

MODEL CB

15-100 HP



Boiler Book
03/2018



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FEATURES AND BENEFITS

In addition to the features provided on all Cleaver-Brooks Firetube Boilers, the following features apply specifically to Model CB Firetube Boilers.

Four-Pass Dryback Design:

- Four-pass design provides high flue gas velocities and low stack temperature for guaranteed maximum efficiency.
- Dryback design provides full access to boiler tubes, tube sheet, and furnace for ease of maintenance.
- Dryback design includes single rear tube sheet construction, providing reduced tube sheet stresses.

Five Square Feet of Heating Surface per Boiler hp:

- Maximum heat transfer with minimum thermal stresses provide guaranteed efficiency and long boiler life.
- Highest guaranteed fuel-to-steam efficiencies.

Low Furnace Location

- Furnace located well below water level with generous clearance from bottom of boiler, allowing proper circulation.
- Low furnace provides additional safety margin between furnace and water level.
- Reduces water carryover, producing drier steam.

Hinged or Davited Front and Rear Doors:

- Provides full access to front and rear tube sheet and furnace.
- Reduces maintenance costs.

High Turndown Burner:

- 4:1 turndown (gas and oil) is standard.
- Advanced burner design provides maximum combustion efficiencies and high turndown.
- Reduced boiler cycling and maintenance.
- Boiler stays on line during low load conditions for optimum efficiency and performance.

Gas, No. 2 Oil, No. 6 Oil, and Combination Gas and Oil Burners Available:

- High radiant multi-port gas burner designed for high gas velocities and complete fuel/air mixing, providing maximum combustion efficiencies.
- Air atomizing oil burner available for proper oil atomization, maximum combustion efficiency, and low maintenance requirements.
- Air atomizing compressor provided with the boiler package for clean oil burning and ease of maintenance.
- Combination gas/oil burners provide quick fuel changeover without re-adjustment of the burner.
- Fuel oil controller eliminates the need for over 40 connections, combining gauges, valves, and regulators into a single casting.
- Retractable oil nozzle provides easy access and cleaning and eliminates coking of oil and nozzle tip when firing gas.

PRODUCT OFFERING

Model CB Firetube Boilers are available in low pressure steam, high pressure steam, and hot water designs. Burners are available to fire natural gas, light oil, heavy oil, or a combination of oil and gas. Optional alternate fuel burners are also available.

Model CB Boilers include:

- Four-pass dryback design.
- 15 hp through 100 hp.
- 150 psig - 350 psig high pressure steam.
- 15 psig low pressure steam.
- 30 psig or 125 psig hot water.
- Natural gas, light oil, or heavy oil firing.

The Model CB Boiler is the premium firetube product offering providing maximum boiler efficiency, the widest range of size and pressures, and premium control packages.

Available options: For option details, contact your Cleaver-Brooks authorized representative. Options include the following:

Boiler Options

- Auxiliary low water cut-off (standard on steam boilers).
- Drain valves.
- Additional screwed or flanged tappings.
- Special design pressures.
- Surge load baffles.
- Seismic design.
- Internal hot water coils.
- Blowdown valves.
- Non-return valves.
- Feedwater valves and regulators.
- Special doors, davited, hinged, left swing.
- Special base rails.
- Surface blowdown systems.
- Combustion relief door.
- Weather-proofing.
- Blend pump.

Burner/Control Options

- Special modulation controls.
- Optional flame safeguard controller.
- Lead/lag system.
- High altitude design, up to 12,000 ft.
- Special insurance and code requirements (e.g. FM, ASME CSD-1).
- Alarm bell/silence switch.

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- Special motor requirements (TEFC, high efficiency).
- Remote contacts.
- Special purpose indicator lights.
- Main disconnect.
- Elapsed time meter.
- Voltmeter/micro-ammeter.
- NEMA enclosures.
- Low fire hold controls.
- Remote emergency shut-off (115V).
- Circuit breaker.
- Day/night controls.
- Special power requirements.

Fuel Options

- Automatic fuel changeover.
- Special gas pressure regulator.
- Oversized/undersized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Special pilot.
- Alternate fuel firing (propane, digester gas, etc.).
- Special oil pumps.

DIMENSIONS AND RATINGS

- Dimensions and ratings for the Model CB boilers are shown in the following tables and illustrations:
- Table 1. Model CB Steam Boiler Ratings (15 thru 100 hp)
- Table 2. Model CB Hot Water Boiler Ratings (15 thru 100 hp)
- Table 3. Safety Valve Openings
- Table 4. Relief Valve Openings
- Table 5. Model CB Steam Boiler Dimensions
- Table 6 Model CB Hot Water Boiler Dimensions
- Figure 1. Space Required to Open Rear Head on Model CB Boilers Equipped with Davits
- Figure 2. Model CB Boiler Mounting Piers
- Figure 3. Lifting Lug Locations, Model CB Boilers

Table 1: Model CB Steam Boiler Ratings (15 - 100 hp)

BOILER HP	15 ^c	20 ^c	30 ^c	40 ^c	50	60	70	80	100
RATINGS - SEA LEVEL TO 3000 FT									
Rated Cap. (lbs steam/hr @212°F) Btu Output (1000 Btu/hr)	518 502	690 670	1035 1004	1380 1339	1725 1674	2070 2009	2415 2343	2760 2678	3450 3348
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY									
Light Oil (gph) ^A	4.5	6.0	9.0	12.0	14.9	17.9	20.9	23.9	29.9
Heavy Oil (gph) ^B	-	-	-	-	13.9	16.7	19.5	22.3	27.9
Gas (cfh) 1000 Btu-Nat Gas (Therm/hr)	628 6.3	837 8.4	1255 12.6	1674 16.7	2092 20.9	2511 25.1	2929 29.3	3348 33.5	4184 41.8
POWER REQUIREMENTS - SEA LEVEL TO 3000 FT, 60 HZ									
Blower Motor hp (except gas)	1	1	1-1/2	2	2	2	2	2 ^D	3
Gas Models (only)	1	1	1-1/2	2	2	2	2	2 ^D	3
Oil Pump Motor, hp No. 2 Oil	Belt-Driven From Blower				1/3	1/3	1/3	1/3	1/3
Oil Pump Motor, hp No. 6 Oil	-	-	-	-	1/3	1/3	1/3	1/3	1/3
Oil Heater kW No. 6 Oil	-	-	-	-	5	5	5	5	5
Air Compressor Motor hp (Oil firing Only)	Air Compressor Belt-Driven from Blower Motor				2	2	2	2	2

NOTES:

1. For altitudes above 3000 ft, contact your local Cleaver-Brooks authorized representative for verification of blower motor hp.
- A. Based on 140,000 Btu/gal.
- B. Based on 150,000 Btu/gal.
- C. No. 6 Oil not available in 15-40 hp range.
- D. 3 hp above 2000 ft.

Table 2: Model CB Hot Water Boiler Ratings (15 - 100 hp)

BOILER HP	15 ^c	20 ^c	30 ^c	40 ^c	50	60	70	80	100
RATINGS - SEA LEVEL TO 3000 FT									
Rated Cap Btu Output (1000 Btu/hr)	502	670	1004	1339	1674	2009	2343	2678	3348
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY									
Light Oil (gph) ^A	4.5	6.0	9.0	12.0	14.9	17.9	20.9	23.9	29.9
Heavy Oil (gph) ^B	-	-	-	-	13.9	16.7	19.5	22.3	27.9
Gas (cfh)MBtu- nat Gas (Therm/hr)	628 6.3	837 8.4	1255 12.6	1674 16.7	2092 20.9	2511 25.1	2929 29.3	3348 33.5	4184 41.8
POWER REQUIREMENTS - SEA LEVEL TO 3000 FT, 60 HZ									
Blower Motor hp (except gas)	1	1	1-1/2	2	2	2	2	2 ^D	3
Gas Models (only)	1	1	1-1/2	2	2	2	2	2 ^D	3
Oil Pump Motor, hp No. 2 Oil	Belt-Driven From Blower				1/3	1/3	1/3	1/3	1/3
Oil Pump Motor, hp No. 6 Oil	-	-	-	-	1/3	1/3	1/3	1/3	1/3
Oil Heater kW No. 6 Oil	-	-	-	-	5	5	5	5	5
Air Compressor Motor hp (Oil firing Only)	Air Compressor Belt-Driven from Blower Motor				2	2	2	2	2

NOTES:

1. For altitudes above 3000 ft, contact your local Cleaver-Brooks authorized representative for verification of blower motor hp.
- A. Based on 140,000 Btu/gal.
- B. Based on 150,000 Btu/gal.
- C. No. 6 Oil not available in 15-40 hp range.
- D. 3 hp above 2000 ft.

Table 3: Steam Boiler Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		100 PSIG STEAM		125 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
15	1	1-1/2	1	1	1	3/4	1	3/4	1	3/4	1	3/4
20	1	1-1/2	1	1	1	3/4	1	3/4	1	3/4	1	3/4
25	1	2	1	1	1	1	1	1	1	3/4	1	3/4
30	1	2	1	1-1/4	1	1	1	1	1	3/4	1	3/4
40	1	2-1/2	1	1-1/4	1	1-1/4	1	1	1	1	1	1
50	1	2-1/2	1	1-1/2	1	1-1/4	1	1-1/4	1	1	1	1
60	1	2	1	1-1/2	1	1-1/4	1	1-1/4	1	1	1	1
70	1	2	1	2	1	1-1/2	1	1-1/2	1	1-1/4	1	1
80	1	2-1/2	1	2	1	1-1/2	1	1-1/2	1	1-1/4	1	1-1/4
100	1	2-1/2	1	2	1	1-1/2	1	1-1/2	1	1-1/2	1	1-1/4

Table 4: Hot Water Boiler Relief Valve Openings

VALVE SETTING	30 PSIG HW		60 PSIG HW		100 PSIG HW		125 PSIG HW	
BOILER HP	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
15	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1
25	1	1-1/4	1	1	1	1	1	1
30	1	1-1/4	1	1	1	1	1	1
40	1	1-1/4	1	1	1	1	1	1
50	1	2	1	1-1/4	1	1	1	1
60	1	2	1	1-1/4	1	1	1	1
70	1	2	1	2	1	1-1/4	1	1
80	1	2	1	2	1	1-1/4	1	1-1/4
100	1	2-1/2	1	2	1	1-1/4	1	1-1/4

NOTES:

1. Hot water relief valves are Kunkle #537.
2. BHP followed by "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in the upper portion of the vessel.

