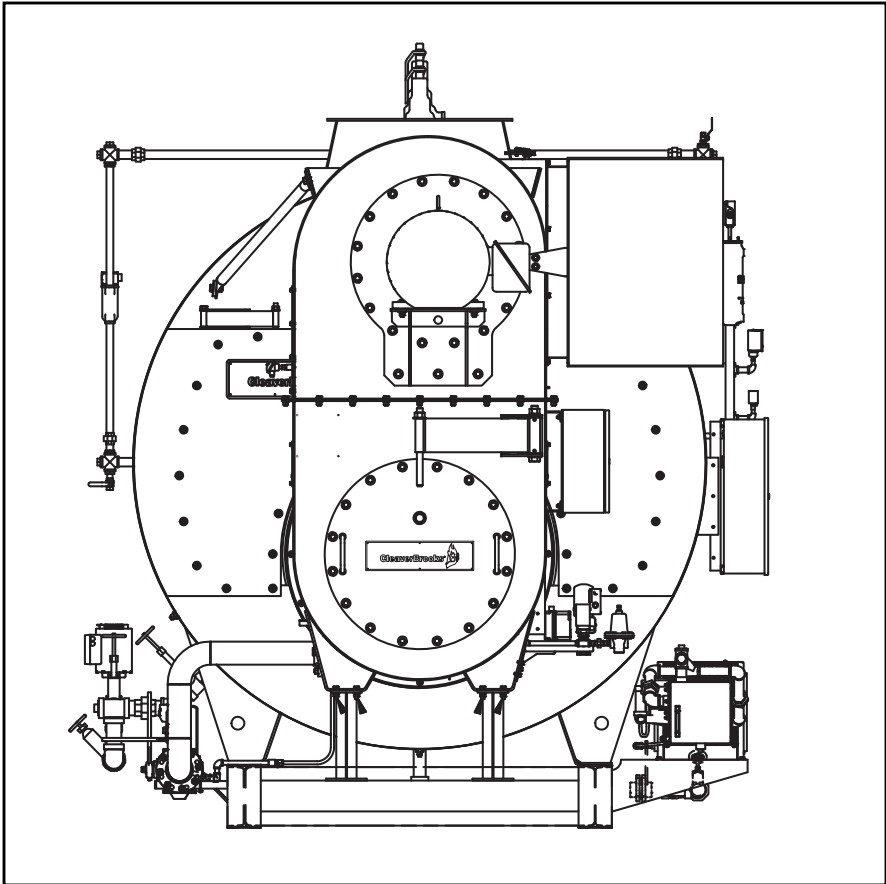


CBEX PREMIUM



900-1200 HP

Boiler Book
03/2018



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FEATURES AND BENEFITS

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

Two Pass Design:

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

Front and Rear Access:

- Davited front doors, all sizes.
- Provides access to front tube sheet and tubes.
- Large rear access plug for turnaround, tubes, and furnace access.

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

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

PRODUCT OFFERING

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

- 900-1200 hp.
- Two pass wetback design.
- Full modulation, all sizes.

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

- Boiler Options:
 - Additional screwed or flanged tappings.
 - Blowdown valves.
 - Non-return valves.
 - Feedwater valves and regulators.
 - Surface blowdown systems.
 - Surge load baffles.
 - Seismic design.
- Burner/Control Options:
 - Flame safeguard controllers.
 - Lead/lag system.
 - Special insurance and code requirements (e.g., FM, NFPA-85).
 - Alarm bell/silence switch.
 - Special motor requirements (TEFC, high efficiency).
 - Special indicating lights.
 - Main disconnect.
 - Elapsed time meter.
 - NEMA enclosures.
 - Remote emergency shut-off (115V).

Circuit breakers.
Day/night controls.
Special power requirements.
Low NOx Equipment.

- Fuel Options:
 - Gas strainer.
 - Gas pressure gauge.
 - Future gas conversion.
 - Oversized/undersized gas trains.
 - Optional Oil Pumps.

