Model CBLE Boilers
125-800HP

CONTENTS

FEATURES AND BENEFITS 4
True Boiler/Burner/Low NOx Package. 4
PRODUCT OFFERING 4
Standard Equipment 4
Available Options 4
DIMENSIONS AND RATINGS 4
PERFORMANCE DATA 24
Specifying Boiler Efficiency 24
Efficiency Specification 24
Emissions 25
ENGINEERING DATA 28
Sound Level 28
Gas-Fired Burners 29
Oil-Fired Burners 33
General Boiler Information 33
Boiler Room Information 33
Stack Support Capabilities 33
Stack/Breeching Size Criteria 33
Boiler Room Combustion Air 33
Sample Specifications (Steam) 44
Sample Specifications (Hot Water) 56

ILLUSTRATIONS

Figure A1-1. CB-LE Steam - 125-200 HP 6
Figure A1-2. CB-LE Steam - 250-350 HP 8
Figure A1-3. CB-LE Steam - 400-800 HP 10
Figure A1-4. CB-LE Hot Water - 125-200 HP 12
Figure A1-5. CB-LE Hot Water 250-350 HP 14
Figure A1-6. CB-LE Hot Water 400-800 HP 16
Figure A1-7. Space Required to Open Rear Head on Model CB-LE Boilers Equipped with Davits 21
Figure A1-8. Model CB-LE Boiler Mounting Piers (60” and 78”) 21
Figure A1-9. Model CB-LE Boiler Mounting Piers (96”) 22
Figure A1-10. Front Davit Support 22
Figure A1-11. Lifting Lug Location, Model CB-LE Boilers 23
Figure A1-12. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig 26
Figure A1-13. Standard Gas Train Connection Size and Location 32
Figure A1-14. Typical Gas Piping Layout 35
Figure A1-15. Model CB-LE Gas Train Components 36
Figure A1-16. No.2 Oil Connection Size, Location, and Recommended Line Sizes 36
Figure A1-17. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump 37
Figure A1-18. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps 37
Figure A1-19. No. 2 Oil Piping, Multiple Boiler Installation 38
Figure A1-20. No. 2 Oil Transfer Tank Detail 38
Figure A1-21. Typical Arrangement 39
Figure A1-22. Boiler Room Length (Typical Layouts) 41
Figure A1-23. Boiler Room Width (Typical Layout) 41
Figure A1-24. Breeching Arrangement 42

TABLES

Table A1-1. Model CB-LE Steam Boiler Ratings 5
Table A1-2. Model CB-LE Hot Water Boiler Ratings 5
Table A1-3. Model CB-LE Steam Boiler Dimensions, 60” (15 - 150 psig Design Pressure) 6
Table A1-4. Model CB-LE Steam Boiler Dimensions, 78” (15 - 150 psig Design Pressure) 8
Table A1-5. Model CB-LE Steam Boiler Dimensions, 96” (15 - 150 psig Design Pressure) 10
Table A1-6. Model CB-LE Hot Water Boiler Dimensions, 60” (30 and 125 psig Design Pressure) 12
Table A1-7. Model CB-LE Hot Water Boiler Dimensions, 78” (30 and 125 psig Design Pressure) 14
Table A1-8. Model CB-LE Hot Water Boiler Dimensions, 96” (30 and 125 psig Design Pressure) 16
Table A1-9. Blower Motor Selection - Steam Boilers ≦ 150 psig, all HW boilers 18
Table A1-10. Blower Motor Selection - Steam Boilers >150 psig 18
Table A1-11. Blower Motor Selection CB-LE NTI Boilers 18
Table A1-12. Turndown Guarantee for CB-LE NTI Boilers - Natural Gas & #2 Oil 18
Table A1-13. Model CB-LE Boiler Weights 19
Table A1-14. Steam Boiler Safety Valve Openings 20

Table A1-15. Hot Water Boiler Relief Valve Openings 20
Table A1-16. Predicted Fuel-to-Steam Efficiencies - Natural Gas 26
Table A1-17. Predicted Fuel-to-Steam Efficiencies - No. 2 Oil 27
Table A1-18. CB-LE Boilers - Natural Gas, Emission Levels 27
Table A1-19. CB-LE Boilers - No. 2 Oil, Emission Levels 27
Table A1-20. Model CB-LE Predicted Sound Levels 30 ppm NOx Systems 28
Table A1-21. Standard, Undersize, and Oversize Gas Trains, Model CB-LE Boilers 30
Table A1-22. Recommended NTI Gas Train Sizes & Pressure Ranges 31
Table A1-23. Minimum Required Regulated Gas Pressure Altitude Conversion 32
Table A1-24. Maximum Gas Consumption (CFH) for Natural Gas and Propane Vapor 32
Table A1-25. Model CB-LE Blowdown Tank Sizing 39
Table A1-26. Heating Surface, Model CB-LE Boilers 39
Table A1-27. Steam Volume & Disengaging Area 40
Table A1-28. Recommended Steam Nozzle Size 40
Table A1-29. Recommended Non-Return Valve Size 40

The Low Emission feature 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 NOx performance. The enhanced burner design assures maximum NOx 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 NOx emission levels are given on a dry volume basis and corrected to 3% O_2):

- NOx performance for 60 ppm (natural gas corrected to 3% O_2) uses a standard size combustion air fan for induced flue gas recirculation.
- NOx performance for 30, 25, or 20 ppm (natural gas corrected to 3% O_2) includes a larger combustion air fan/motor assembly and a larger internal NOx reduction system.

Cleaver-Brooks' commitment to lowering emissions is based on more than 400 low NOx 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 inTable 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 CONSUMPTON 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.

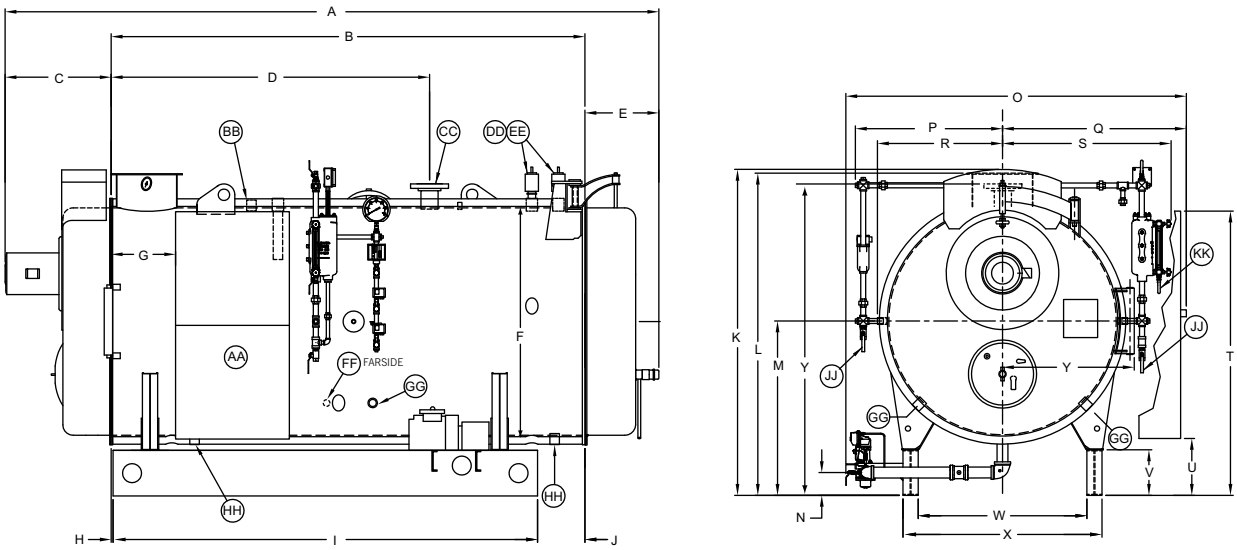


Figure A1-1. CB-LE Steam - 125-200 HP

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

(measurements shown in inches)

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	87	87	87
Base to Vent Outlet	L	87	87	87
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 (2) 150#	HH	1.5	1.5	1.5
Drain (2) 15#	HH	1.5	1.5	2
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

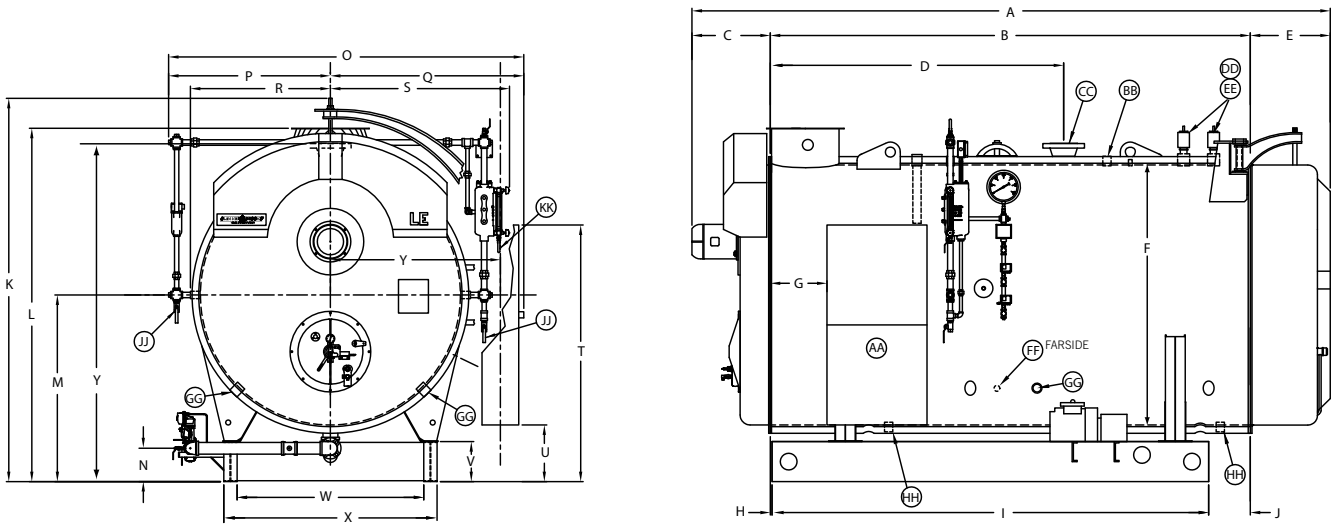


Figure A1-2. CB-LE Steam - 250-350 HP

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

(measurements shown in inches)