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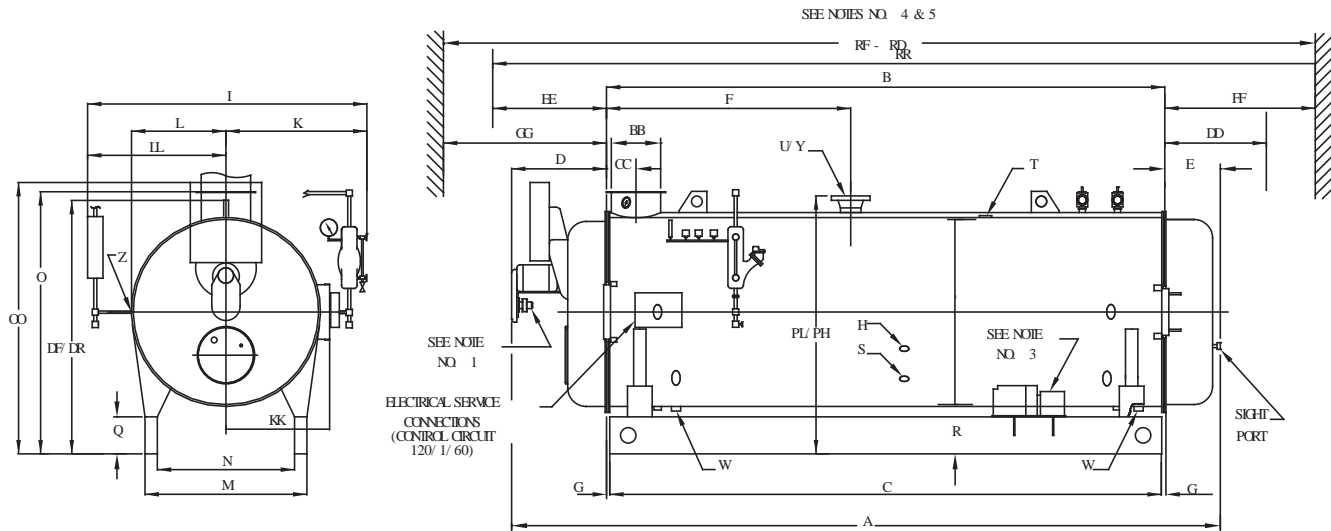


Table 5: Model CB Steam Boiler Dimensions

BOILER HP	DIM	15	20	30	40	50	60	70	80	100
LENGTHS										
Overall	A	96-5/8	96-5/8	114-5/8	140-5/8	129	129	168	168	187
Shell	B	62-5/8	62-5/8	80-5/8	106-5/8	92	92	131	131	150
Base Frame	C	59	59	77	103	91	91	130	130	148
Front Head Extension	D	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Rear Head Extension	E	15-1/2	15-1/2	15-1/2	15-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Front Ring Flange to Nozzle - 15 psig	F	36	36	45	57	46	46	65-1/2	65-1/2	75
Front Ring Flange to Nozzle - 150 psig	F	36	36	45	57	46	46	72-1/2	72-1/2	82
Ring Flange to Base	G	1-13/16	1-13/16	1-13/16	1-13/16	5/8	1/2	1/2	1/2	1/2
WIDTHS										
Overall	I	61	61	61	61	73	73	73	73	73
ID, Boiler	J	36	36	36	36	48	48	48	48	48
Center to Water Column	K	33	33	33	33	39	39	39	39	39
Center to Outside Hinge	KK	22	22	22	22	29	29	29	29	29
Center to Lagging	L	20	20	20	20	27	27	27	27	27
Center to Auxiliary LWCO	LL	28	28	28	28	34	34	34	34	34
Base, Outside	M	28	28	28	28	37-5/8	37-5/8	37-5/8	37-5/8	37-5/8
Base, Inside	N	22	22	22	22	29-5/8	29-5/8	29-5/8	29-5/8	29-5/8
Base to Steam Outlet (15 psig only)	PL	50-1/4	50-1/4	50-1/4	50-1/4	70-1/2	70-1/2	70-1/2	70-1/2	70-1/2
Overall	OO	66	66	66	66	78-3/4	78-3/4	78-3/4	78-3/4	78-3/4
Base to Vent Outlet	O	53-1/2	53-1/2	53-1/2	53-1/2	70	70	70	70	70
Base to Steam Outlet (150 psig only)	PH	50-1/4	50-1/4	50-1/4	50-1/4	66-1/2	66-1/2	66-1/2	66-1/2	70-5/16
Height of Base	Q	8	8	8	8	12	12	12	12	12
Base to Bottom of Boiler	R	12	12	12	12	16	16	16	16	16

Table 5: Model CB Steam Boiler Dimensions (Continued)

BOILER HP	DIM	15	20	30	40	50	60	70	80	100
BOILER CONNECTIONS										
Chemical Feed	H	1	1	1	1	1	1	1	1	1
Feedwater, Right and Left	S	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Low Pressure (15 psig only) Steam Nozzle Drain, Front and Rear	U W	4 1	4 1	4 1	6 ^A 1-1/4	6 ^A 1-1/4	6 ^A 1-1/4	6 ^A 1-1/2	6 ^A 1-1/2	8 ^A 1-1/2
High Pressure (150 psig only) Surface Blowoff, Top C _L Steam Nozzle Blowdown, Front and Rear	T Y W	1 1-1/2 1	1 1-1/2 1	1 2 1	1 2 1	1 3 1-1/4	1 3 1-1/4	1 3 1-1/4	1 3 1-1/4	1 4 ^B 1-1/4
VENT STACK										
Diameter (flgd connection)	BB	6	6	8	8	10	10	12	12	12
Front Ring Flange to Vent C _L	CC	4	4	5	5	6	6	7	7	7
MINIMUM CLEARANCES										
Rear Door Swing ^C	DD	44	44	44	44	55	55	55	55	55
Front Door Swing ^C	EE	44	44	44	44	55	55	55	55	55
Tube Removal, Rear	FF	56	56	74	100	84	84	123	123	142
Tube Removal, Front	GG	46	46	64	90	74	74	113	113	132
MINIMUM BOILER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:										
Rear of Boiler	RR	163	163	199	251	231	231	309	309	347
Front of Boiler	RF	153	153	189	241	221	221	299	299	337
Thru Window or Doorway	RD	151	151	169	195	202	202	241	241	260
WEIGHT IN LBS										
Normal Water Capacity		1340	1300	1710	2290	3130	2920	4620	4460	5088
Approx. Ship Wgt - 15 psig		3000	3100	3650	4350	6900	7000	8100	8200	9000
Approx. Ship Wgt - 150 psig		3100	3200	3800	4500	7000	7200	8800	9000	9500
Approx. Ship Wgt - 200 psig		3300	3400	4100	4700	7400	7600	9300	9500	10000

NOTES:

1. Air compressor belt driven from blower motor on sizes 15 thru 40
2. Air compressor module on sizes 50 thru 100 hp.
3. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
 - A. ANSI 150 psig flange.
 - B. ANSI 300 psig flange.
 - C. 15 thru 100 hp standard hinged door.

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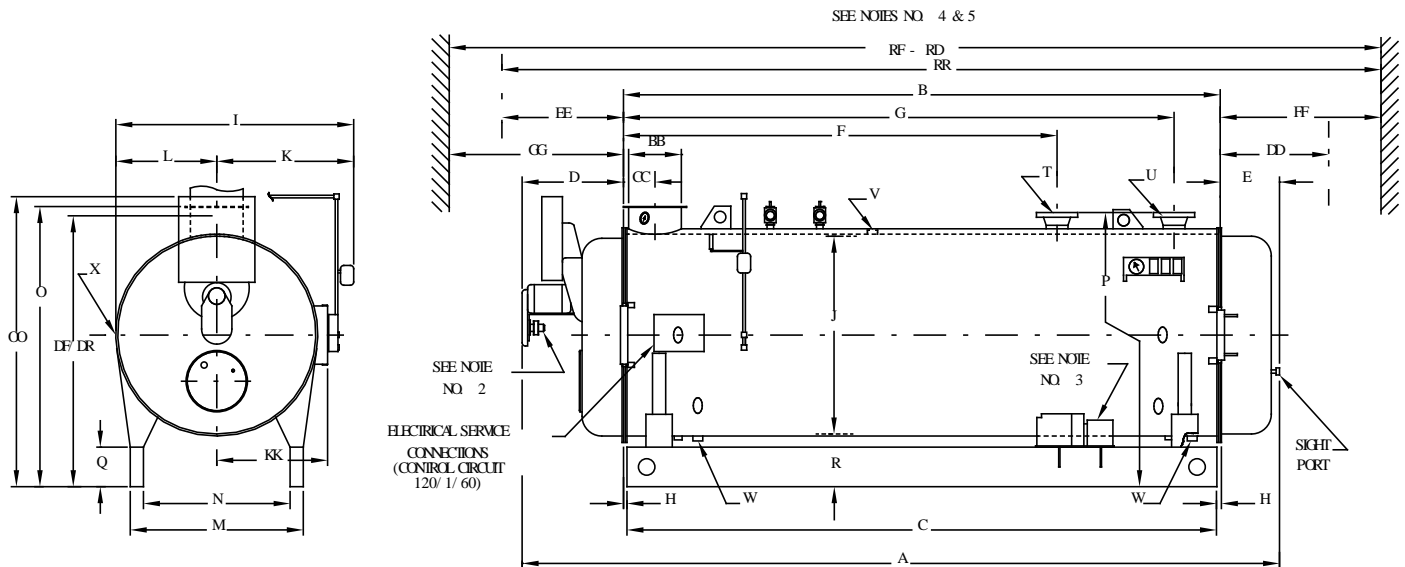


Table 6: Model CB Hot Water Boiler Dimensions (30 psig Design Pressure)

