

FLEXIBLE WATERTUBE BOILERS

1.5 – 12.0 MMBTU/H
Steam and Hot Water



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This section contains information on the Flexible Watertube boiler. The product model name is “FLX” for factory-assembled boilers, and “FLE” for field-erectable boilers. It is available in sizes ranging from 1.5 to 12 MMBtu/hr input.

Cleaver-Brooks offers the Model FLX “bent-tube” boiler to meet today’s demanding commercial user’s needs. The flexible watertube design has distinct advantages, including resistance to thermal shock and easy boiler maintenance. In addition Model FLX boilers offer high operating efficiency. These combined factors equate to a real increase on the return from your boiler room investment.



FEATURES AND BENEFITS

A.S.M.E. Construction:

- Built in accordance with the ASME Code, ensures design integrity for long life.
- Ensures safety and reliability with third party inspection of standards compliance.

Underwriters Package Label [UL/cUL]:

- Ensures the complete package [burner/boiler] has been tested and certified to the UL standards of safety and controls requirements.

High Turndown Burner:

- For standard emissions [uncontrolled], up to 10:1 turndown on Gas firing, reduces inefficient on/off operation, reducing fuel consumption.
- Boiler stays on line during low load conditions for optimum efficiency and performance.
- Airfoil damper design eliminates low fire excess air spikes, increasing combustion efficiency.
- Boiler/burner by single manufacturer eliminating divided responsibility.

Hinged Burner Design:

- Standard for all sizes of the Elite series and sizes 400 and greater on the Premium series, optional for Premium series sizes 350 and less.
- Burner assembly is attached to the front boiler wall with integral hinges, permits burner swing out for ease of service, maintenance, and inspection.

Swedge-Fitted Tube Attachment:

- Eliminates welded tube attachment to each drum providing ease of tube replacement.
- Eliminates rolling or welding of tube replacement, reduces maintenance costs.

Thermal Stress Protection:

- 25 Year Thermal Shock Warranty ensures tube integrity against thermal stress, associated with hydronic heating systems.
- Bent tube design provides ability to withstand thermal stress of tubes during rapid load swings and cold water returns.

Removable Side Panel Casing:

- Sectional side panels easily remove to provide access to each tube eliminates total casing removal for tube access.
- Reduces maintenance time and costs.

Field Assembly Option:

- Boiler can be erected on the project site where access space is minimized.
- Pressure vessel parts, tubes, burner and controls can fit through a standard doorway, elevator shaft or reduced side wall opening or window.

PRODUCT OFFERING

Information in this section applies to steam and hot water boiler sizes ranging from 1.5 to 12 MMBtu/hr input, as shown in Table B1-1.

The Flexible Watertube Boiler is a five-pass steel boiler with flexible tubes formed and arranged to direct the flow of combustion gases through the boiler. The pressure vessel conforms to Section I or Section IV of the ASME Code, and consists of the formed tubes and the external downcomer connected to the top and bottom drums. The heated area of the pressure vessel is contained within a gas-tight, insulated casing that is composed of removable, formed-steel panels. The boiler/burner package is manufactured by Cleaver-Brooks and UL/cUL approved as a package.

Table B1-1. Model FLX Watertube Boiler Sizes

MODEL	CAPACITY INPUT BTU/HR	HEAT OUTPUT BTU/HR	EQUIV HP
FLX-150	1,500,000	1,200,000	36
FLX-200	2,000,000	1,600,000	48
FLX-250	2,500,000	2,000,000	60
FLX-300	3,000,000	2,400,000	72
FLX-350	3,500,000	2,800,000	84
FLX-400	4,000,000	3,200,000	96
FLX-450	4,500,000	3,600,000	108
FLX-500	5,000,000	4,000,000	119
FLX-550	5,500,000	4,400,000	132
FLX-600	6,000,000	4,800,000	143
FLX-700	7,000,000	5,600,000	167
FLX-800	8,000,000	6,400,000	191
FLX-900	9,000,000	7,200,000	215
FLX-1000	10,000,000	8,000,000	239
FLX-1100	11,000,000	8,800,000	263
FLX-1200	12,000,000	9,600,000	287

NOTES:

1. Standard design pressure: 160 psig Hot Water, 15 psig Steam, and 150 psig Steam.
2. Also available as field erect and designated as Model FLE



Standard Equipment: Equipment described below is for the standard factory package offering.

