1.5 in - 2.0 in	BB	BB	4.0 - 5.0 psi	4.0 - 5.0 psi	3.9 - 5.0 psi
350 HP	1.5 in - 2.0 in	PC	PC	4.4 - 5.0 psi	4.4 - 5.0 psi	4.4 - 5.0 psi
350 HP	2.0 in	BB	BB	3.0 - 4.0 psi	2.9 - 4.0 psi	2.9 - 3.9 psi
350 HP	2.0 in	PC	PC	3.1 - 4.4 psi	3.1 - 4.4 psi	3.1 - 4.4 psi
350 HP	2.5 in	PC	PC	1.8 - 3.0 psi	1.8 - 2.9 psi	1.7 - 2.9 psi
350 HP	3.0 in	PC	PC	1.4 - 1.8 psi	1.3 - 1.8 psi	1.3 - 1.7 psi
400 HP	1.5 in - 2.0 in	BB	BB	4.7 - 5.0 psi	4.7 - 5.0 psi	4.6 - 5.0 psi
400 HP	1.5 in - 2.0 in	PC	PC	5.2 - 8.2 psi	5.2 - 8.2 psi	5.2 - 8.2 psi
400 HP	2.0 in	BB	BB	3.2 - 4.7 psi	3.2 - 4.7 psi	3.2 - 4.6 psi
400 HP	2.0 in	PC	PC	3.5 - 5.0 psi	3.4 - 5.0 psi	3.4 - 5.0 psi
400 HP	2.5 in	PC	PC	1.8 - 3.2 psi	1.8 - 3.2 psi	1.8 - 3.2 psi
400 HP	3.0 in	PC	PC	1.3 - 1.8 psi	1.3 - 1.8 psi	1.3 - 1.8 psi
500 HP	2.0 in - 2.5 in	BB	PC	4.9 - 5.0 psi	4.9 - 5.0 psi	4.9 - 5.0 psi
500 HP	2.0 in - 2.5 in	PC	PC	5.1 - 7.6 psi	5.1 - 7.6 psi	5.1 - 7.6 psi
500 HP	2.5 in	PC	PC	2.7 - 4.9 psi	2.6 - 4.9 psi	2.6 - 4.9 psi
500 HP	3.0 in	PC	PC	2.0 - 2.7 psi	1.9 - 2.6 psi	1.9 - 2.6 psi
600 HP	2.0 in - 2.5 in	BB	PC	7.1 - 10.7 psi	7.1 - 10.6 psi	7.1 - 10.6 psi
600 HP	2.0 in - 2.5 in	PC	PC	7.4 - 11.0 psi	7.3 - 11.0 psi	7.3 - 11.0 psi
600 HP	2.5 in	PC	PC	3.9 - 5.0 psi	3.8 - 5.0 psi	3.8 - 5.0 psi
600 HP	2.5 in - 3.0 in	PC	PC	3.7 - 3.9 psi	3.7 - 3.8 psi	3.7 - 3.8 psi
600 HP	3.0 in	PC	PC	2.7 - 3.7 psi	2.7 - 3.7 psi	2.7 - 3.7 psi
700 HP	2.0 in - 3.0 in	BB	PC	9.5 - 14.3 psi	9.5 - 14.2 psi	9.5 - 14.2 psi
700 HP	2.0 in - 3.0 in	PC	PC	9.8 - 14.7 psi	9.8 - 14.7 psi	9.8 - 14.7 psi
700 HP	2.5 in - 3.0 in	PC	PC	4.9 - 5.0 psi	4.9 - 5.0 psi	4.8 - 5.0 psi
700 HP	3.0 in	PC	PC	3.6 - 4.9 psi	3.6 - 4.9 psi	3.5 - 4.8 psi
700 HP	4.0 in	PC	PC	2.6 - 3.6 psi	2.6 - 3.6 psi	2.6 - 3.5 psi
800 HP	2.5 in - 3.0 in	PC	PC	6.2 - 9.0 psi	6.2 - 9.0 psi	6.2 - 9.0 psi
800 HP	3.0 in	PC	PC	4.7 - 5.0 psi	4.7 - 5.0 psi	4.6 - 5.0 psi
800 HP	4.0 in	PC	PC	3.4 - 4.7 psi	3.4 - 4.7 psi	3.3 - 4.6 psi

* BB = Butter Ball; PC = Plug Cock

NOTE: In cases where the gas train increases in size after the regulating valve, two diameters are listed. The first number is the customer connection size.