BOILER HP	DIM	15	20	30	40	50	60	70	80	100
LENGTHS										
Overall	A	97	97	114-5/8	140-5/8	129	129	168	168	187
Shell	B	62-5/8	62-5/8	80-5/8	106-5/8	92	92	131	131	150
Base Frame	C	59	59	77	103	91	91	130	130	148
Front Head Ext.	D	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Rear Head Ext.	E	15-1/2	15-1/2	15-1/2	15-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2
Front Ring Flange to Return	F	43-5/8	43-5/8	62	81	69	69	108	108	127
Front Ring Flange to Outlet	G	55-1/8	55-1/8	73-1/8	98-1/2	84-5/8	84-5/8	123-5/8	123-5/8	142-5/8
Ring Flange to Base	H	1-13/16	1-13/16	1-13/16	1-13/16	5/8	5/8	5/8	5/8	1
WIDTHS										
Overall	I	48-3/4	48-3/4	48-3/4	48-3/4	63	63	63	63	63
ID, Boiler	J	36	36	36	36	48	48	48	48	48
Center to Entrance Box	K	28-3/4	28-3/4	28-3/4	28-3/4	36	36	36	36	36
Center to Outside Hinge	KK	22	22	22	22	29	29	29	29	29
Center to Lagging	L	20	20	20	20	27	27	27	27	27
Base, Outside	M	28	28	28	28	37-5/8	37-5/8	37-5/8	37-5/8	37-5/8
Base, Inside	N	22	22	22	22	29-5/8	29-5/8	29-5/8	29-5/8	29-5/8
Overall	OO	66	66	66	66	72-5/8	72-5/8	72-5/8	72-5/8	72-5/8
Base to Vent Outlet	O	53-1/2	53-1/2	53-1/2	53-1/2	70	70	70	70	70
Base to Return and outlet	P	50	50	50	50	70-1/2	70-1/2	70-1/2	70-1/2	70-1/2
Davit (Front)	DF	-	-	-	-	-	-	-	-	-
Davit (Rear)	DR	-	-	-	-	-	-	-	-	-

Table 6: Model CB Hot Water Boiler Dimensions (30 psig Design Pressure) (Continued)

BOILER HP	DIM	15	20	30	40	50	60	70	80	100
Height of Base	Q	8	8	8	8	12	12	12	12	12
Base to bottom of boiler	R	12	12	12	12	16	16	16	16	16
BOILER CONNECTION										
Water Return ^A	T	2-1/2	2-1/2	3	3	4	4	4	4	4
Water Outlet ^A -dip tube included	U	2-1/2	2-1/2	3	3	4	4	4	4	4
Air Vent	v	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4
Drain, Front and Rear	W	1	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2
Auxiliary Connection	X	1	1	1	1	1	1	1	1	1
VENT STACK										
Diameter (flgd. connection)	BB	6	6	8	8	10	10	12	12	12
Front Ring Flange to vent C _L	CC	4	4	5	5	6	6	7	7	7
MINIMUM CLEARANCES										
Rear Door Swing	DD	44	44	44	44	55	55	55	55	55
Front Door Swing	EE	44	44	44	44	55	55	55	55	55
Tube Removal, Rear	FF	56	56	74	100	84	84	123	123	142
Tube, Removal, Front	GG	46	46	64	90	74	74	113	113	132
MINIMUM BOLER ROOM LENGTH ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:										
Rear of Boiler	RR	163	163	199	251	231	231	309	309	347
Front of Boiler	RF	153	153	189	241	221	221	299	299	337
Thru Window or Doorway	RD	151	151	169	195	202	202	241	241	260
WEIGHT IN LBS										
Water Capacity Flooded		1500	1460	1915	2585	3665	3500	5420	5250	5960
Approx. Ship. Wgt. – 30 psig		3000	3100	3650	4350	6800	7000	8000	8100	8800
Approx. Ship. Wgt. – 125 psig		3300	3400	3880	4580	7100	7300	8350	8450	9150

NOTES:

1. Accompanying dimensions and ratings while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
 2. Air compressor belt driven from blower motor on sizes 15 thru 40 hp.
 3. Air compressor module on sizes 50 thru 100 hp.
 4. 15 - 100 hp, hinged door standard.
 5. Add 370 lbs to the 80 hp ship weight for 100A and 485 lbs to the 100 hp ship weight for the 125A.
- A. 15-40 HP are threaded connection; 50-100 HP are 150# flange.

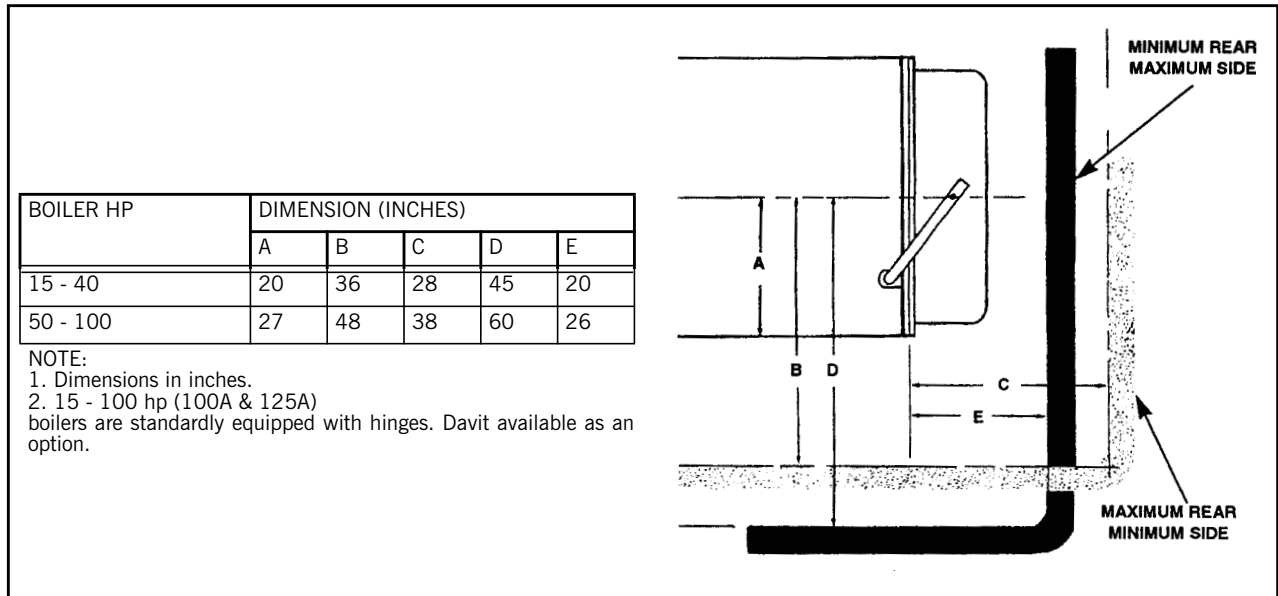


Figure 1. Space Required to Open Rear Head on Model CB Boilers Equipped with Davits

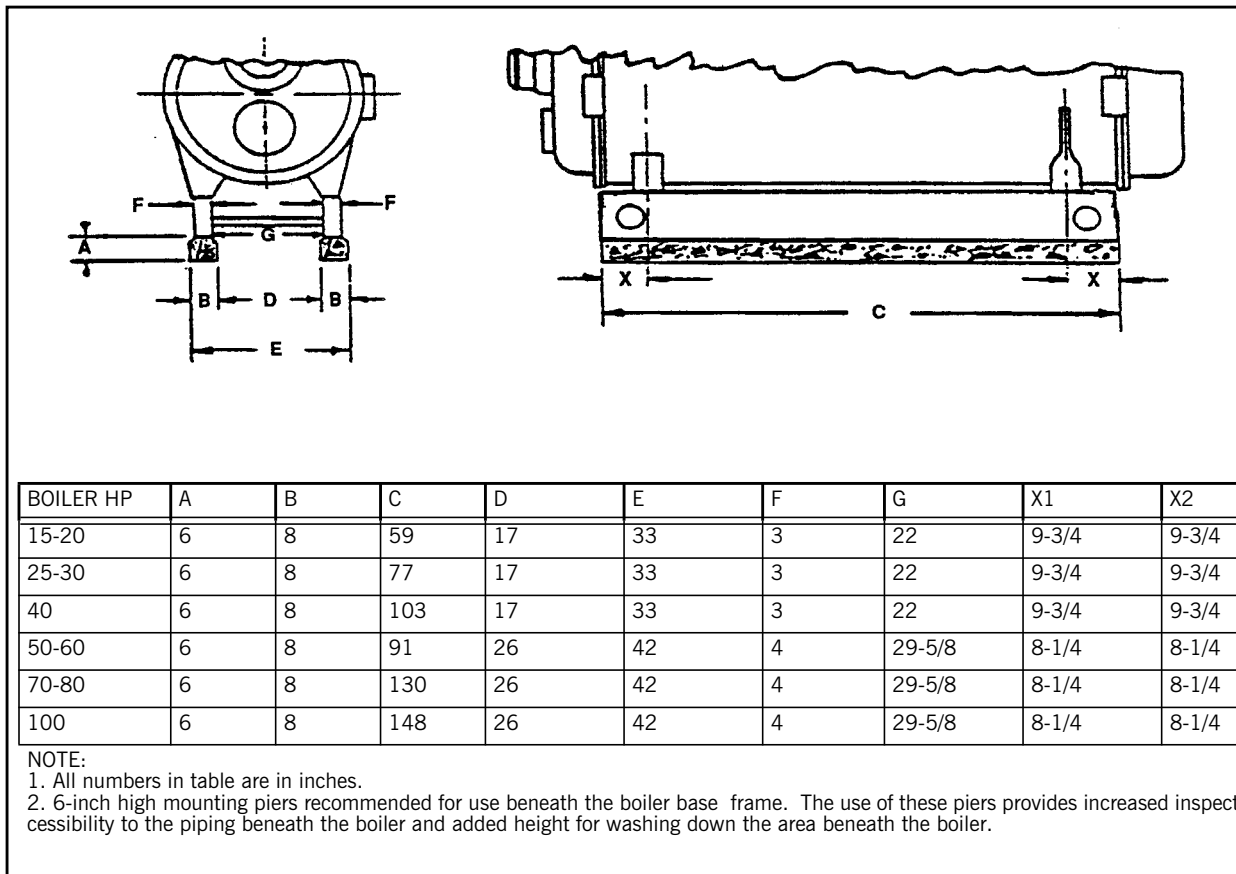
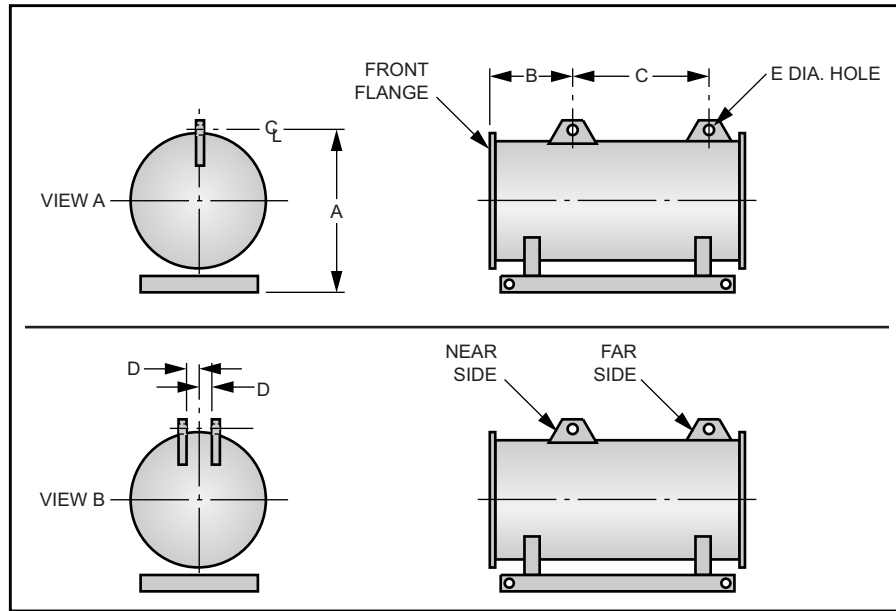