DIMENSIONS AND RATINGS

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

- Table 1 - CBEX Premium Steam Boiler Ratings
- Figure 1, Table 2 - CBEX Premium Steam Boiler Dimensions 900-1200 HP

Table 1: CBEX Premium 900-1200 Ratings

BOILER H.P.	900	1000	1100	1200
Burner Model (Standard)	XL-1	XL-1	XL-1	XL-1
Burner Model (30 ppm)	LNXL-1	LNXL-1	LNXL-1	LNXL-1
RATINGS - SEA LEVEL TO 700 FT.				
Rated Capacity (lbs-steam/hr from and at 212 OF)	31050	34500	37950	41400
Btu Output (1000 Btu/hr)	30128	33475	36823	40170
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY				
Light Oil gph (140,000 Btu/gal)	269.0	298.9	328.8	358.7
Gas CFH (1000 Btu)	37659	41844	46028	50213
Gas (Therm/hr)	376.6	418.4	460.3	502.1
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)				
Blower Motor hp (Standard) ^A	30	40	50	60
Blower Motor hp (30 ppm) ^A	40	50	60	75
Circulating Oil Pump Motor hp ^B	1 1/2	1 1/2	1 1/2	1 1/2
Oil Metering Pump Motor hp ^B	n/a	n/a	n/a	n/a
Air Compressor Motor hp ^B	15	15	40	40
BOILER DATA				
Heating Surface sq-ft. (Fireside)	2810	2810	2955	2955

NOTES:

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

B. Required for #2 Oil Firing.

C. All fractional hp motors will be single phase voltage except oil metering pump motors which are three phase. Integral hp motors will be three phase voltage.