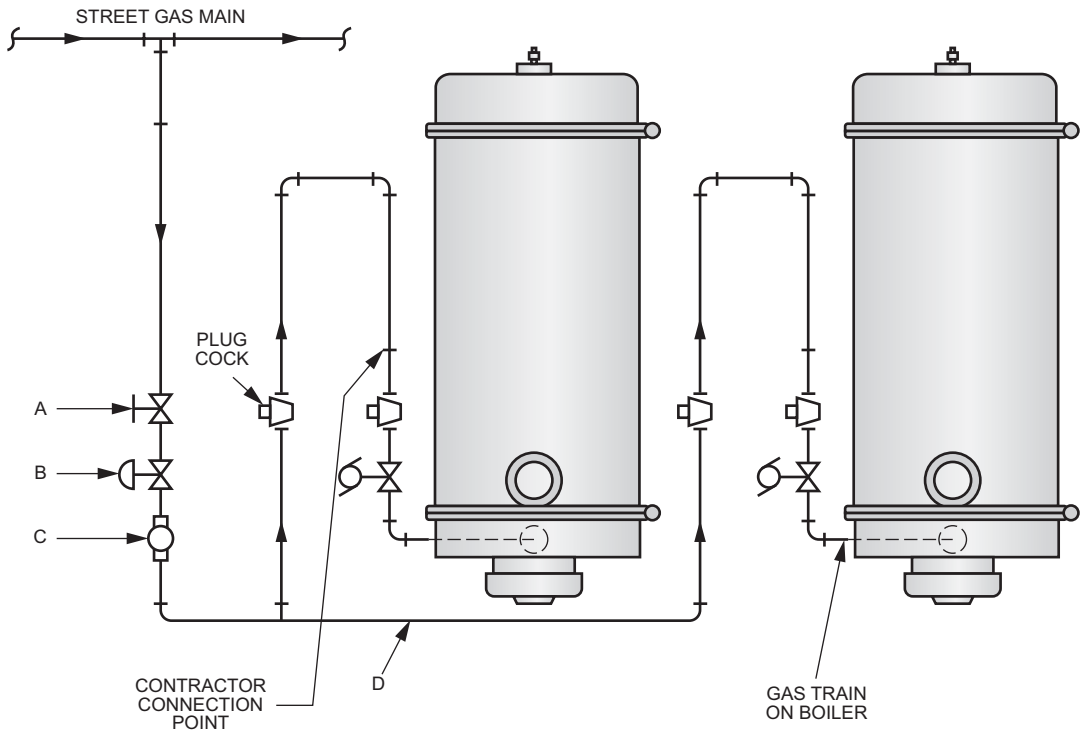
Standard Gas Train size is highlighted

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 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 A10-11. Typical Gas Piping Layout