Figure 2. Model CB Boiler Mounting Piers

BOILER BOOK MODEL CB



BOILER HP		VIEW	ALL DIMENSIONS IN INCHES				
			A	B	C	D	E
15	Steam	A	51-3/4	12	38-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	38-3/4	6	2-1/2
20	Steam	A	51-3/4	12	38-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	38-3/4	6	2-1/2
25	Steam	A	51-3/4	12	56-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	56-3/4	6	2-1/2
30	Steam	A	51-3/4	12	56-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	56-3/4	6	2-1/2
40	Steam	A	51-3/4	12	82-3/4	-	2-1/2
	Hot Water	B	50-1/2	12	82-3/4	6	2-1/2
50	All	B	68	18	57	10	2-1/2
60	All	B	68	18	57	10	2-1/2
70	All	B	68	27	67	10	2-1/2
80	All	B	68	27	67	10	2-1/2
100	All	B	68	27	86	10	2-1/2

NOTE:

1. A, B and C Dimensions may vary by 1/2 inch.
2. BHP followed by "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in upper portion of vessel.

Figure 3. Lifting Lug Locations, Model CB Boilers

PERFORMANCE DATA

Efficiency

Tables 7 through 9 show predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks Model CB Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

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

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in the tables listed above) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, 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.

When specifying the efficiencies in the tables, be sure to include the specific guarantee conditions to maximize the effectiveness of your efficiency specification. If you have any questions regarding the efficiency specifications, please contact your local Cleaver-Brooks authorized representative. For efficiencies and stack temperatures at operating pressures not listed, follow these procedures:

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

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

Example:

Boiler: 100 hp.

Fuel: natural gas.

Operating steam pressure: 200 psig.

Find the fuel-to-steam efficiency at 100% firing rate. For a 100 hp boiler operating at 100% firing rate and an operating steam pressure of 125 psig, the efficiency is 88.0%.

Using Figure 4, note that the stack temperature increases 36 °F at the higher operating pressure. To estimate boiler efficiency, use this rule of thumb: For every 40 °F increase in stack temperature, efficiency decreases by 1%. Since the stack temperature rise is 36 °F, the decrease in the boiler efficiency at 200 psig operating pressure is calculated as follows: $36/40 = .9\%$. Therefore, the boiler efficiency at 200 psig operating pressure is $88.5 - .9 = 87.6\%$.

Emissions

The emission data included in this section consists of typical uncontrolled emission levels for Cleaver-Brooks Model CB Firetube Boilers.

The data shown here represent typical emission levels only. Guaranteed emission levels are available from your local Cleaver-Brooks authorized representative.

Table 7: Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - Natural Gas

BOILER HP	10 psig				125 psig			
	FIRING RATE (%)				FIRING RATE (%)			
	25	50	75	100	25	50	75	100
50	83.0	83.2	82.9	82.4	80.2	80.5	80.4	80.1
60	82.9	83.1	82.7	82.3	80.1	80.4	80.3	80.1
70	84.5	84.7	84.3	83.9	81.7	82.0	81.9	81.7
80	84.6	84.8	84.5	84.0	81.8	82.1	82.0	81.8
100	84.4	85.0	84.8	84.4	81.5	82.4	82.3	82.2

Table 8: Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - No. 2 Oil

BOILER HP	10 psig				125 psig			
	FIRING RATE (%)				FIRING RATE (%)			
	25	50	75	100	25	50	75	100
50	86.5	86.7	86.3	85.8	83.6	84.0	83.8	83.5
60	86.3	86.6	86.2	85.7	83.5	83.8	83.7	83.5
70	87.9	88.2	87.8	87.3	85.1	85.4	85.3	85.1
80	88.1	88.3	87.9	87.4	85.2	85.6	85.4	85.3
100	87.8	88.4	88.1	87.7	84.8	85.7	85.6	85.5

Table 9: Predicted Fuel-to-Steam Efficiencies (%), Model CB Boilers - No. 6 Oil

BOILER HP	FIRING RATE (%)				FIRING RATE (%)			
	25	50	75	100	25	50	75	100
	50	86.8	87.0	86.6	86.1	83.9	84.2	84.0
60	86.7	86.9	86.5	86.0	83.8	84.1	83.9	83.8
70	88.4	88.6	88.2	87.7	85.5	85.8	85.6	85.4
80	88.5	88.7	88.3	87.8	85.6	85.9	85.7	85.6
100	88.2	88.5	88.3	88.0	84.6	85.8	85.9	85.8

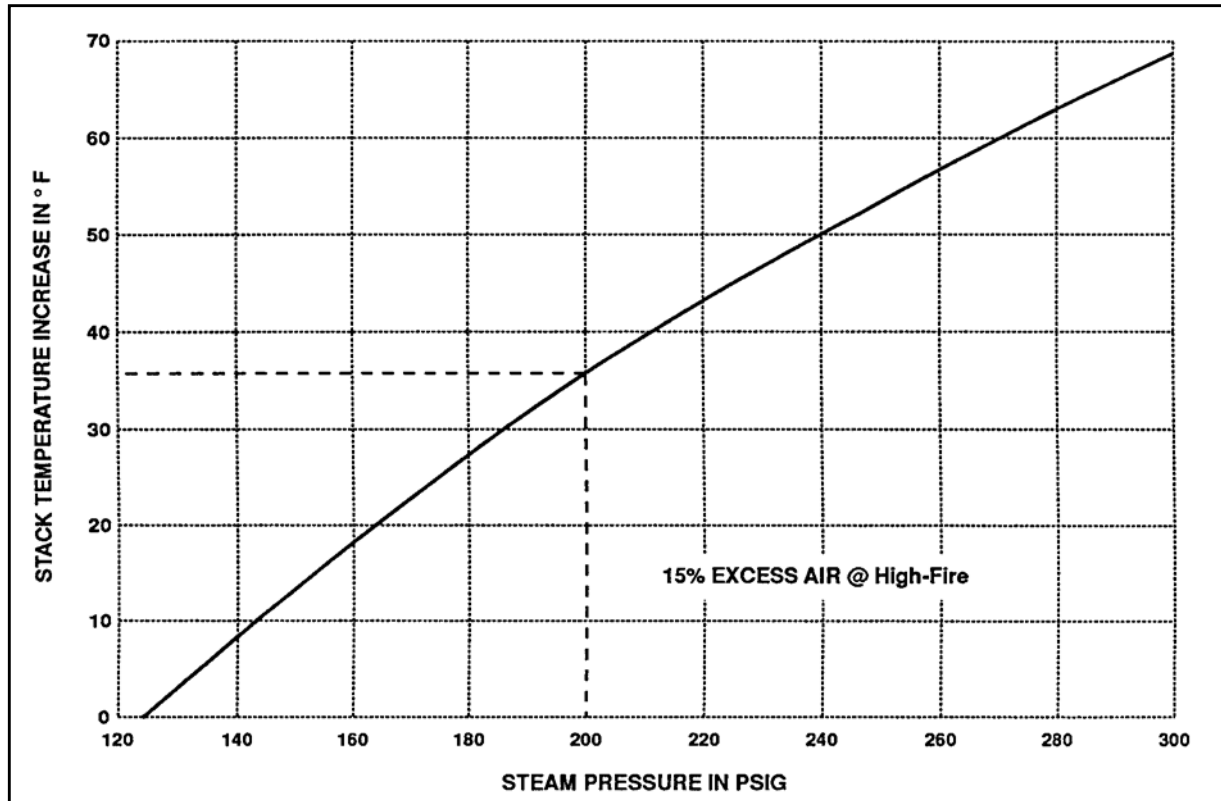


Figure 4. Predicted Stack Temperature Increase for Pressure Greater Than 125 psig

Table 10: Model CB Boiler Emission Data

POLLUTANT		ESTIMATED LEVELS - UNCONTROLLED		
		NATURAL GAS	NO. 2 OIL ^B	NO. 6 OIL ^C
CO	ppm ^A	200	90	95
	Lb/MMBtu	0.15	0.07	0.075
NOx	ppm ^A	100	185	502
	Lb/MMBtu	0.12	0.25	0.67
SOx	ppm ^A	1	278	278
	Lb/MMbtu	0.001	0.52	0.52
HC/VOCs	ppm ^A	40	50	70
	Lb/MMBtu	0.016	0.025	0.035
PM	ppm ^A	-	-	-
	Lb/MMBtu	0.01	0.025	0.160

NOTES:

Refer to Section E for detailed emission information.

A. ppm levels corrected to 3% O₂, dry basis.

B. Based on fuel constituent levels of:

Fuel-bound nitrogen content = 0.015% by weight

Sulfur content = 0.5% by weight

Ash content = 0.01% by weight

C. Based on fuel constituent levels of:

Fuel-bound nitrogen content = 0.7% by weight

Sulfur content = 0.5% by weight

Ash content = 0.1% by weight

Conradson carbon residue = 16% by weight

Table 11: Heating Surface, Model CB Boilers

BOILER HP	HEATING SURFACE (SQ-FT)	
	FIRESIDE	WATERSIDE
15	75	85
20	100	109
25	125	144
30	150	162
40	200	219
50	250	266
60	300	323
70	350	388
80	400	441
100	500	544

ENGINEERING DATA

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

Blowdown Water Requirements

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

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

Sound Level

Table 16 summarizes predicted sound pressure levels for Model CB Boilers. Tables 17 and 18 give detailed octave band sound pressure levels for each boiler. These values are based on standard motors. Optional motor types and altitude conditions can increase sound levels.

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

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

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

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

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

Octave Band

When predicting sound pressures in octave bands (e.g., dB at 125 Hz), even greater variations between boilers, between sound meters, and between operators can be expected. These larger variations in the low and high frequencies make octave band levels a less reliable method of reporting than A-scale sound levels. (Since A-scale sound levels are dominated by mid-frequency sounds, the A-scale sound levels between two boilers can be in reasonable agreement even though the low and high frequencies of octave band measurement do not closely correspond).