Figure 1. Dimension Diagram, CBEX Premium 900-1200 HP

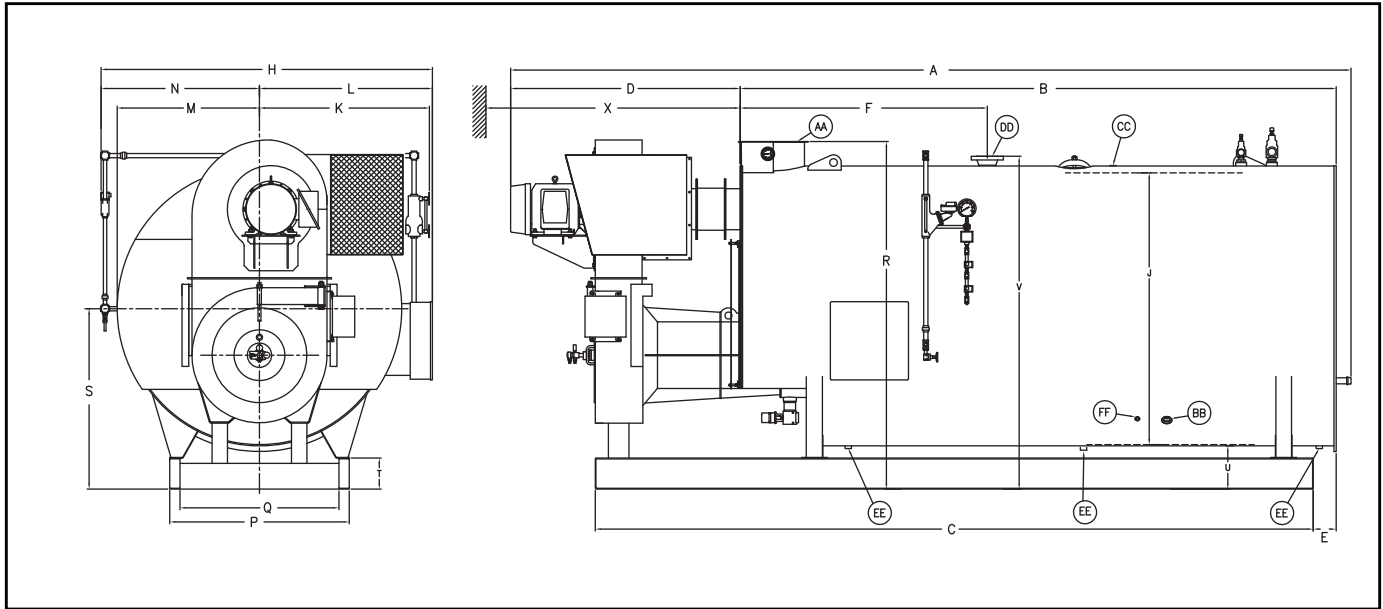


Table 2: CBEX Premium 900-1200 Dimensions

BOILER H.P.	DIM	900	1000	1100	1200
LENGTHS					
Overall Length	A	354	354	364	364
Shell	B	256	256	266	266
Base Frame	C	305.5	305.5	315.5	315.5
Burner Extension	D	92	92	92	92
Rear Ring Flange to Base	E	11.25	11.25	11.25	11.25
Shell Flange to Steam Nozzle	F	134	134	140	140
WIDTHS					
Overall Width	H	130.5	130.5	130.5	130.5
I.D. Boiler	J	106	106	106	106
Center to Water Column	K	68	68	68	68
Center to Panel	L	67.5	67.5	67.5	67.5
Center to Lagging	M	56	56	56	56
Center to Auxiliary LWCO	N	63	63	63	63
Base Outside	P	74.75	74.75	74.75	74.75
Base Inside	Q	61.75	61.75	61.75	61.75
HEIGHTS					
Base to Vent Outlet (Overall Height)	R	138	138	138	138
Base to Boiler Centerline	S	71	71	71	71
Height of Base Frame	T	12	12	12	12
Base to Bottom of Boiler	U	17.5	17.5	17.5	17.5
Base to Steam Outlet	V	131	131	131	131
BOILER CONNECTIONS					
Feedwater Inlet (Both Sides)	BB	3	3	3	3

Table 2: CBEX Premium 900-1200 Dimensions (Continued)

Surface Blowoff	CC	1	1	1	1
Steam Nozzle (300# ANSI Flange)	DD	10	10	10	10
Blowdown-Front & Rear	EE	2	2	2	2
Chemical Feed	FF	0.75	0.75	0.75	0.75
VENT STACK					
Vent Stack Diameter (Flanged)	AA	32	32	32	32
MINIMUM CLEARANCES					
Tube Removal - Front Only	X	181	181	192	192
MINIMUM BOILER ROOM LENGTH ALLOWING FOR TUBE REMOVAL:					
Thru Window or Door		396	396	406	406
Front of Boiler		473	473	494	494
WEIGHTS IN LBS					
Normal Water Weight		34,430	34,430	32,670	32,670
Approx. Shipping Weight - (150psig)		47,000	47,000	49,000	49,000

NOTES:

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing.

All connections are threaded unless otherwise indicated.

PERFORMANCE DATA

Efficiency

Tables 8-9 show predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks CBEX Premium Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

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

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

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

ENGINEERING DATA

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

Boiler Information

Table 3 lists quantity and outlet size for safety valves supplied on CBEX Premium boilers. Table 4 gives steam volume and disengaging area.

Table 5 shows recommended steam nozzle sizes for CBEX Premium boilers.

Table 6 gives recommended non-return valve sizes for CBEX Premium Boilers.

Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of

the National Board of Boiler and Pressure Vessel Inspectors.

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

Table 13 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks CBEX Premium Boilers.

Burner/Control Information

Burner Characteristics

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

Fuel Connections - Gas

The local gas company should be consulted for requirements and authorization for installation and inspection of gas supply piping. Installation of gas supply piping and venting must be in accordance with all applicable engineering guidelines and regulatory codes. All connections made to the boiler should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

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

Fuel Connections - Oil

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

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

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

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

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

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

Boiler Room Information

Table 13 shows typical boiler room width requirements.

Stack Support Capabilities

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

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

Boiler Room Combustion Air

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

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

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

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

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

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

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

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

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

The low NOx option allowable pressure range is -0.25" W.C. to +0.25" W.C. The maximum pressure

variation at any firing rate for the boiler is 0.25"W.C.

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

Table 3: CBEX Premium Steam Boiler Safety Valve Outlet Size

BOILER HP	VALVE SETTING					
	150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
	NO. OF VALVES REQ'D	OUTLETSIZE (IN.)	NO. OF VALVES REQ'D	OUTLETSIZE (IN.)	NO. OF VALVES REQ'D	OUTLETSIZE (IN.)
900	3	2-1/2	3	(2) 2-1/2 (1) 1-1/2	2	2-1/2
1000	4	(3) 2-1/2 (1) 2	3	(2) 2-1/2 (1) 2	2	2-1/2
1100	4	(3) 2-1/2 (1) 2	3	2-1/2	3	(2) 2-1/2 (1) 1-1/2
1200	4	2-1/2	3	2-1/2	3	(2) 2-1/2 (1) 2

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

Table 4: Model CBEX Premium Steam Volume and Disengaging Areas

BOILER HP	STEAM VOLUME CU-FT	STEAM RELIEVING AREA SQ-IN
	HIGH PRESSURE	HIGH PRESSURE
	(A)	(A)
900	140.2	18605
1000	140.2	18605
1100	160.5	19901
1200	160.5	19901