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 (2) 150#	HH	1.5	1.5	1.5
Drain (2) 15#	HH	2	2	2
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

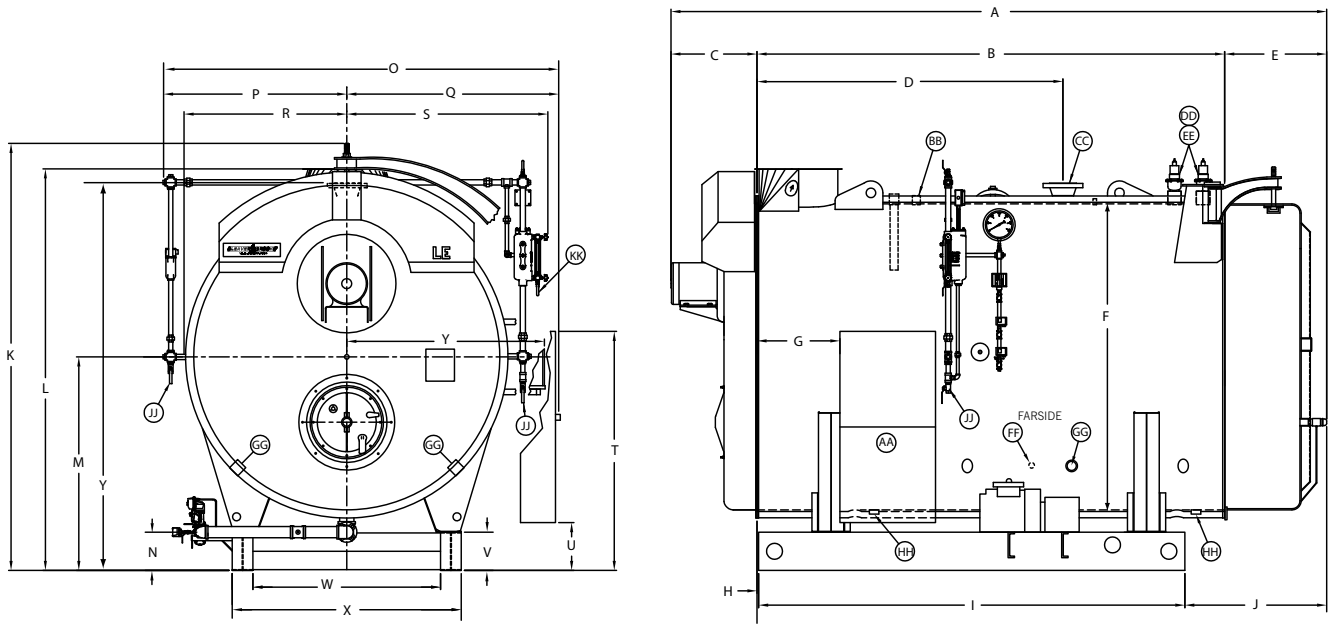


Figure A1-3. CB-LE Steam - 400-800 HP

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

(measurements shown in inches)

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

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
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
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

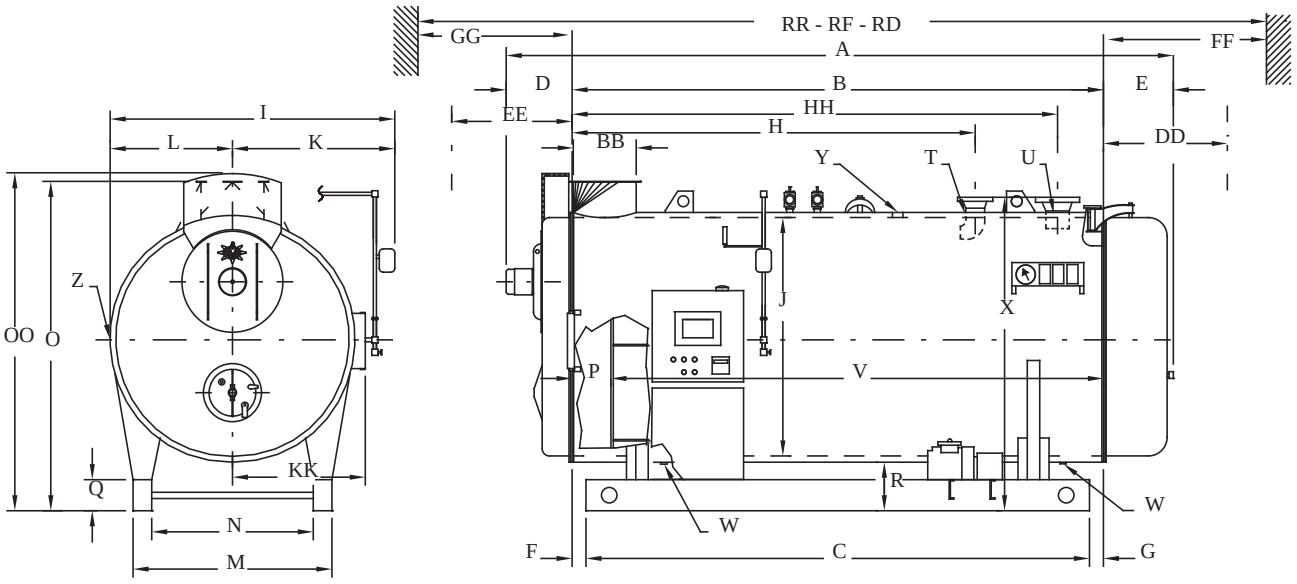


Figure A1-4. CB-LE Hot Water - 125-200 HP

Table A1-6. Model CB-LE Hot Water Boiler Dimensions, 60" (30 and 125 psig Design Pressure) - Sheet 1 of 2

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	87	87	87
Base to Vent Outlet	O	87	87	87
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				
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 Approx. Ship. Wgt. – 125 psig		11400 11800	12500 12900	14500 14900

NOTES: All connections are threaded unless indicated.
A. ANSI 150 psig flange.

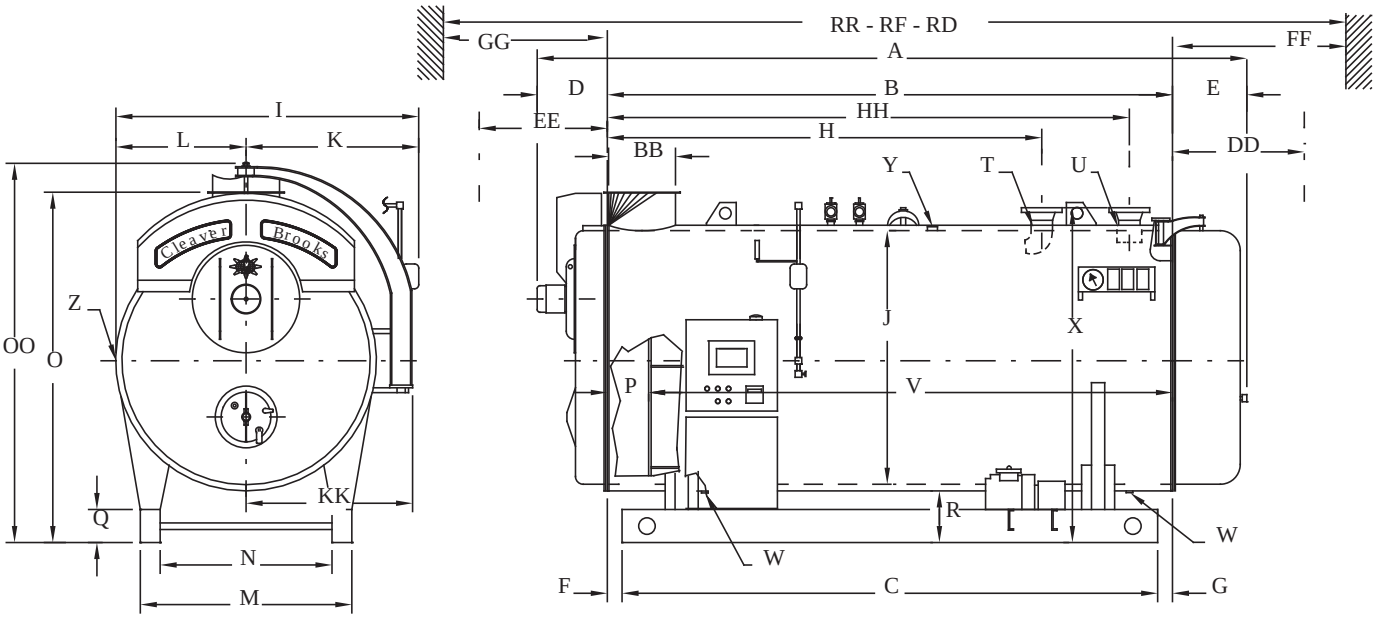


Figure A1-5. CB-LE Hot Water 250-350 HP

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				
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 Approx. Ship. Wgt. – 125 psig		21400 22200	23500 24300	26700 27500

NOTES: All connections are threaded unless indicted.
A. ANSI 150 psig flange.