Table 12: Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA, SQ-IN	
	HIGH PRESSURE ^A	LOW PRESSURE ^B	HIGH PRESSURE ^A	LOW PRESSURE ^B
15	2.9	5.9	1356	1637
20	2.9	5.9	1356	1637
25 & 30	3.9	7.9	1817	2195
40	5.3	10.8	2485	2999
50	9.7	16.0	2959	3372
60	9.7	16.0	2959	3372
70	14.3	23.7	4367	4975
80	14.3	23.7	4367	4975
100	16.6	27.4	5053	5757

NOTE: Based on normal water level.
 A. Based on 150 psig design pressure.
 B. Based on 15 psig design pressure.

Table 13: Water Circulation Rate and Temperature Drop for Hot Water Boiler

BOILER HP	BOILER OUTPUT (1000) BTU/HR	SYSTEM TEMPERATURE DROP - DEGREES F									
		10	20	30	40	50	60	70	80	90	100
		MAXIMUM CIRCULATING RATE - GPM									
15	500	100	50	33	25	20	17	14	12	11	10
20	670	134	67	45	33	27	22	19	17	15	13
30	1005	200	100	67	50	40	33	29	25	22	20
40	1340	268	134	89	67	54	45	38	33	30	27
50	1675	335	168	112	84	67	56	48	42	37	33
60	2010	402	201	134	101	80	67	58	50	45	40
70	2345	470	235	157	118	94	78	67	59	52	47
80	2680	536	268	179	134	107	90	77	67	60	54
100	3350	670	335	223	168	134	112	96	84	75	67

NOTES: 1. Minimum recommended return water temperature is 150 °F. Minimum recommended outlet temperature for Model CB Hot Water Boilers is 170 °F. Contact your local Cleaver-Brooks authorized representative for special hot water application information.

Table 14: Recommended Steam Nozzle Size (To Maintain 4000 to 5000 fpm Nozzle Velocity)

OPERATING PRESSURE PSIG	BOILER HP									
	15	20	25	30	40	50	60	70	80	100
15	4	4	4	4	6	6	6	6	6	8
30	2	2	2.5	2.5	3	4	4	4	4	6
40	2	2	2.5	2.5	3	3	4	4	4	6
50	1.5	2	2	2.5	2.5	3	3	4	4	4
75	1.5	2	2	2	2.5	3	3	3	4	4
100	1.5	1.5	2	2	2	3	3	3	3	4
125	1.5	1.5	2	2	2	3	3	3	3	4
150	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5
200	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5
250	1.5	1.5	2	2	2	2	2	2	2	2

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity. Spool pieces (300 lb flanges) are available in the following sizes (in inches): 3x2-1/2x30, 4x3x30, 6x4x36, 8x6x48, 10x8x48, and 12x8x48.
3. All standard steam nozzle sizes for 150 psig design pressure or greater are the same as 125 psig operating pressure on the above table. To increase or decrease the standard size, request the change with your local Cleaver-Brooks authorized representative.

Table 15: Blowdown Tank Sizing

BOILER HP	WATER (GAL.)
15-20	26
25-30	34
40	47
50-60	55
70-80	80
100	93

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

Table 16: Sound Pressure Level Summary (50-100 hp)

BOILER HP	50	60	70	80	100
HFO, dBA	79	79	79	79	81
LFO, dBA	78	78	78	78	79
HFG, dBA	77	77	78	78	78
LFG, dBA	72	73	74	75	75

NOTES:

1. Boiler No. followed by an "a" designates hot water boilers furnished in a smaller vessel size with additional tubes in the upper portion of the vessel.
2. Sound Pressure levels measured on boilers operating in various locations and expressed in dBA are as follows:

Table 16: Model CB Boiler Sound Pressure Level Details (40 hp)

FIRING RATE FUEL	SOUND LEVEL dBA	OCTAVE BAND SOUND PRESSURE LEVELS IN dB RE .0002 MICROBAR									
		31Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	16kHz
40HP ^A											
LFG	76	73	75	72	74	76	70	67	68	64	57
LFO	77	73	75	75	76	75	72	67	66	66	58
HFG	79	81	78	74	80	78	71	69	68	64	58
HFO	79	72	77	77	81	78	73	69	66	66	58

NOTE:
ABBREVIATIONS:
HF = High Fire

LF = Low Fire
O = Oil
G = Gas

A. The data shown above was taken on the 40 hp. Since the highest Sound Level is below 80 dBA, no additional 36" diameter Firetubes were tested. If Sound Level predictions are required for the 15 thru 30 hp, use the values shown for the 40 hp.

Table 17: Model CB Boiler Sound Pressure Level Details (50 - 100 hp)

FIRING RATE FUEL	SOUND LEVEL dBA	OCTAVE BAND SOUND PRESSURE LEVELS IN dB RE .0002 MICROBAR									
		31Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	16kHz
50 HP											
LFG	72	71	65	71	71	70	68	63	60	53	46
LFO	78	71	76	78	73	72	72	76	61	56	54
HFG	77	72	68	75	76	74	74	66	61	54	47
HFO	79	72	70	75	75	77	77	70	63	56	54
60 HP											
LFG	73	70	75	72	72	73	68	61	56	50	45
LFO	78	68	77	74	74	75	74	71	58	53	48
HFG	77	73	75	72	72	75	76	63	55	50	44
HFO	79	75	75	75	75	77	77	72	59	52	45
70 HP											
LFG	74	70	70	75	74	73	71	62	56	51	46
LFO	78	70	73	77	74	75	74	70	59	53	57
HFG	78	72	72	77	78	75	76	68	58	52	57
HFO	79	73	73	80	77	77	76	70	60	54	48
80 HP											
LFG	75	70	75	75	73	75	76	66	62	62	53
LFO	78	69	77	76	74	76	74	73	63	62	57
HFG	78	72	74	78	75	75	76	57	61	59	52
HFO	79	75	75	75	74	76	75	69	62	59	54
100 HP											
LFG	75	69	69	75	76	73	71	65	63	59	50
LFO	79	68	73	78	78	75	79	76	63	59	54
HFG	78	69	70	77	77	74	74	69	63	59	50
HFO	81	68	70	77	78	78	77	71	64	59	57

NOTES:

1. ABBREVIATIONS:

HF = High Fire

LF = Low Fire

O = Oil

G = Gas

2. Boiler HP followed by an "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in the upper portion of the vessel.

Gas-Fired Burners

Table 18 shows minimum gas pressure requirements for Model CB Boilers.

Table 19 shows minimum required gas pressure altitude conversion.

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

Figure 5 shows standard gas train sizes and locations for Model CB Firetube Boilers.

Figure 6 shows typical gas train piping layouts for multiple boiler applications.

Figure 7 shows gas train components.

Oil-Fired Burners

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

Figure 8 shows the oil connection sizes and locations for Model CB Boilers firing No. 2 oil.

Figure 9 shows the oil connection sizes and locations for Model CB Boilers firing No. 6 oil.

Figures 10 and 11 show typical oil systems and layouts.

Figure 12 shows the detail of an oil transfer tank (day tank) typically utilized to provide a storage reservoir between the oil system supply pump and the boiler oil pump.

No. 6 Oil Piping, Storage Tank Heating

If the oil viscosity exceeds 4,000 SSU at the pumping temperature, tank preheating is required.

Based on the climate conditions for the job location, the minimum pumping temperature can be predicted, and the viscosity for the particular oil at this pumping temperature can be determined.

It is recommended to provide for tank and/or line heating on all No. 6 oil installations to ensure against high viscosities at decreased pumping temperatures. The following are two common methods:

1. Provide a tank suction heater and bundling the steam or water lines to the heater with the oil lines.
2. Provide electric heating equipment on the oil lines and/or in the storage tank.

The temperature in the oil suction line should not exceed 130 °F as higher temperatures could cause vapor binding of the oil pump and decreased oil flow.

Table 18: Minimum required gas pressure at entrance to gas train

Boiler Hp	Train Size	Gas Supply Pressure Less Than 27" W.C.		Gas Supply Pressure Up To 10 Psi	
		Regulator Model*	Min. Supply Press "W.C.	Regulator Model*	Min. Supply Press "W.C.
15	1-1/4	Maxitrol 1-1/4", RV-61	4	Maxitrol 1-1/4", 210-D	4
20	1-1/4	Maxitrol 1-1/4", RV-61	7	Maxitrol 1-1/4", 210-D	7
30	1-1/2	Maxitrol 1-1/2", RV-81	6	Maxitrol 1-1/2", 210-D	7
40	1-1/2	Maxitrol 1-1/2", RV-81	9	Maxitrol 1-1/2", 210-D	10
50	2	Maxitrol 2", RV-91	6	Maxitrol 2", 210-E	7
60	2	Maxitrol 2", RV-91	7	Maxitrol 2", 210-E	8
70	2	Maxitrol 2", RV-91	10	Maxitrol 2", 210-E	11
80	2	Maxitrol 2", RV-91	12	Maxitrol 2", 210-E	14
100	2	Maxitrol 2", RV-91	12	Maxitrol 2", 210-E	15

*Maxitrol RV series is standard; 210 series is optional

Table 19: Minimum required gas pressure altitude conversion

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

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:
 Inches WC x 0.577 = oz/sq-in.
 Oz/sq-in x 1.732 = Inches WC.
 Inches WC x 0.0361 = psig.
 Oz/sq-in x 0.0625 = psig.
 Psig x 27.71 = Inches WC.
 Psig x 16.0 = Oz/sq-in.

Table 20: Maximum Gas Consumption (CFH) for Natural Gas and Propane Vapor

BOILER HP	TYPE OF GAS AND HEAT CONTENT	
	NATURAL GAS 1000 (Btu/cu-ft)	PROPANE GAS 2550 (Btu/cu-ft)
15	625	245
20	835	330
25	1045	410
30	1255	490
40	1675	655
50	2095	820
60	2510	985
70	2930	1150
80	3350	1315
100	4185	1640

NOTES:
BHP followed by "A" designates hot water boilers furnished in a smaller vessel size with additional tubes in upper portion of vessel.

Approximate Gas Usage:

1. Multiply the CFH rate by 0.007 to obtain the number of cu.ft of gas used in 25 sec. (Length of (1) light off).
2. Multiply the number of cu. ft/light (item 1) by the estimated number of lights/hour or per day to obtain the approximate usage in cu.ft/hour or cu.ft/day.