Table 5: CBEX Premium Recommended Steam Nozzle Size

OPERATING PRESSURE PSIG	BOILER HP			
	900	1000	1100	1200
50	12	12	14	14
75	10	10	12	12
100	10	10	10	10
125	8	8	10	10
150	8	8	8	8
200	8	8	8	8
250	6	6	6	6

NOTES:

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

Table 6: Model CBEX Premium Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURE (PSIG)							
		50	75	100	125	150	175	200	250
900	31050	8	8	8	6	6	6	6	6
1000	34500	8	8	8	6	6	6	6	6
1100	37950	10	8	8	8	6	6	6	6
1200	41405	10	8	8	8	6	6	6	6

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

Table 7: Altitude Correction for Gas

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

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

- Inches WC x 0.577 = oz/sq-in.
- oz/sq-in x 1.732 = inches WC.
- Inches WC x 0.0361 = psig.
- oz/sq-in x 0.0625 = psig.
- psig x 27.71 = Inches WC.
- psig x 16.0 = oz/sq-in.

Table 8: Predicted Fuel-to-Steam Efficiencies - Natural Gas

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
900	82.7	82.2	81.5	80.7
1000	82.6	82.1	81.3	80.5
1100	82.7	82.2	81.5	80.8
1200	82.6	82.1	81.4	80.6

Table 9: Predicted Fuel-to-Steam Efficiencies - No. 2 Oil

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
900	86.0	85.5	84.8	84.1
1000	85.9	85.4	84.6	83.8
1100	86.0	85.5	84.8	84.1
1200	86.0	85.4	84.7	83.9

Table 10: CBEX Premium Natural Gas Estimated Emission Levels

POLLUTANT	UNITS	UNCONTROLLED	30 PPM SYSTEM
CO	ppm ^A	50	50
	lb/MMBTU	0.037	0.037
NOx	ppm ^A	120	30
	lb/MMBTU	0.1214	0.364
SOx	ppm ^A	-	-
	lb/MMBTU	0.001	0.001
HC/VOC	ppm ^A	-	-
	lb/MMBTU	0.0055	0.0055
PM	ppm ^A	-	-
	lb/MMBTU	0.0076	0.0076

Table 11: CBEX Premium Boilers: No. 2 Oil, Estimated Emission Levels

POLLUTANT	UNITS	UNCONTROLLED	30 PPM SYSTEM
CO	ppm ^A	50	50
	lb/MMBTU	0.039	0.039
NOx	ppm ^A	160	90
	lb/MMBTU	0.2047	0.12
SOx	ppm ^A	55	55
	lb/MMBTU	0.1	0.1
HC/VOC	ppm ^A	-	-
	lb/MMBTU	0.0021	0.0021
PM	ppm ^A	-	-
	lb/MMBTU	0.0089	0.0089

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

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 = 0.02% or less by weight.
 Sulfur content = 0.1% by weight.
 Ash content = 0.01% by weight.

Table 12: Min. required gas pressure at entrance to C-B supplied regulator/gas valve

BOILER HP	Combination Regulator and Gas Valve Size (in)	PRESSURE REQUIRED ("WC)
900	4	50
1000	4	63
1100	4	64
1200	4	59

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

Table 13: Blowdown Tank Sizing

BOILER HP	WATER (GAL)
900	336
1000	336
1100	358
1200	358

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

Table 14: Boiler Room Width (Typical Layout) - Model CBEX Premium

BOILER HP	900-1200
DIM. "A" ¹	110"
DIM. "B" ²	180"

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.

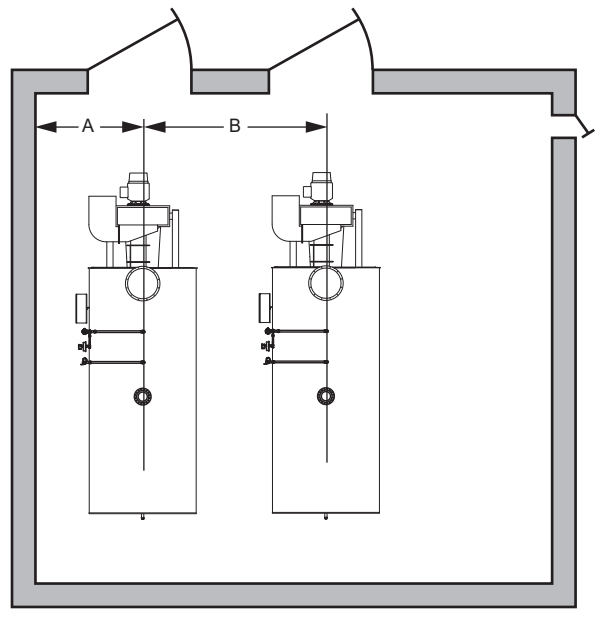


Table 15: CBEX Premium Boilers Lifting Lug Location

BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
900	128	48.375	188.25	12	3
1000	128	48.375	188.25	12	3
1100	128	48.375	198.25	12	3
1200	128	48.375	198.25	12	3