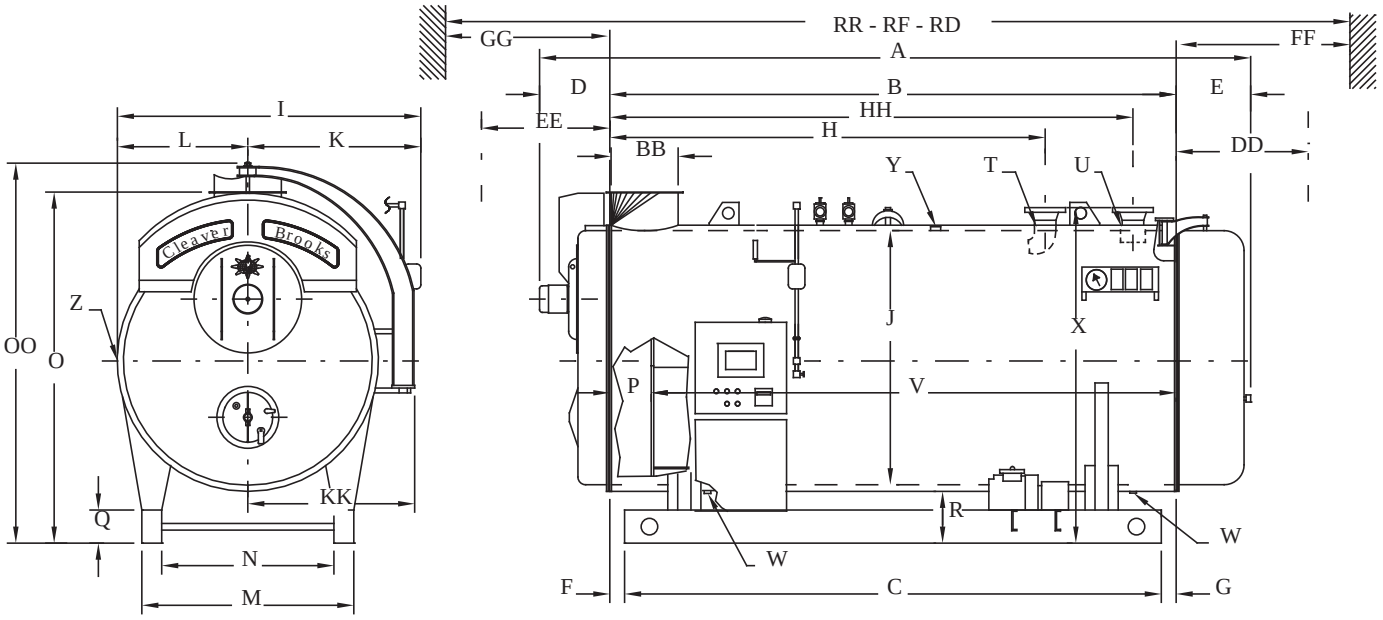


Figure A1-6. CB-LE Hot Water 400-800 HP

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							
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 Approx. Ship. Wgt. – 125 psig		33300 37270	36900 40780	42150 46005	49650 53300	49750 53400	49750 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

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

Nominal Boiler Size	15 ppm Blower Motor HP		9 ppm Blower Motor HP
125	7.5		7.5
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 derated to 720 HP for 9 ppm and 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 shippers weight and count. All weights are in US pounds.

Table A1-14. Steam Boiler Safety Valve Openings

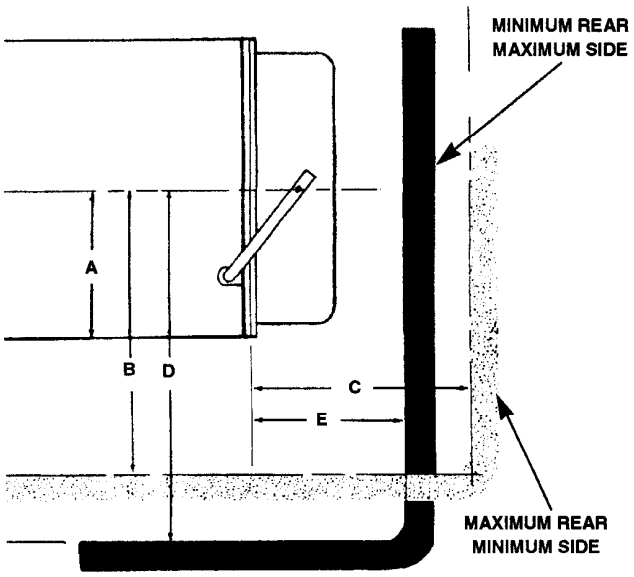
VALVE SETTING	15 PSIG STEAM		100 PSIG STEAM		125 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM		300 PSIG STEAM	
BOILER HP	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	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	1-1/4	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	1-1/2	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	(1)2 (1)1-1/2	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	2	1-1/4
300	2	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) 1-1/2 (1) 1-1/4
350	3	(1) 2 (2) 3	3	(1) 2-1/2 (2) 2	2	(1)2 (1)1-1/2	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	(1)2 (1)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	2	2-1/2	2	(1) 2-1/2 (1) 2	2	(1) 2 (1) 2-1/2	2	(1) 2 (1)1-1/2	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	2
700	5	(3) 3 (2) 2-1/2	5	(3) 2-1/2 (2) 2	3	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. This table revised 04/2012.

Table A1-15. Hot Water Boiler Relief Valve Openings

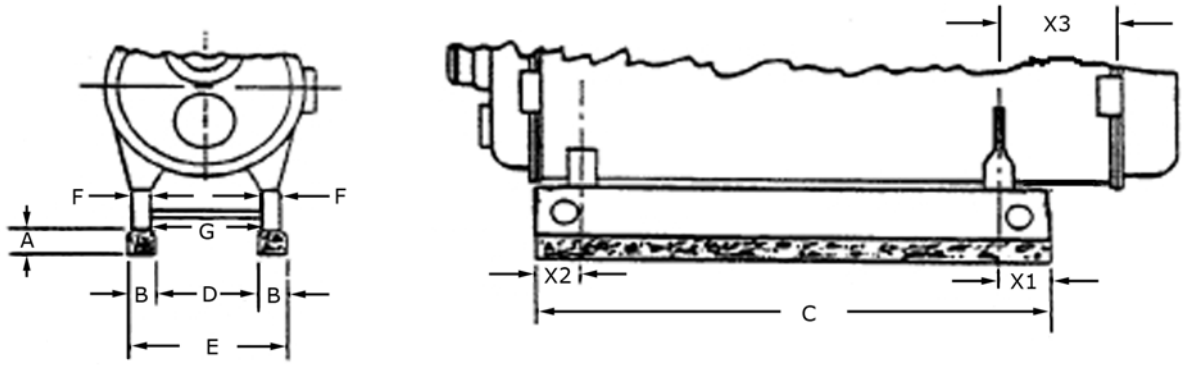
VALVE SETTING	30 PSIG HW		60 PSIG HW		100 PSIG HW		125 PSIG HW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
125	1	2-1/2	1	2	1	2	1	1-1/4
150	1	2-1/2	1	2-1/2	1	2	1	2
200	2	(1) 2-1/2 (1) 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	DIMENSIONS (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

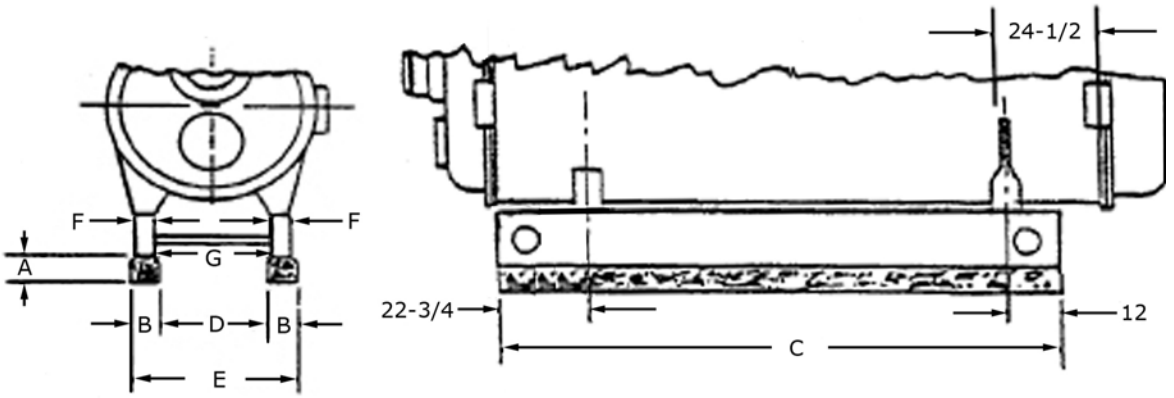


BOILER HP	A	B	C	D	E	F	G	X1	X2	X3
125	6	9	112	39-1/2	57-1/2	4	44-1/2	10	9-3/4	22-1/2
150	6	9	136	39-1/2	57-1/2	4	44-1/2	10	9-3/4	22-1/2
200	6	9	167	39-1/2	57-1/2	4	44-1/2	10	9-3/4	22-1/2
250	6	12	131	46	70	4	56	10	22	22-1/2
300	6	12	158	46	70	4	56	10	22	22-1/2
350	6	12	188	46	70	4	56	10	22	22-1/2