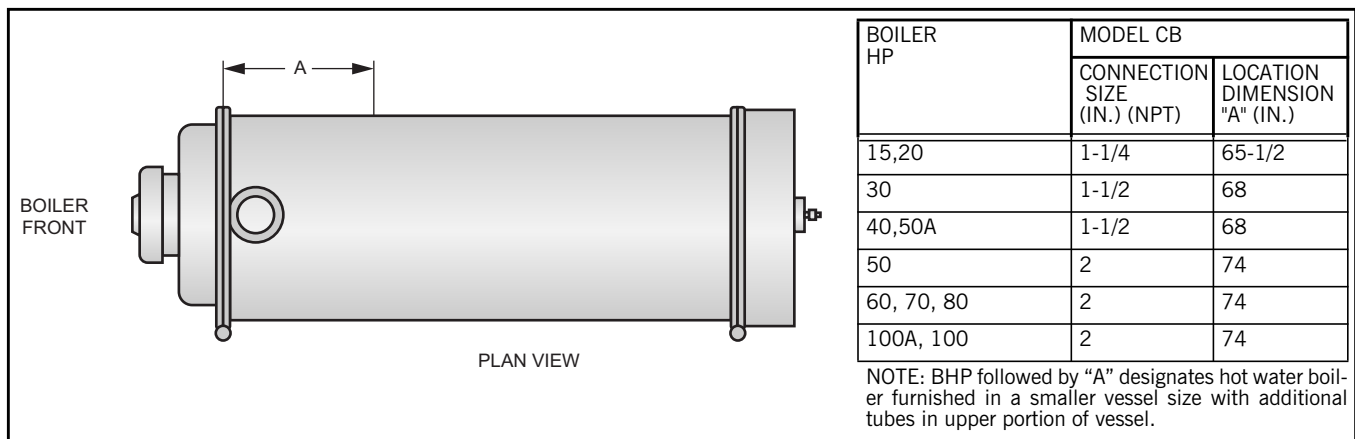


Figure 5. Standard Gas Train Connection Size and Location

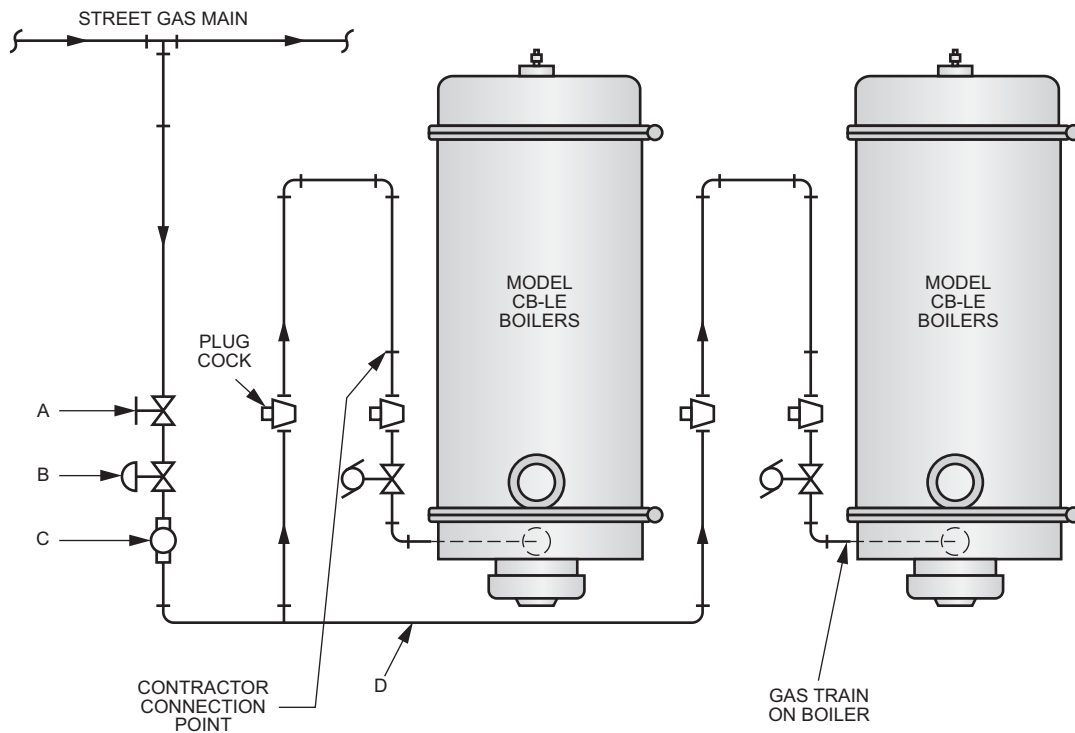


Figure 6. Typical Gas Piping Layout

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.