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

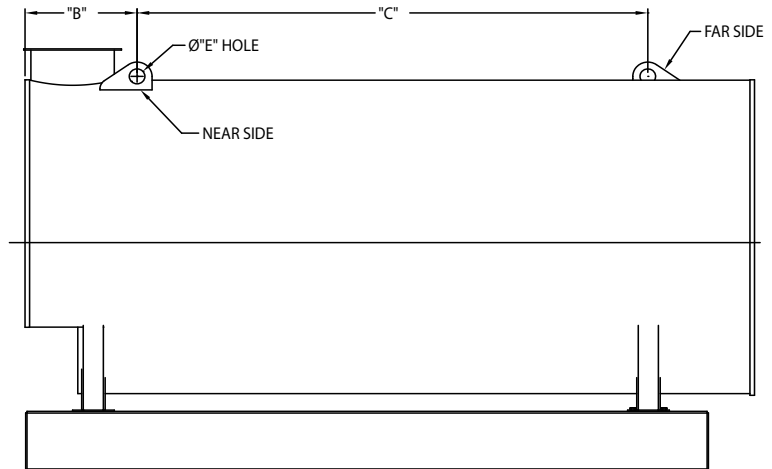
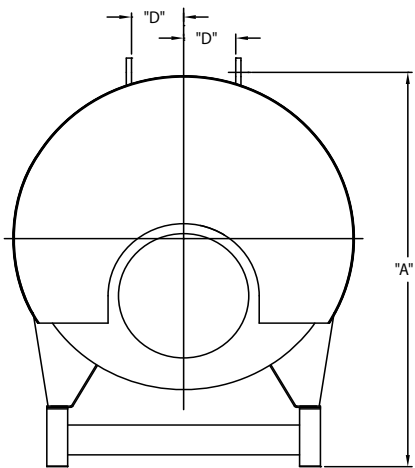
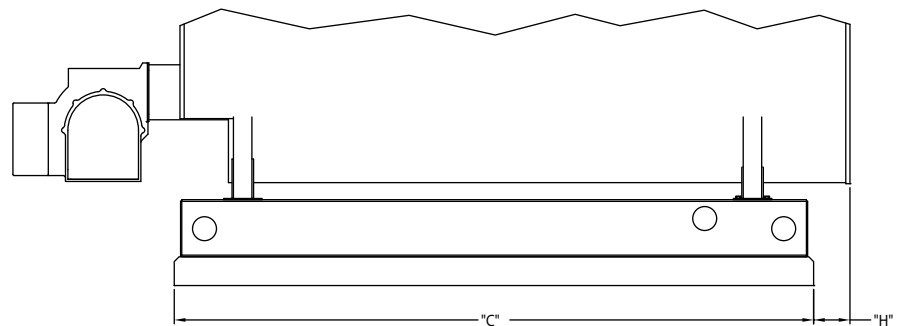
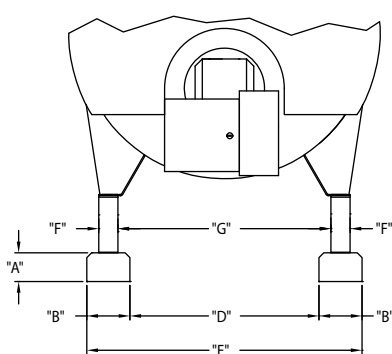


Table 16: CBEX Premium Boiler Mounting Piers

BOILER HP	ALL DIMENSIONS IN INCHES								
	A	B	C	D	E	F	G	H	
900	6	12	318	56.25	80.25	6.5	61.75	5	
1000	6	12	318	56.25	80.25	6.5	61.75	5	
1100	6	12	328	56.25	80.25	6.5	61.75	5	
1200	6	12	328	56.25	80.25	6.5	61.75	5	

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





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