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")

CBLE 250-350HP

Motor HP	Hole Number
7.5	1
15	1
25	2
40	3

CBLE 400-800HP

Motor HP	Hole Number
10	1
20	1
30	2
50	2
75	3

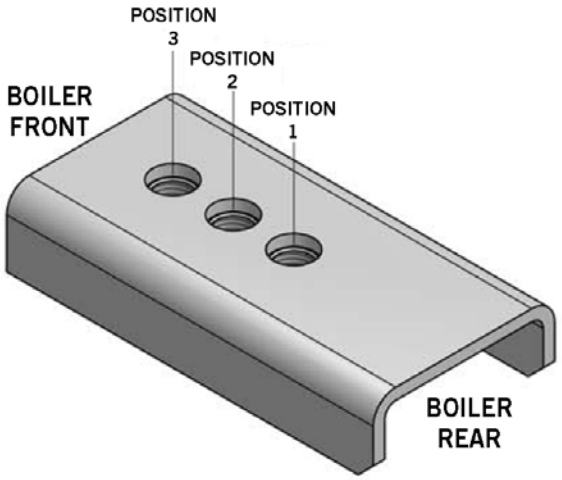
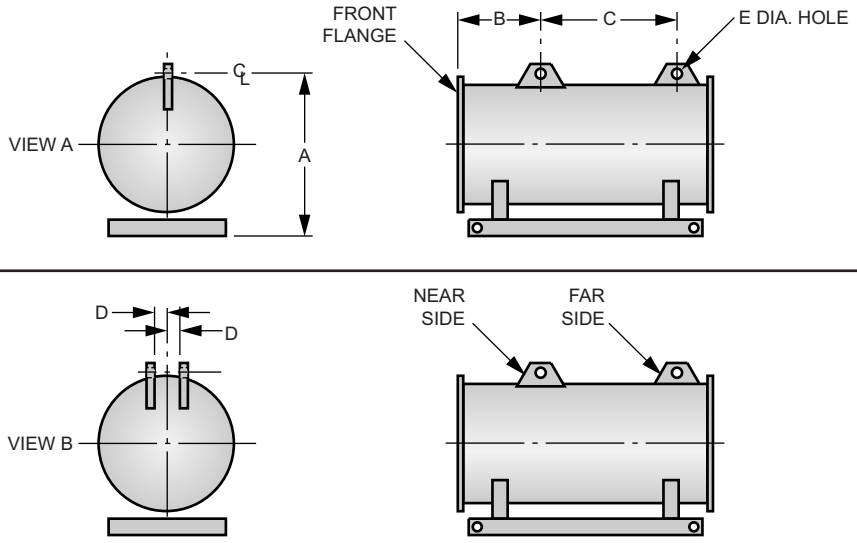


Figure A1-10. Front Davit Support



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 A1-11. Lifting Lug Location, Model CB-LE Boilers

PERFORMANCE DATA

The Low Emission Option provides NOx 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 A1-12, 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

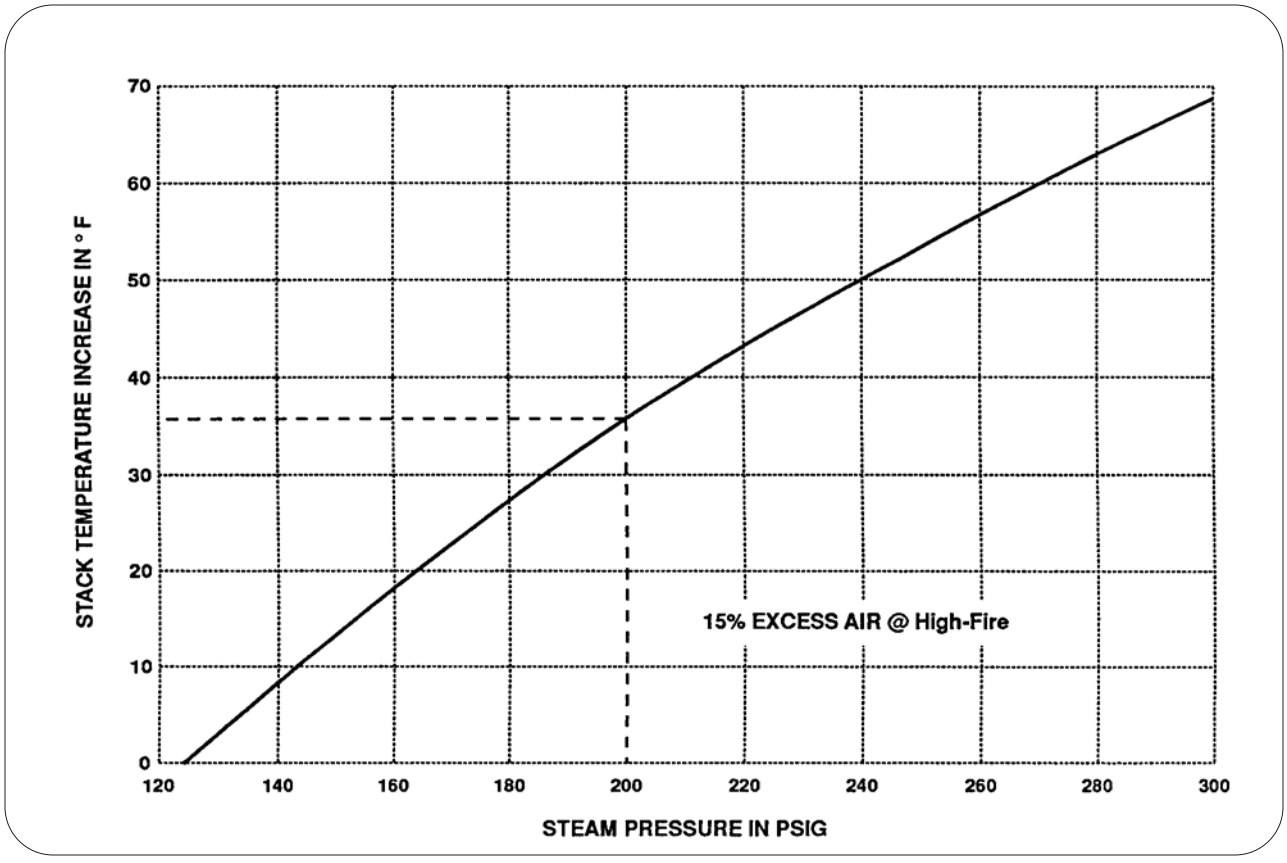


Figure A1-12. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig

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/VOC5	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 A1-20 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 CBLE Predicted Sound Levels 30 ppm NOx Systemss

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 A1-21 shows gas pressure with standard, over- and undersized gas trains.

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

Figure A1-13 shows standard gas train sizes and locations for Model CB Firetube Boilers.

Figure A1-14 shows typical gas train piping layouts for multiple boiler applications.

Figure A1-15 shows standard gas train components.