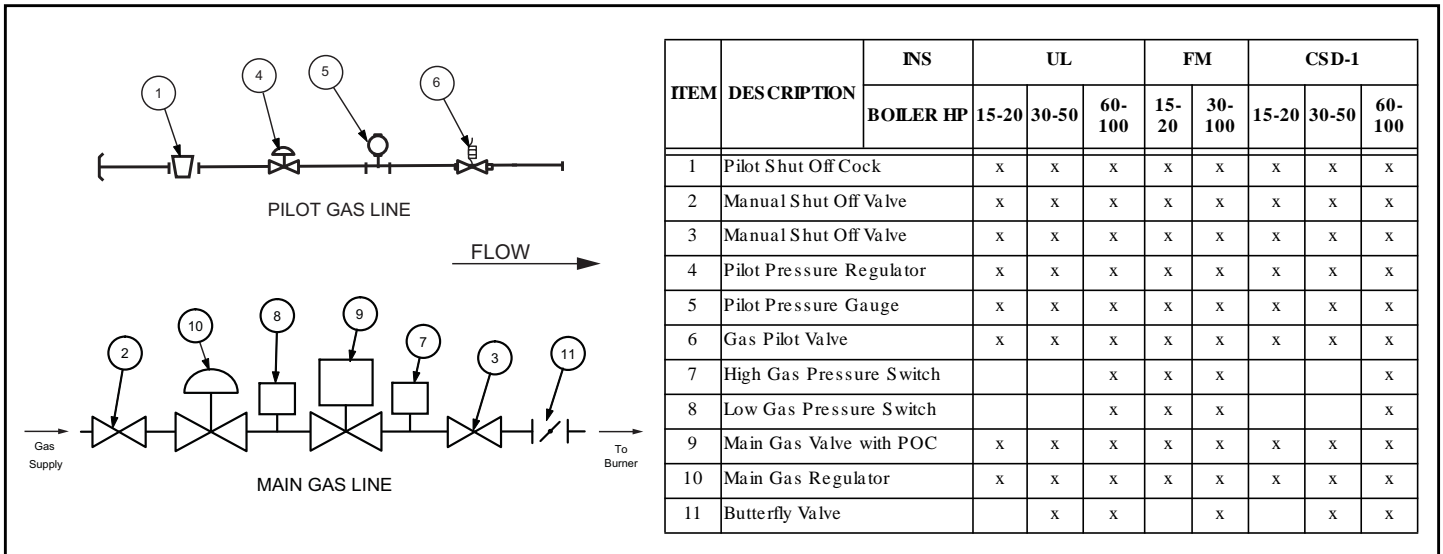


Figure 7. Model CB Gas Train Components

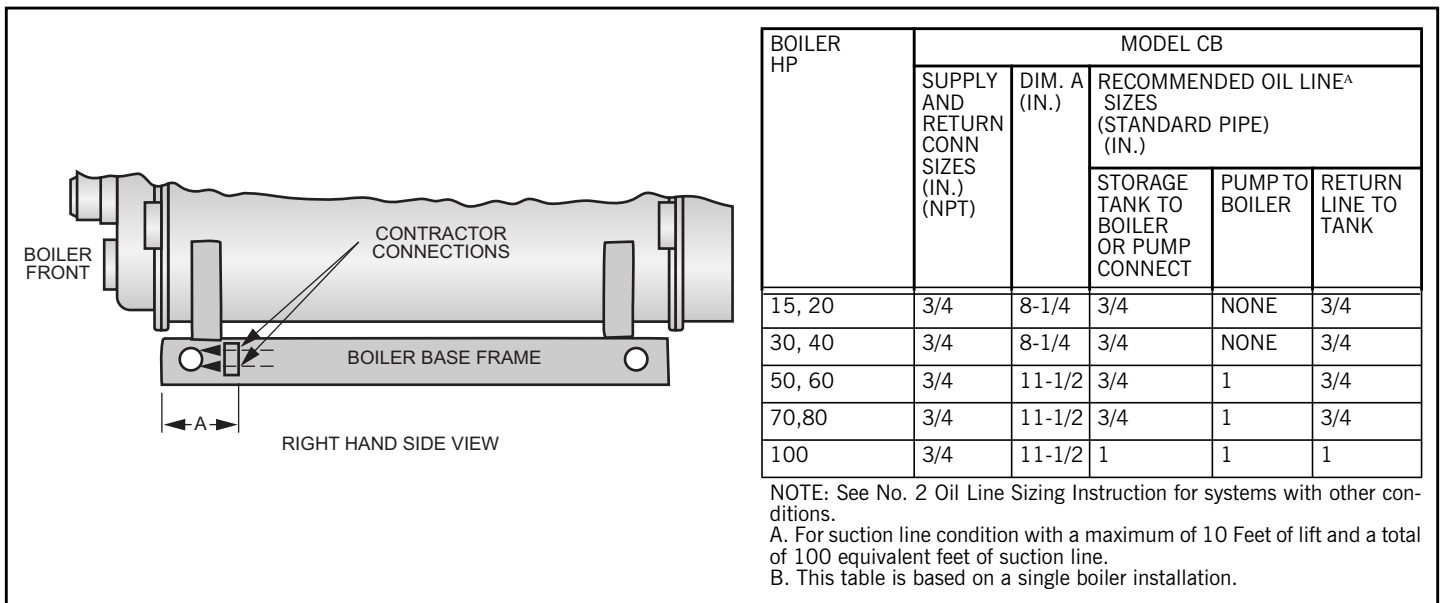


Figure 8. No. 2 Oil Connection Size, Location and Recommended Line Sizes

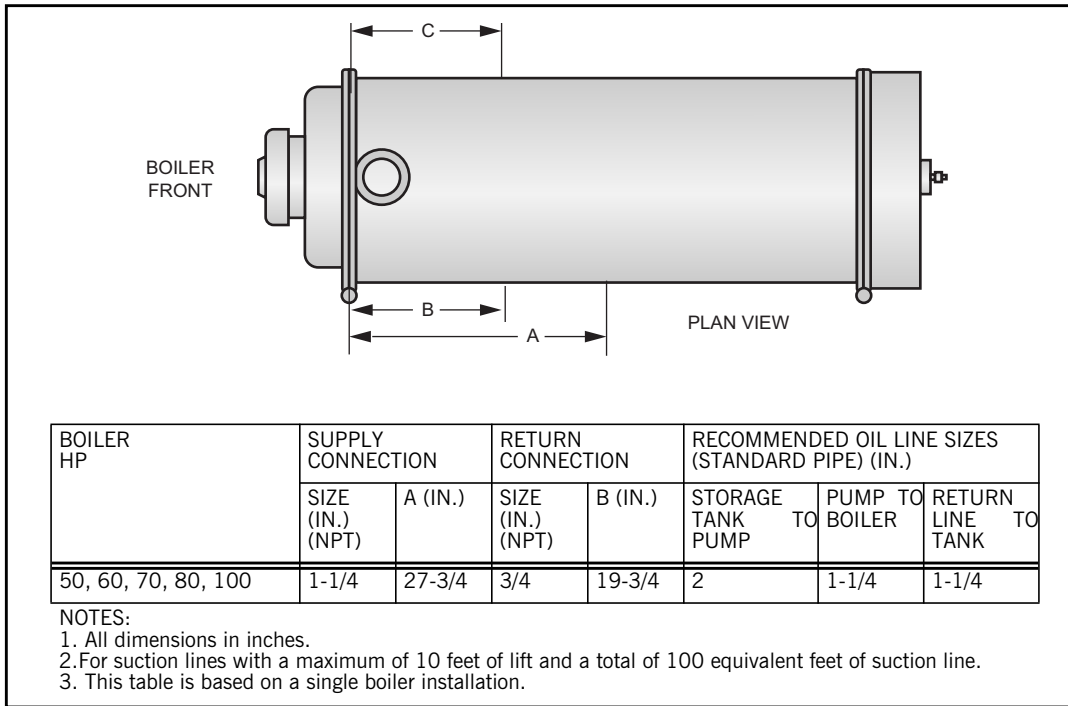


Figure 9. No. 6 Oil Connection Size, Location and Recommended Line Sizes, Model CB Boiler

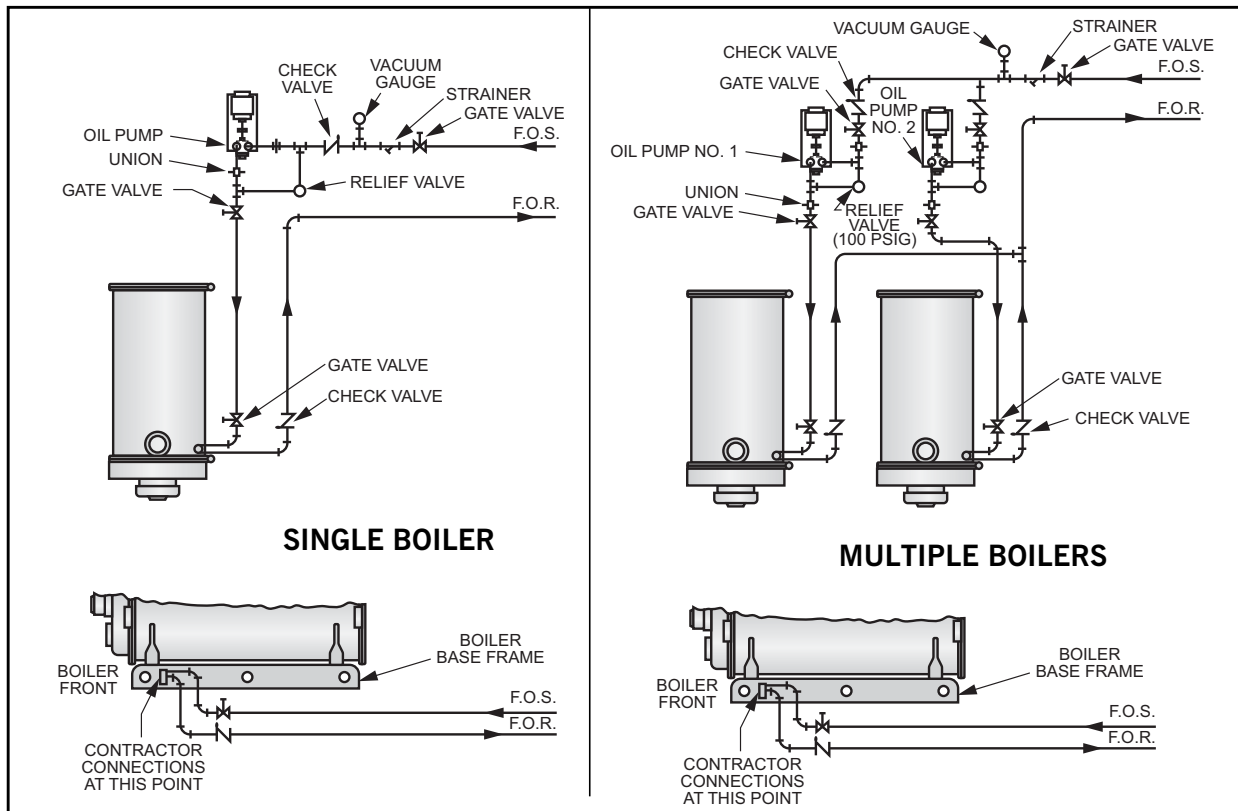


Figure 10. No. 2 Oil Piping, Remote Oil Pump

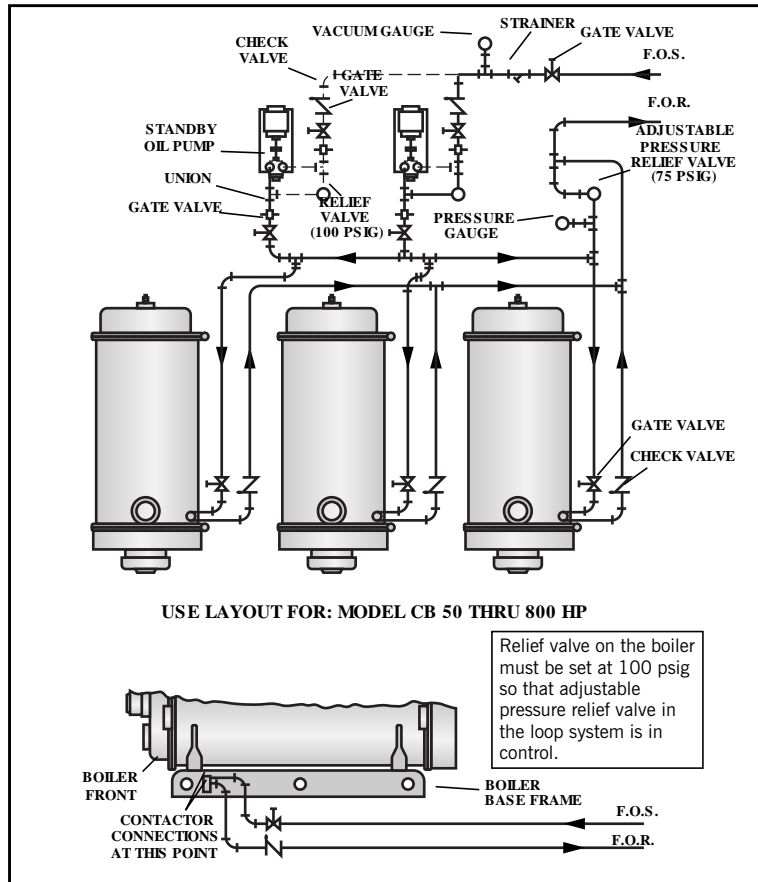


Figure 11. No. 2 Oil Piping, Multiple Boiler Installation

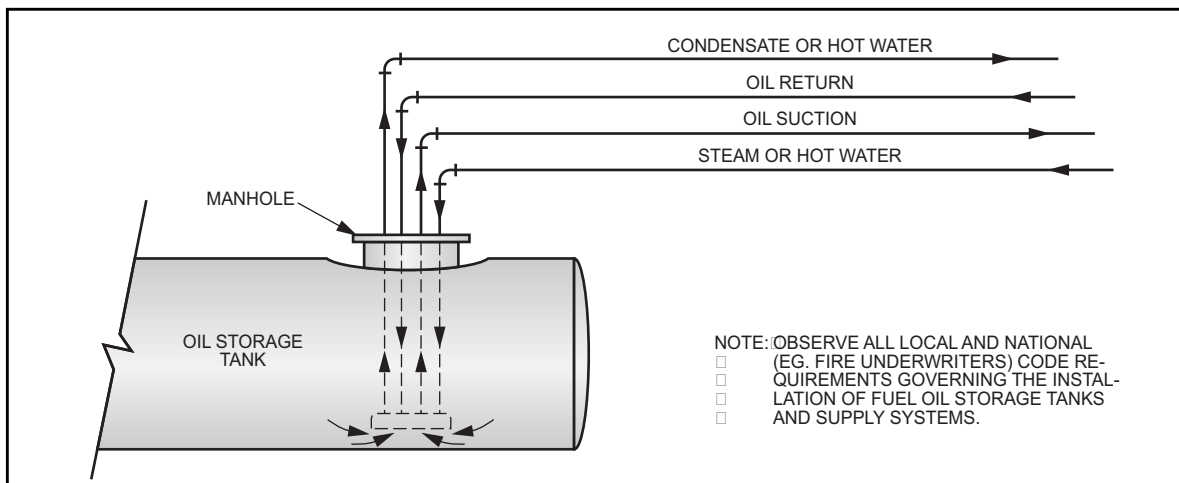


Figure 12. Typical Fuel Storage Tank Arrangement

Boiler Room Information

Figure 13 shows typical boiler room length requirements.

Figure 14 shows typical boiler room width requirements.

Figure 15 shows typical breeching arrangements.

Stack Support Capabilities

Cleaver-Brooks Firetube Boilers 15 hp through 100 hp can support up to 1,000 lbs without additional support.

Firetube boilers 125 hp through 800 hp can support up to 2,000 lbs without additional support.

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

Stack/Breeching Size Criteria

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

Although constant pressure at the flue gas outlet of the Model CB is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. For boiler sizes 50 – 800 horsepower, the allowable pressure range is –0.5" W.C. to +0.5" W.C. The maximum pressure variation at any firing rate for the boiler is 0.5" W.C. For boiler sizes 15 – 40 horsepower, the allowable pressure range is –0.25" W.C. to +0.25" W.C.