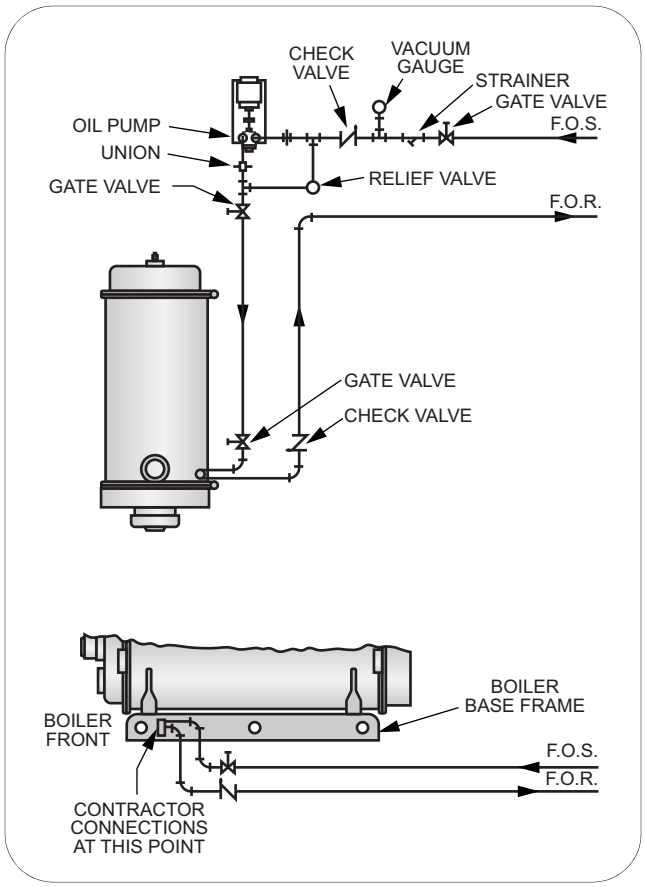


Figure A10-12. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump

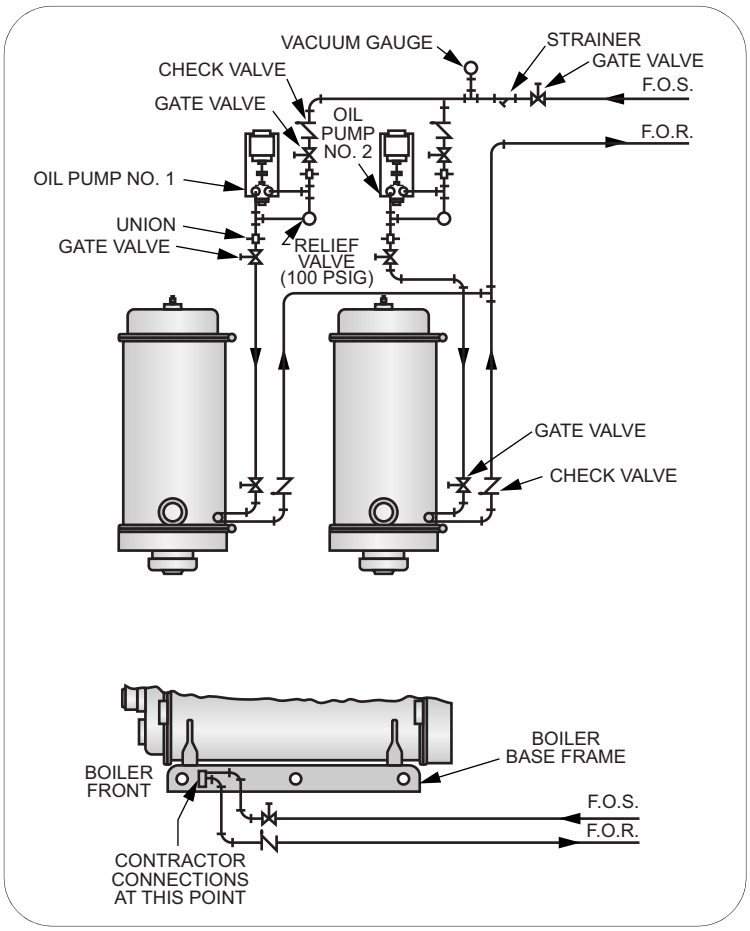


Figure A10-13. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

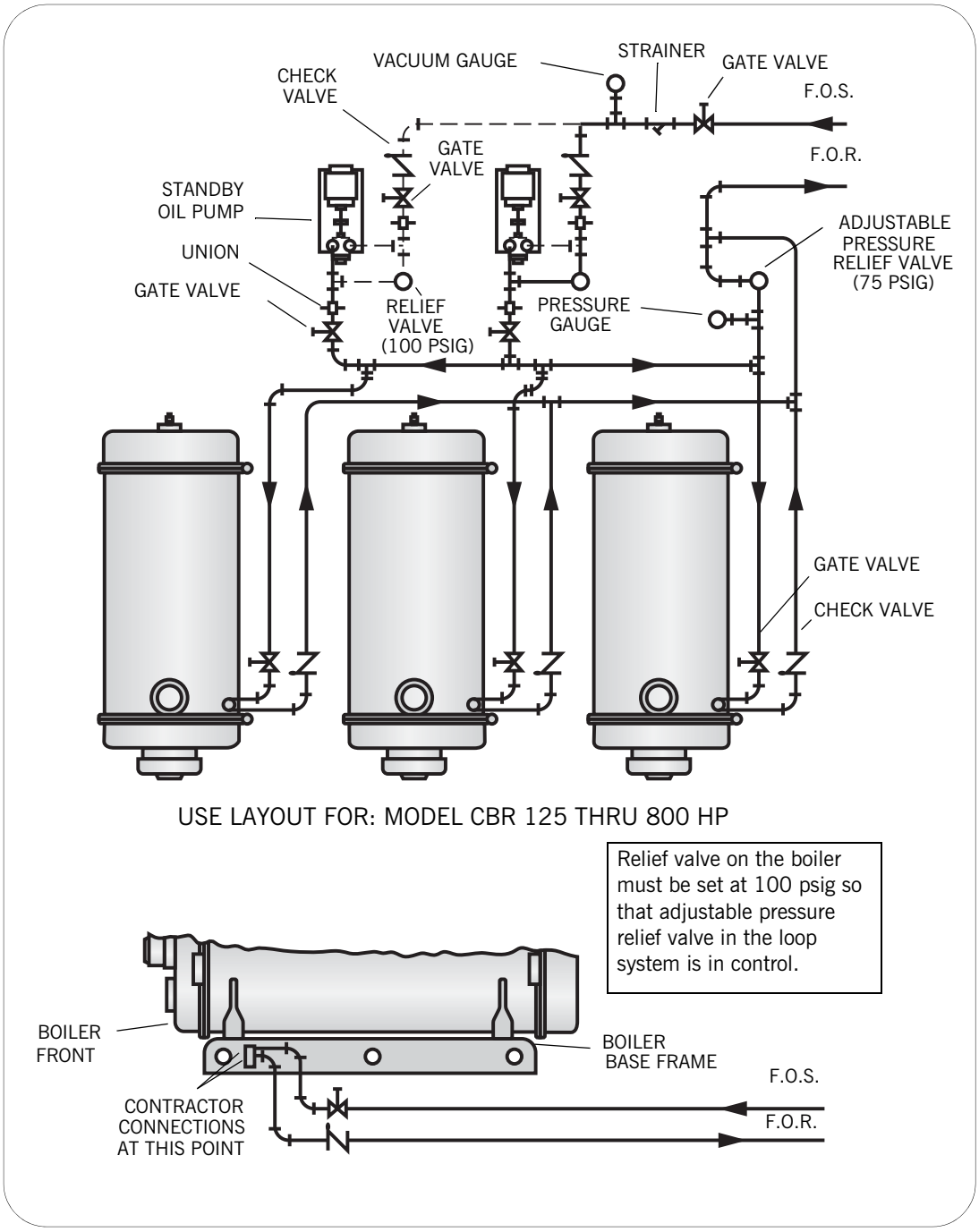


Figure A10-14. No. 2 Oil Piping, Multiple Boiler Installation

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:

Area (sq-ft.) = 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.

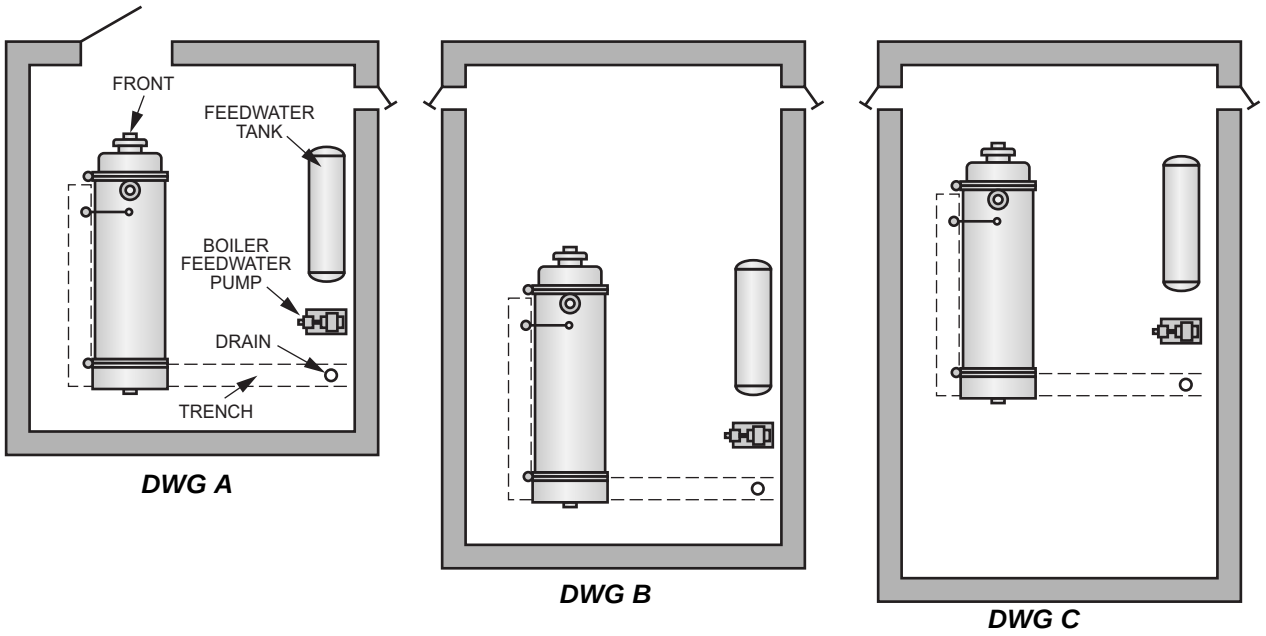
Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: 300 x 10 = 3000 cfm (from 2B above).

- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: Area = 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.



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.