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

CBLE									
BOILER HP	GAS TRAIN SIZE	UPSTREAM VALVE*	DOWNSTREAM VALVE*	EMISSIONS LEVEL 09 ppm	15 ppm	20 ppm	30 ppm	60 ppm	UC
125 HP	1.5 in	BB	BB	3.3 - 4.9 psi	3.3 - 4.9 psi	0.8 - 5.0 psi	0.7 - 5.0 psi	0.7 - 5.0 psi	0.7 - 5.0 psi
125 HP	1.5 in	PC	PC	3.4 - 5.0 psi	3.4 - 5.0 psi	0.9 - 5.0 psi	0.8 - 5.0 psi	0.8 - 5.0 psi	0.8 - 5.0 psi
125 HP	2.0 in	BB	BB	3.1 - 3.3 psi	3.1 - 3.3 psi	0.6 - 0.8 psi	0.6 - 0.7 psi	0.5 - 0.7 psi	0.5 - 0.7 psi
125 HP	2.0 in	PC	PC	3.1 - 3.4 psi	3.1 - 3.4 psi	0.6 - 0.9 psi	0.6 - 0.8 psi	0.6 - 0.8 psi	0.5 - 0.8 psi
125 HP	2.5 in	PC	PC	3.0 - 3.1 psi	3.0 - 3.1 psi	0.4 - 0.6 psi	0.4 - 0.6 psi	0.4 - 0.5 psi	0.4 - 0.5 psi
125 HP	3.0 in	PC	PC	2.9 - 3.0 psi	2.9 - 3.0 psi	0.4 - 0.4 psi	0.4 - 0.4 psi	0.4 - 0.4 psi	0.3 - 0.4 psi
125 HP	4.0 in	PC	PC	2.9 - 2.9 psi	2.9 - 2.9 psi	0.4 - 0.4 psi	0.3 - 0.4 psi	0.3 - 0.4 psi	0.3 - 0.3 psi
150 HP	1.5 in	BB	BB	3.7 - 5.5 psi	3.9 - 5.8 psi	1.0 - 4.7 psi	0.9 - 5.0 psi	0.9 - 5.0 psi	0.9 - 5.0 psi
150 HP	1.5 in	PC	PC	3.8 - 5.7 psi	4.0 - 6.0 psi	1.1 - 4.2 psi	1.1 - 5.0 psi	1.0 - 5.0 psi	1.0 - 5.0 psi
150 HP	2.0 in	BB	BB	3.4 - 3.7 psi	3.6 - 3.9 psi	0.7 - 1.0 psi	0.6 - 0.9 psi	0.6 - 0.9 psi	0.6 - 0.9 psi
150 HP	2.0 in	PC	PC	3.4 - 3.8 psi	3.6 - 4.0 psi	0.7 - 1.1 psi	0.7 - 1.1 psi	0.7 - 1.0 psi	0.6 - 1.0 psi
150 HP	2.5 in	PC	PC	3.2 - 3.4 psi	3.4 - 3.6 psi	0.5 - 0.7 psi	0.4 - 0.6 psi	0.4 - 0.6 psi	0.4 - 0.6 psi
150 HP	3.0 in	PC	PC	3.2 - 3.2 psi	3.4 - 3.4 psi	0.4 - 0.5 psi	0.4 - 0.4 psi	0.4 - 0.4 psi	0.3 - 0.4 psi
150 HP	4.0 in	PC	PC	3.1 - 3.2 psi	3.3 - 3.4 psi	0.4 - 0.4 psi	0.3 - 0.4 psi	0.3 - 0.4 psi	0.3 - 0.3 psi
200 HP	1.5 in	BB	BB	4.6 - 6.9 psi	5.0 - 7.5 psi		1.6 - 5.0 psi	1.5 - 5.0 psi	1.5 - 5.0 psi
200 HP	1.5 in	PC	PC	4.8 - 7.2 psi	5.2 - 7.8 psi		1.8 - 5.0 psi	1.7 - 5.0 psi	1.7 - 5.0 psi
200 HP	2.0 in	BB	BB	4.1 - 4.6 psi	4.5 - 5.0 psi		1.0 - 1.6 psi	1.0 - 1.5 psi	1.0 - 1.5 psi
200 HP	2.0 in	PC	PC	4.1 - 4.8 psi	4.5 - 5.2 psi		1.1 - 1.8 psi	1.1 - 1.7 psi	1.0 - 1.7 psi
200 HP	2.5 in	PC	PC	3.8 - 4.1 psi	4.2 - 4.5 psi		0.7 - 1.0 psi	0.7 - 1.0 psi	0.6 - 1.0 psi
200 HP	3.0 in	PC	PC	3.6 - 3.8 psi	4.0 - 4.2 psi		0.6 - 0.7 psi	0.5 - 0.7 psi	0.5 - 0.6 psi
200 HP	4.0 in	PC	PC	3.6 - 3.6 psi	4.0 - 4.0 psi		0.5 - 0.6 psi	0.5 - 0.5 psi	0.4 - 0.5 psi
250 HP	1.5 in	BB	BB	4.1 - 6.2 psi	4.4 - 6.7 psi	2.4 - 5.0 psi	2.4 - 2.7 psi	2.4 - 2.6 psi	2.3 - 2.6 psi
250 HP	1.5 in	PC	PC	4.5 - 6.7 psi	4.8 - 7.2 psi	2.8 - 5.0 psi	2.7 - 2.8 psi	2.7 - 2.7 psi	2.7 - 2.7 psi
250 HP	2.0 in	BB	BB	3.3 - 3.8 psi	3.7 - 4.1 psi	1.6 - 2.4 psi	1.6 - 2.4 psi	1.6 - 2.4 psi	1.5 - 2.3 psi
250 HP	2.0 in	PC	PC	3.4 - 4.0 psi	3.7 - 4.3 psi	1.7 - 2.8 psi	1.7 - 2.7 psi	1.6 - 2.7 psi	1.6 - 2.7 psi
250 HP	2.5 in	PC	PC	2.9 - 3.3 psi	3.2 - 3.7 psi	1.1 - 1.6 psi	1.1 - 1.6 psi	1.1 - 1.6 psi	1.0 - 1.5 psi
250 HP	3.0 in	PC	PC	2.7 - 2.9 psi	3.1 - 3.2 psi	0.9 - 1.1 psi	0.9 - 1.1 psi	0.9 - 1.1 psi	0.9 - 1.0 psi
250 HP	4.0 in	PC	PC	2.6 - 2.7 psi	2.9 - 3.1 psi	0.8 - 0.9 psi	0.8 - 0.9 psi	0.8 - 0.9 psi	0.8 - 0.9 psi
300 HP	1.5 in - 2.0 in	BB	BB	5.5 - 8.3 psi	5.7 - 8.5 psi	3.0 - 5.0 psi	3.0 - 3.6 psi	3.0 - 3.5 psi	3.0 - 3.5 psi
300 HP	1.5 in - 2.0 in	PC	PC	5.8 - 8.7 psi	6.0 - 9.0 psi	3.3 - 5.0 psi	3.3 - 3.7 psi	3.3 - 3.6 psi	3.3 - 3.6 psi
300 HP	2.0 in	BB	BB	4.6 - 5.5 psi	4.7 - 5.7 psi	2.1 - 3.0 psi	2.1 - 3.0 psi	2.0 - 3.0 psi	2.0 - 3.0 psi
300 HP	2.0 in	PC	PC	4.7 - 5.8 psi	4.8 - 6.0 psi	2.2 - 3.3 psi	2.2 - 3.3 psi	2.1 - 3.3 psi	2.1 - 3.3 psi
300 HP	3.0 in	PC	PC	3.9 - 4.6 psi	4.0 - 4.7 psi	1.3 - 2.1 psi	1.3 - 2.1 psi	1.2 - 2.0 psi	1.2 - 2.0 psi
300 HP	4.0 in	PC	PC	3.7 - 3.9 psi	3.9 - 4.0 psi	1.1 - 1.3 psi	1.1 - 1.3 psi	1.0 - 1.2 psi	1.0 - 1.2 psi
350 HP	1.5 in - 2.0 in	BB	BB	6.4 - 9.0 psi	6.2 - 9.0 psi	4.2 - 5.0 psi	4.2 - 5.0 psi	4.1 - 5.0 psi	4.1 - 5.0 psi
350 HP	1.5 in - 2.0 in	PC	PC	6.8 - 9.0 psi	6.6 - 9.0 psi	4.6 - 5.0 psi	4.6 - 5.0 psi	4.5 - 5.0 psi	4.5 - 5.0 psi
350 HP	2.0 in	BB	BB	5.4 - 6.4 psi	5.3 - 6.2 psi	3.2 - 4.2 psi	3.2 - 4.2 psi	3.2 - 4.1 psi	3.1 - 4.1 psi
350 HP	2.0 in	PC	PC	5.6 - 6.8 psi	5.4 - 6.6 psi	3.4 - 4.6 psi	3.4 - 4.6 psi	3.3 - 4.5 psi	3.3 - 4.5 psi
350 HP	2.5 in	PC	PC	4.3 - 5.4 psi	4.2 - 5.3 psi	2.1 - 3.2 psi	2.1 - 3.2 psi	2.0 - 3.2 psi	2.0 - 3.1 psi
350 HP	3.0 in	PC	PC	4.0 - 4.3 psi	3.8 - 4.2 psi	1.7 - 2.1 psi	1.7 - 2.1 psi	1.7 - 2.0 psi	1.6 - 2.0 psi
350 HP	4.0 in	PC	PC	3.7 - 4.0 psi	3.6 - 3.8 psi	1.5 - 1.7 psi	1.5 - 1.7 psi	1.4 - 1.7 psi	1.4 - 1.6 psi
400 HP	1.5 in - 2.0 in	BB	BB	6.9 - 9.0 psi	6.9 - 9.0 psi	4.6 - 5.0 psi	4.6 - 5.0 psi	4.5 - 5.0 psi	4.5 - 5.0 psi
400 HP	1.5 in - 2.0 in	PC	PC	7.4 - 9.0 psi	7.5 - 9.0 psi	5.1 - 8.7 psi	5.1 - 7.7 psi	5.1 - 7.7 psi	5.1 - 7.7 psi
400 HP	2.0 in	BB	BB	5.5 - 6.9 psi	5.6 - 6.9 psi	3.2 - 4.6 psi	3.2 - 4.6 psi	3.2 - 4.5 psi	3.2 - 4.5 psi
400 HP	2.0 in	PC	PC	5.7 - 7.4 psi	5.8 - 7.5 psi	3.4 - 5.0 psi	3.4 - 5.0 psi	3.4 - 5.0 psi	3.4 - 5.0 psi
400 HP	2.5 in	PC	PC	4.1 - 5.5 psi	4.2 - 5.6 psi	1.8 - 3.2 psi	1.8 - 3.2 psi	1.8 - 3.2 psi	1.8 - 3.2 psi
400 HP	3.0 in	PC	PC	3.7 - 4.1 psi	3.8 - 4.2 psi	1.3 - 1.8 psi	1.3 - 1.8 psi	1.3 - 1.8 psi	1.3 - 1.8 psi
400 HP	4.0 in	PC	PC	3.4 - 3.7 psi	3.5 - 3.8 psi	1.1 - 1.3 psi	1.0 - 1.3 psi	1.0 - 1.3 psi	1.0 - 1.3 psi
500 HP	2.0 in - 2.5 in	BB	PC	5.8 - 7.6 psi	5.8 - 7.6 psi	4.6 - 5.0 psi	4.6 - 5.0 psi	4.5 - 5.0 psi	4.5 - 5.0 psi