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

Boiler Room Combustion Air

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

1. Size (area) and location of air supply openings in boiler room.
 - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
 - B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging by dust or dirt.
 - C. A vent fan in the boiler room is not recommended, as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsatisfactory burner performance.
 - D. Under no condition should the total area of the air supply openings be less than (1) square foot.
 - E. Size the openings by using the formula:

Area (sq-ft) = cfm/fpm

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

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

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

Consult local codes, which may supersede these requirements.

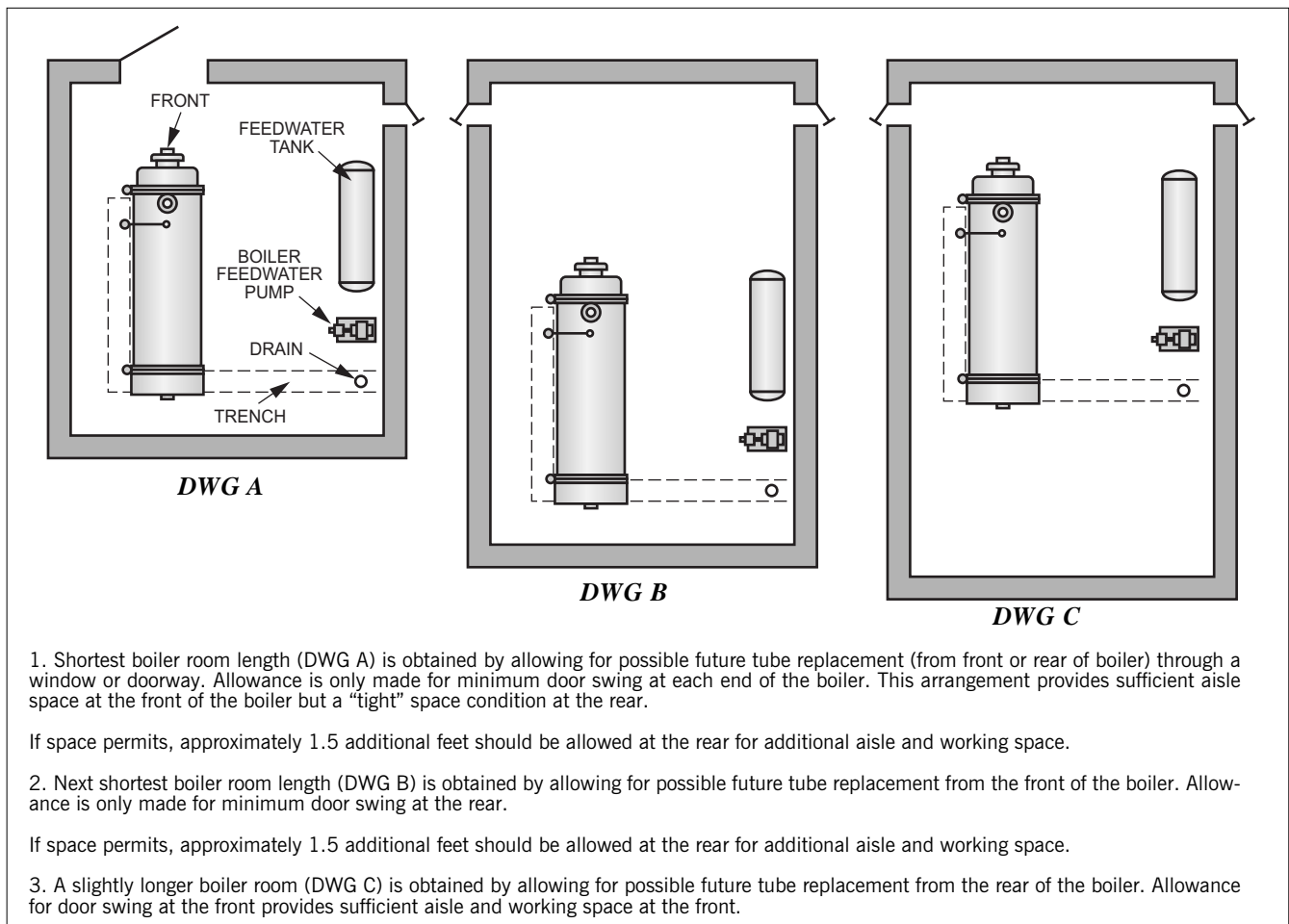


Figure 13. Boiler Room Length (Typical Layout)

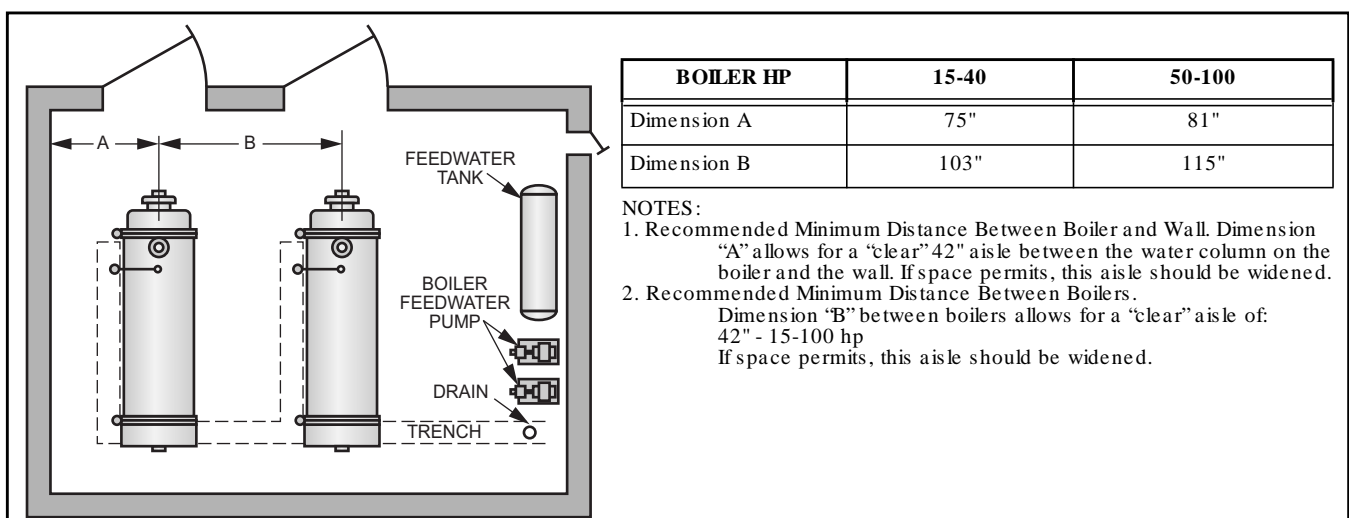


Figure 14. Boiler Room Width (Typical Layout)

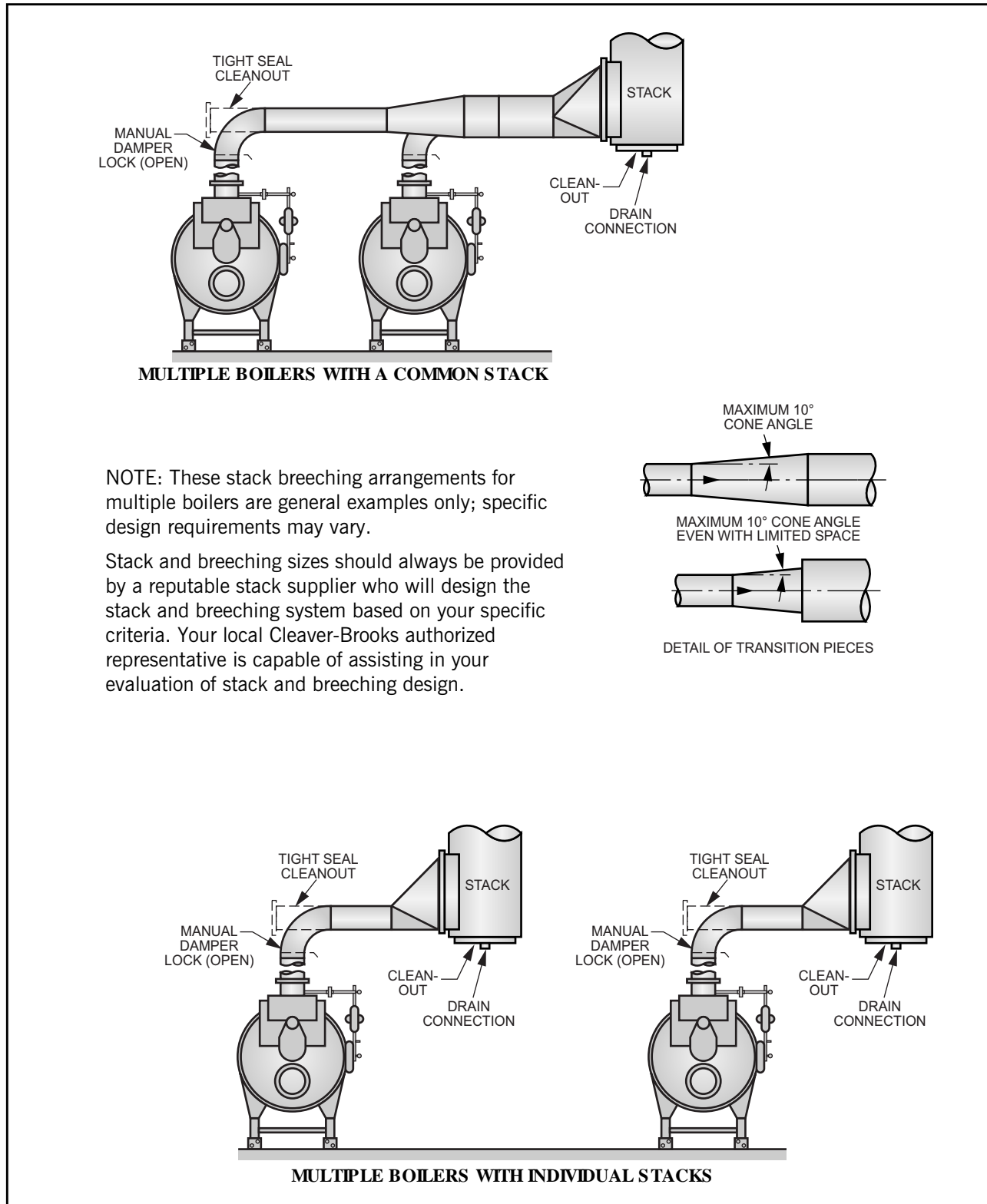


Figure 15. Breaching Arrangement, Multiple Boilers



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