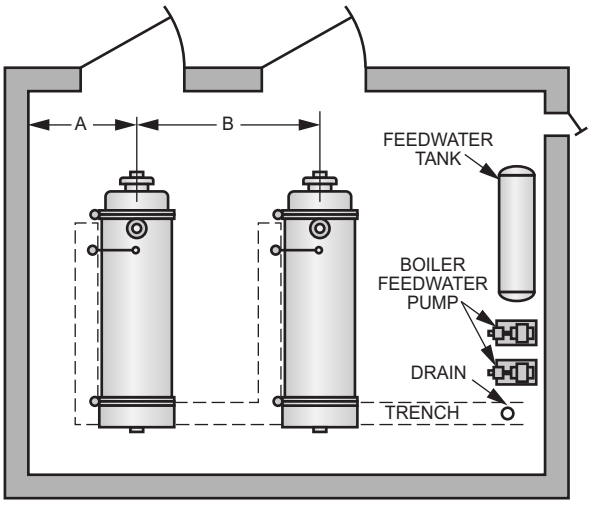
If space permits, approximately 1.5 additional feet should be allowed at the rear for additional aisle and working space.

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.

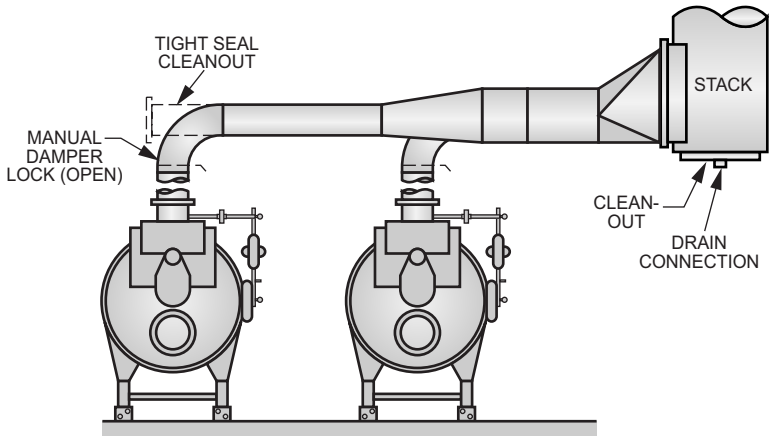
Figure A10-15. Boiler Room Length (Typical Layout)



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.

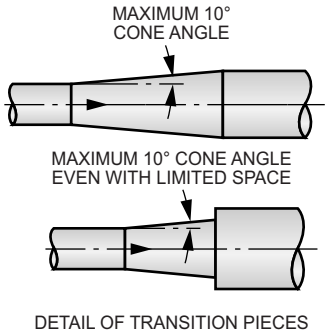
Figure A10-16. Boiler Room Width (Typical Layout)



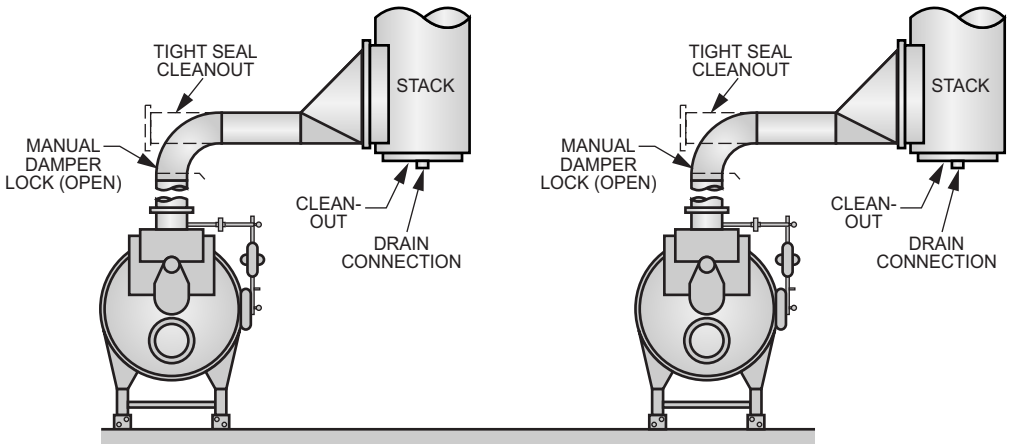
MULTIPLE BOILERS WITH A COMMON STACK

NOTE: These stack 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 A10-17. Breeching Arrangement

SECTION A10
MODEL CBR STEAM BOILER

125-800 hp, Steam (15, 150, 200, or 250 psig) Sample Specification

STEAM SPECIFICATIONS

CONTENTS

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 ElectricalCode.

   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

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 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.
  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.