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

CBLE									
BOILER HP	GAS TRAIN SIZE	UPSTREAM VALVE*	DOWNSTREAM VALVE*	EMISSIONS LEVEL 09 ppm	15 ppm	20 ppm	30 ppm	60 ppm	UC
500 HP	2.0 in - 2.5 in	PC	PC	6.0 - 8.3 psi	6.0 - 8.3 psi	4.8 - 5.0 psi	4.7 - 5.0 psi	4.7 - 5.0 psi	4.7 - 5.0 psi
500 HP	2.5 in	PC	PC	3.9 - 5.8 psi	3.9 - 5.8 psi	2.7 - 4.6 psi	2.7 - 4.6 psi	2.7 - 4.5 psi	2.6 - 4.5 psi
500 HP	3.0 in	PC	PC	3.3 - 3.9 psi	3.3 - 3.9 psi	2.0 - 2.7 psi	2.0 - 2.7 psi	2.0 - 2.7 psi	2.0 - 2.6 psi
500 HP	4.0 in	PC	PC	2.8 - 3.3 psi	2.8 - 3.3 psi	1.6 - 2.0 psi	1.6 - 2.0 psi	1.5 - 2.0 psi	1.5 - 2.0 psi
600 HP	2.0 in - 2.5 in	BB	PC	8.0 - 9.0 psi	8.0 - 9.0 psi	6.5 - 9.0 psi	6.5 - 9.0 psi	6.4 - 8.9 psi	6.3 - 8.8 psi
600 HP	2.0 in - 2.5 in	PC	PC	8.2 - 9.0 psi	8.2 - 9.0 psi	6.7 - 10.0 psi	6.7 - 10.0 psi	6.6 - 9.9 psi	6.6 - 9.9 psi
600 HP	2.5 in	PC	PC	5.4 - 8.0 psi	5.4 - 8.0 psi	3.9 - 5.0 psi	3.8 - 5.0 psi	3.8 - 5.0 psi	3.7 - 5.0 psi
600 HP	2.5 in - 3.0 in	PC	PC	5.2 - 5.4 psi	5.2 - 5.4 psi	3.7 - 3.9 psi	3.6 - 3.8 psi	3.5 - 3.8 psi	3.5 - 3.7 psi
600 HP	3.0 in	PC	PC	4.3 - 5.2 psi	4.3 - 5.2 psi	2.8 - 3.7 psi	2.7 - 3.6 psi	2.7 - 3.5 psi	2.6 - 3.5 psi
600 HP	4.0 in	PC	PC	3.7 - 4.3 psi	3.7 - 4.3 psi	2.2 - 2.8 psi	2.1 - 2.7 psi	2.0 - 2.7 psi	2.0 - 2.6 psi
700 HP	2.0 in - 3.0 in	BB	PC	11.0 - 15.0 psi	10.7 - 15.0 psi	8.7 - 13.1 psi	8.6 - 13.0 psi	8.6 - 12.9 psi	8.6 - 12.8 psi
700 HP	2.0 in - 3.0 in	PC	PC	11.3 - 15.0 psi	11.0 - 15.0 psi	9.0 - 13.5 psi	8.9 - 13.4 psi	8.9 - 13.4 psi	8.9 - 13.3 psi
700 HP	2.5 in - 3.0 in	PC	PC	7.1 - 9.0 psi	6.8 - 9.0 psi	4.8 - 5.0 psi	4.7 - 5.0 psi	4.7 - 5.0 psi	4.6 - 5.0 psi
700 HP	3.0 in	PC	PC	6.0 - 7.1 psi	5.7 - 6.8 psi	3.6 - 4.8 psi	3.6 - 4.7 psi	3.5 - 4.7 psi	3.5 - 4.6 psi
700 HP	4.0 in	PC	PC	5.1 - 6.0 psi	4.8 - 5.7 psi	2.8 - 3.6 psi	2.7 - 3.6 psi	2.7 - 3.5 psi	2.6 - 3.5 psi
800 HP	2.0 in - 3.0 in	BB	PC				10.8 - 15.0 psi	10.7 - 15.0 psi	10.6 - 15.0 psi
800 HP	2.0 in - 3.0 in	PC	PC				11.2 - 15.0 psi	11.1 - 15.0 psi	11.0 - 15.0 psi
800 HP	2.5 in - 3.0 in	PC	PC				6.1 - 9.0 psi	6.0 - 10.0 psi	5.9 - 10.0 psi
800 HP	3.0 in	PC	PC				4.8 - 6.1 psi	4.7 - 5.0 psi	4.6 - 5.0 psi
800 HP	4.0 in	PC	PC				3.5 - 4.8 psi	3.4 - 4.7 psi	3.4 - 4.6 psi

* BB = Butter Ball; PC = Plug Cock

Standard Gas Train size is highlighted

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.

Table A1-22. 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 A1-23. 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

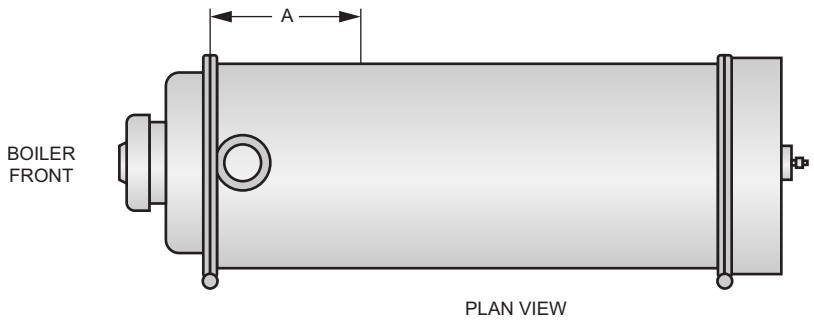


Figure A1-13. Standard Gas Train Connection Size and Location

Oil-Fired Burners

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

Figure A1-16 shows the oil connection sizes and locations for Model CB Boilers firing No. 2 oil.

Figure A1-17 through Figure A1-18 show typical oil systems and layouts.

Figure A1-19 and Figure A1-21 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 A1-22 shows typical boiler room length requirements.

Figure A1-23 shows typical boiler room width requirements.

Figure A1-24 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:
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

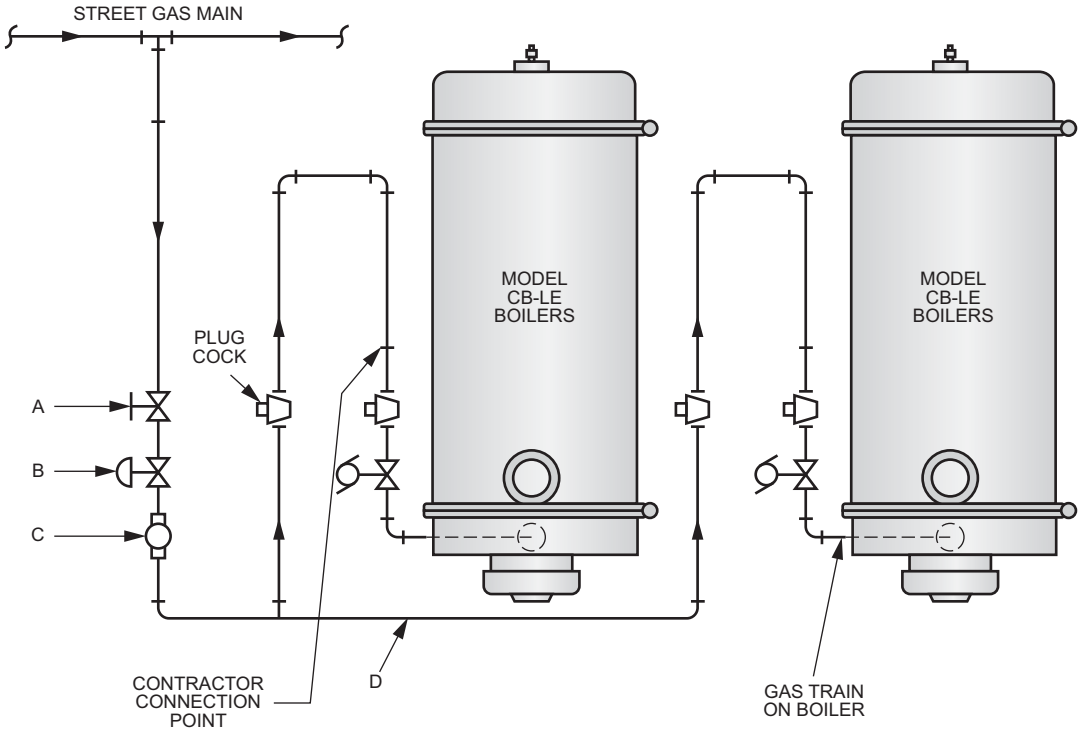
Example: Determine the area of the boiler room air supply openings for (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- 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.

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 A1-14. 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

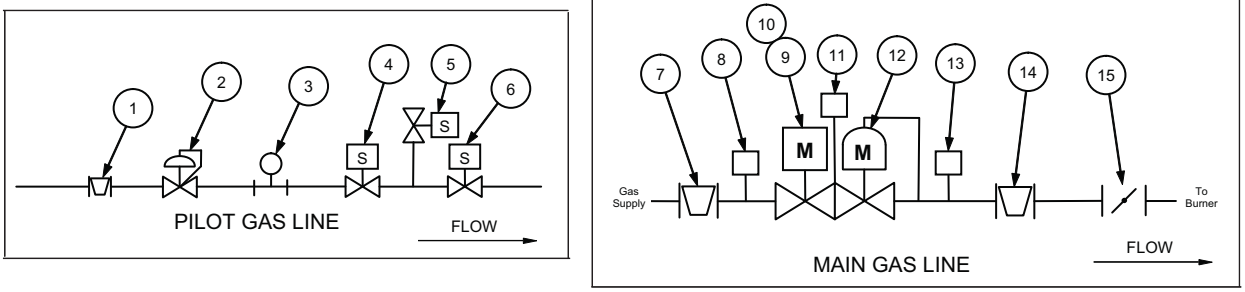
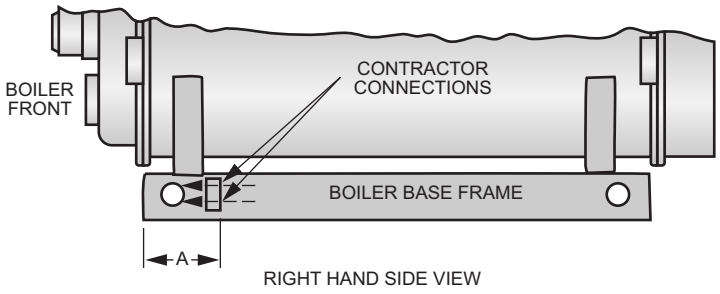


Figure A1-15. Model CB-LE Gas Train Components



BOILER HP	MODEL CB				
	SUPPLY AND RE-TURN CONN SIZES (IN.) (NPT)	A (IN.)	RECOMMENDED OIL LINE[A] SIZES (STANDARD PIPE) (IN. - IPS)		
			STOR-AGE TANK TO BOILER OR PUMP CONNECT	PUMP TO BOILER	RE-TURN 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 A1-16. No.2 Oil Connection Size, Location, and Recommended Line Sizes

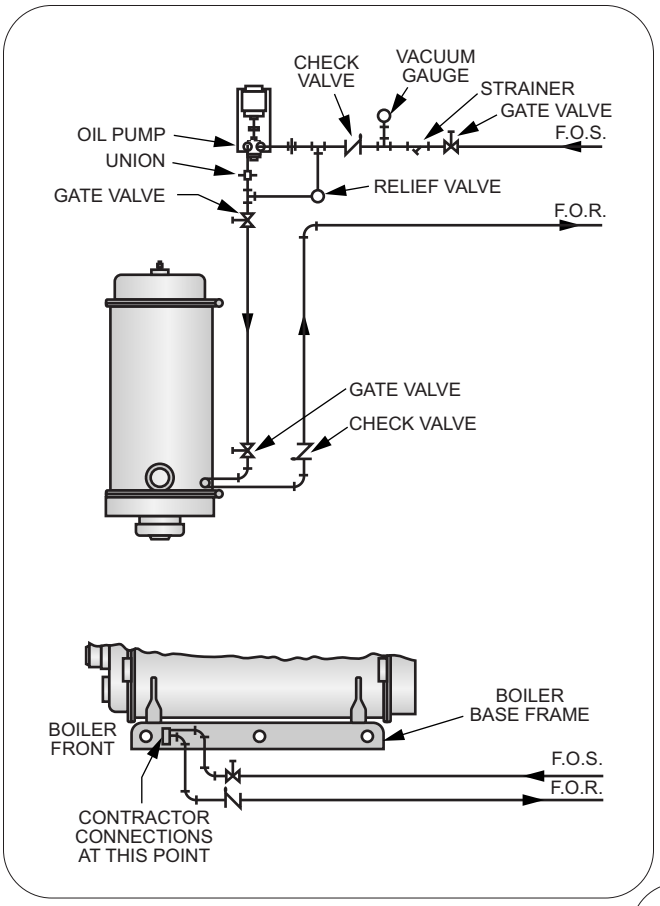


Figure A1-17. No. 2 Oil Piping, Single Boiler Installation, Remote Oil Pump

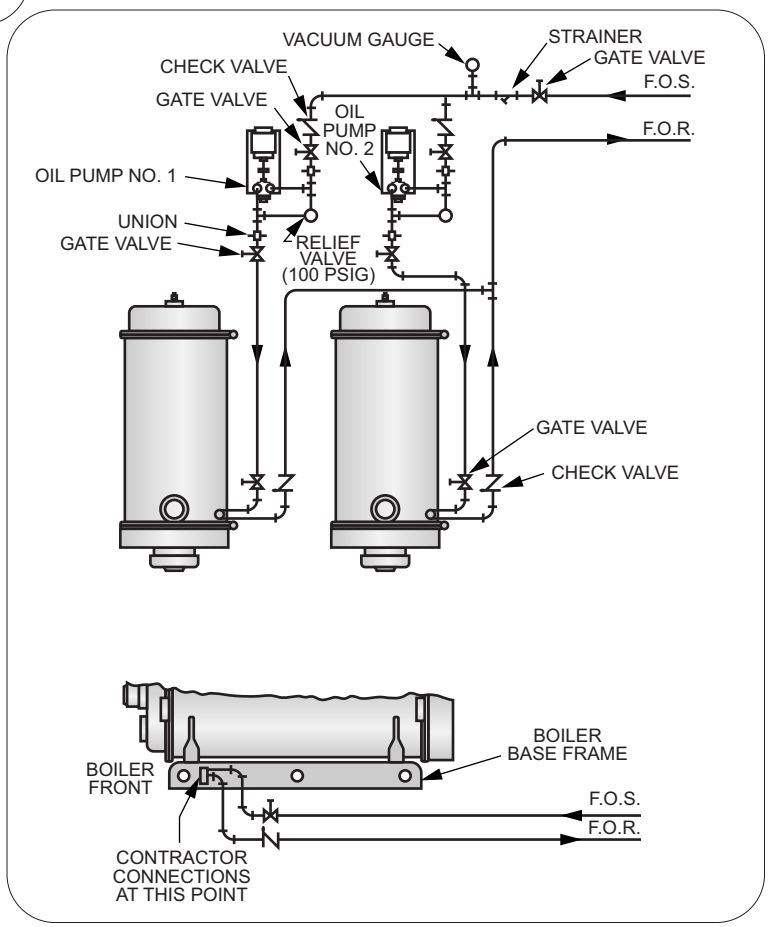


Figure A1-18. No. 2 Oil Piping, Multiple Boiler Installation, Remote Oil Pumps

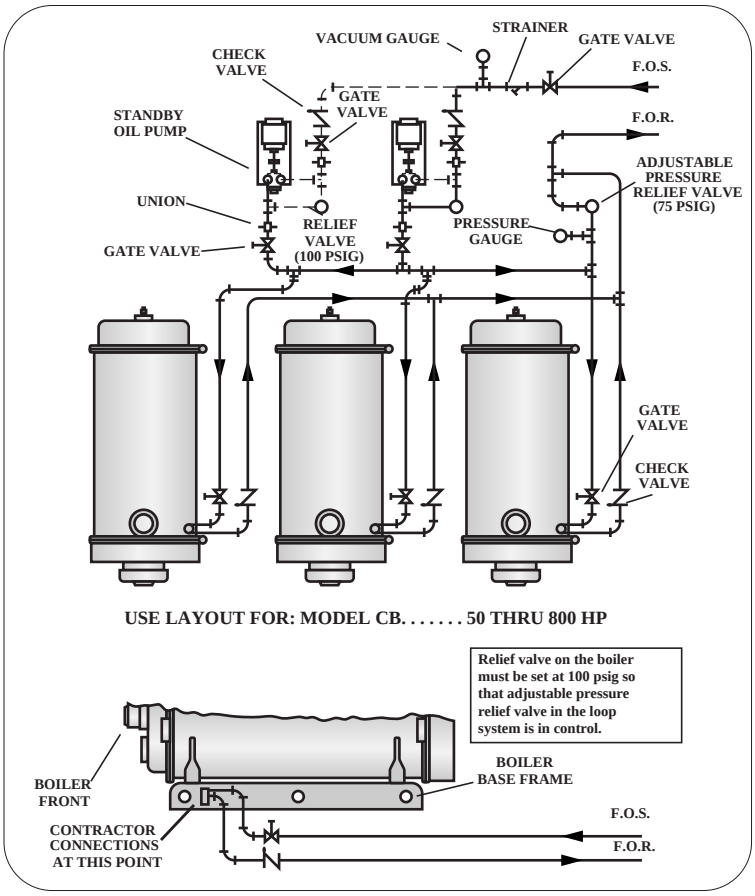


Figure A1-19. No. 2 Oil Piping, Multiple Boiler Installation

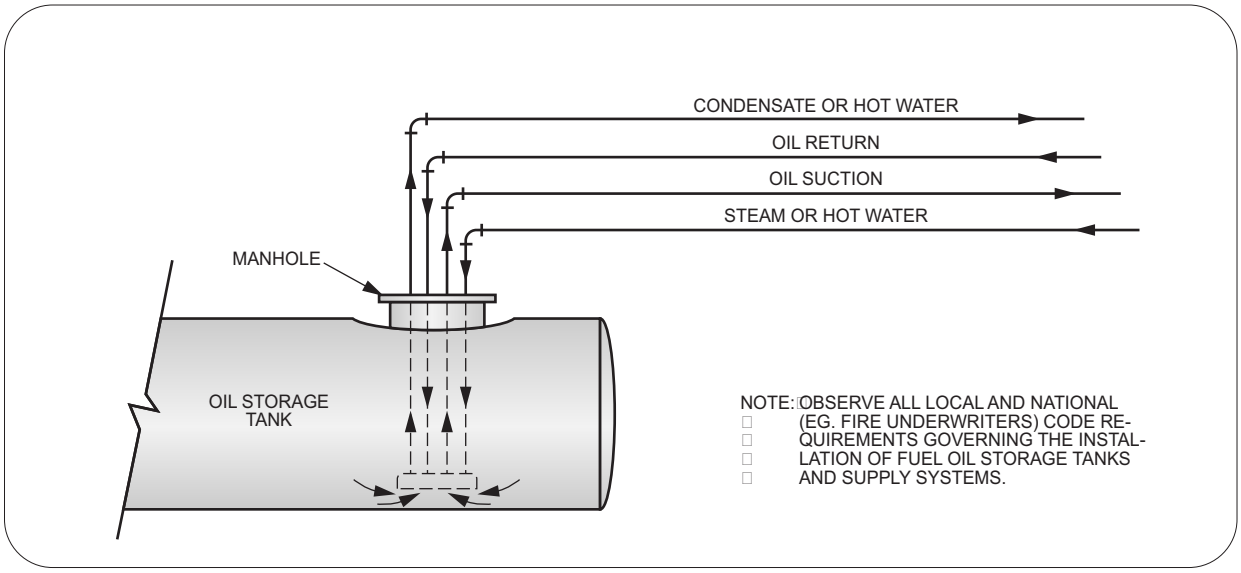


Figure A1-20. No. 2 Oil Piping

Table A1-24. 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 A1-25. 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 A1-26. 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)

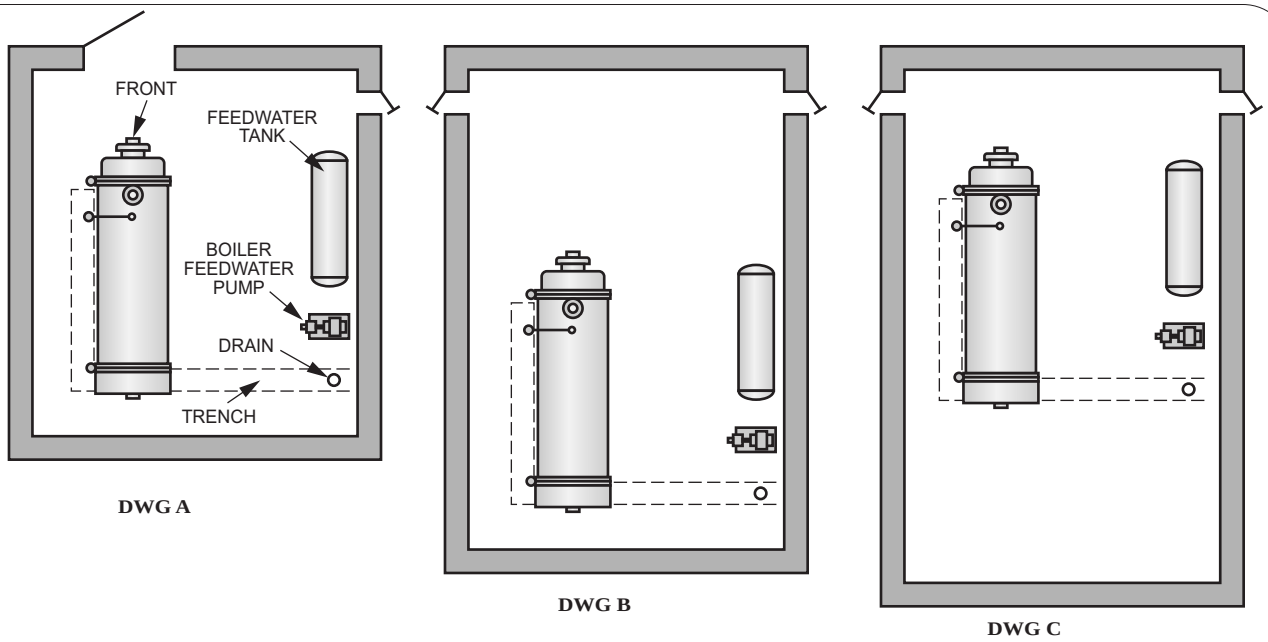
	Boiler HP											
OPERATING PRESSURE PSIG	**125**	**150**	**200**	**250**	**300**	**350**	**400**	**500**	**600**	**700**	**750**	**800**
15	8	8	10	10	12	12	12	12	12	12	12	12
30	6	6	8	8	8	10	10	10	12	12	12	12
40	6	6	6	8	8	8	10	10	10	12	12	12
50	6	6	6	6	8	8	8	10	10	10	12	12
75	4	4	6	6	6	8	8	8	8	10	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.

(For elevated boiler room locations using an oil transfer pump and tank)

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.

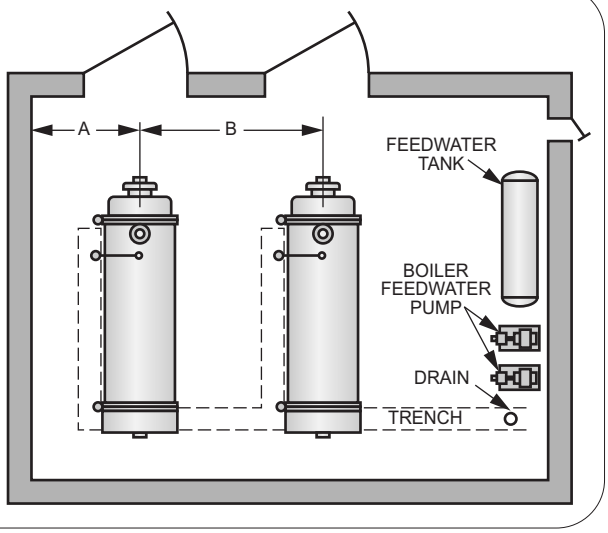
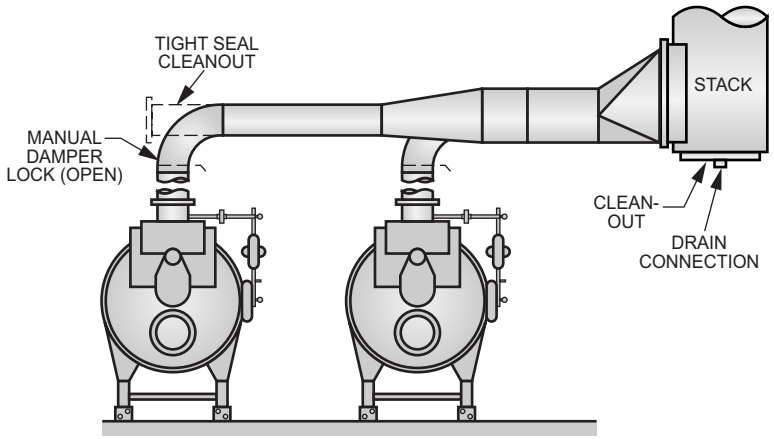


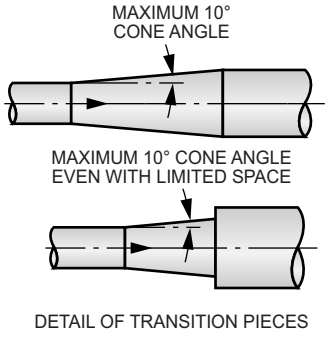
Figure A1-21. Typical Arrangement



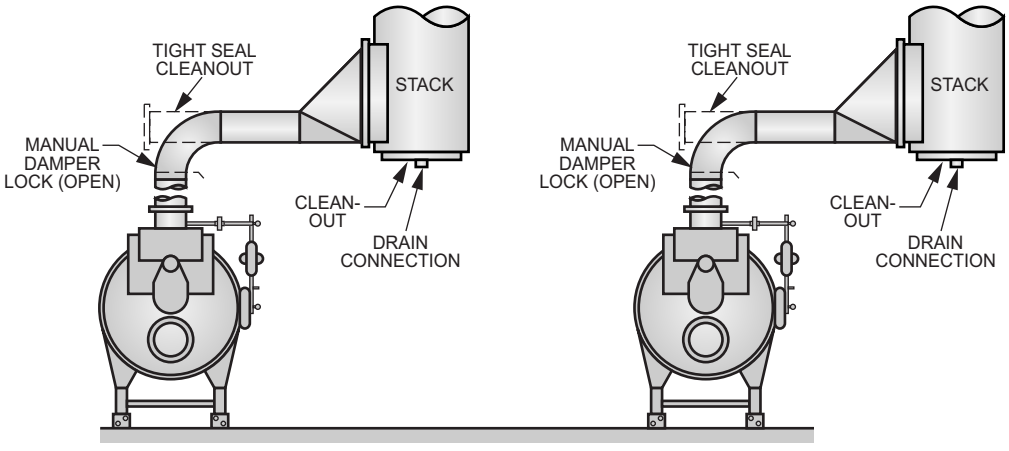
MULTIPLE BOILERS WITH A COMMON STACK

NOTE: These stack breeching arrangements for multiple boilers are generic 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 A1-22. Boiler Room Length (Typical Layouts)

SECTION A1
MODEL CB-LE STEAM BOILER SPECIFICATIONS
(125-800 HP, STEAM 15-300 PSIG)

SAMPLE SPECIFICATIONS (STEAM)

CONTENTS

PART 1 GENERAL A1-45
1.1 Boiler Characteristics (Steam) A1-45
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
2.3 Burner and Controls A1-47
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
3.1 Shop Tests A1-55
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 NOx (dry volume basis and corrected to 3% O_2) when firing natural gas. For assistance in specifying, or for information on NOx 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 regulatinggas 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 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:

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:	Prometean 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

PART 1 GENERAL A1-57
1.1 Boiler Characteristics (Hot Water) A1-57
PART 2 PRODUCTS A1-57
2.1 General Boiler Design A1-57
2.2 Hot Water Boiler Trim A1-58
2.3 Burner and Controls A1-58
2.4 Efficiency Guarantee A1-64
2.5 Performance Criteria A1-65
PART 3 EXECUTION A1-66
3.1 Warranty A1-66
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% O_2 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 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 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.