1. Boiler:

- A. All boilers are designed and constructed in accordance with the ASME Code.
- B. Each vessel is mounted on an integral base frame; refractories for the boiler and burner are installed.
- C. Each vessel receives a factory hydro test with third party witness.
- D. ASME Code Stamped and National Board Registered.
- E. For Canadian installations, appropriate CRN Stamping.

Notice

Hot water boilers with design pressures up to 160 psig, and with design temperatures less than 250 °F, are constructed under Section IV of the ASME Code, and 'H' stamped for low- pressure heating boilers.

Notice

Steam boilers with design pressure of 15 psig, and maximum allowable operating pressure of <15 psig, are constructed under Section IV of the ASME Code, and 'H' stamped for low pressure heating boilers.

Notice

Steam boilers with design pressure of 150 psig are constructed under Section I of the ASME code and "S" stamped for high pressure steam boilers.

2. Forced Draft Burner, Cleaver-Brooks ProFire™ V Series:

- A. Mounted on a hinged backing plate for easy access to furnace.
Note: Standard on all sizes Elite Series and sizes 400 and larger Premium Series.
- B. Pressure atomizing type for No. 2 oil burner. This includes the oil pump.
- C. Stainless steel flame-retention type combustion head for gas, with UV scanner and gas pressure regulator.
- D. External access to flame scanner for ease of maintenance.

3. Water/Steam Controls:

- A. ASME safety relief valve(s).
- B. Pressure and temperature gauges for hot water boilers. C. Pressure gauge for steam boilers.
- D. Operating and limit controls:
- E. High limit control - manual reset.
- F. Operating limit control - automatic reset. G. Modulating or proportional controller.
- H. Low water cutoff:
 - Probe type - hot water.
 - Float type main and probe type auxiliary for steam.
- K. Pump Control - steam boilers.

4. Altitude: Standard boilers attain full ratings at altitudes up to 2,000 feet. Altitude compensation for most models is available for altitudes up to 10,000 ft above sea level.

Optional Equipment

1. Boiler Options

- Auxiliary low water cut-off (hot water).
- Stack thermometer.
- Insulated downcomer(s). (Standard for Elite Series)
- Drain valves.
- Additional screwed tapings.
- Packaged for field erection.

2. Burner/Control Options

- Special burner modulation controls.
- Low NOx burner.
- Optional flame safeguard controller.
- Lead/lag system.
- High altitude design - up to 10,000 ft.
- Special insurance and code requirements (e.g., XL-GAPS, FM, ASME CSD-1).
- Alarm Horn/silence switch.
- Special motor requirements (TEFC, high efficiency).
- Remote contacts.
- Additional relay points and indicator lights.
- Main disconnect (fusible/circuit breaker).
- Optional NEMA enclosures.
- Key lock panel.
- System pump interlock.
- Low fire hold controls.
- Assured low fire cut-off.
- Flow switches.
- High stack temperature cut-off/alarm.
- Remote emergency shutoff (115V).

3. Fuel Options

- Special gas pressure regulator.
- Oversized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Digester Gas.
- Remote oil pump set.
- Special pilot.
- Direct spark oil ignition.
- Automatic fuel changeover.

Table B1-2. FLX Steam Dimensions Sizes 150-500

	Dim.	BOILER SIZE - NOTE 1							
		150	200	250	300	350	400	450	500
LENGTHS Inches									
Overall	A	108	108	108	114	114	139	139	139
Boiler Base Frame	B	68	68	68	74	74	94	94	94
Front Extension Lower Drum	C	15	15	15	15	15	17	17	17
Rear Extension Lower Drum	D	13	13	13	13	13	13	13	13
Burner Extension	F	27	27	27	27	27	31	31	31
WIDTHS Inches									
Boiler Base Frame [See Note 2]	G	42	42	42	46	46	48	48	48
Centerline to Casing	G ₁	41	41	41	23	23	24	24	24
Width to outside of Gas Train	G ₂	54	54	54	58	58	60	60	60
HEIGHTS Inches									
Base to Stack Flange	H	86	86	86	90	90	95	95	95
Base to Steam Nozzle	H ₁	87	87	87	91	91	95	95	95
Base to Top of Casing	J	85	85	85	89	89	93	93	93
Base to Lifting Lug	J ₁	86	86	86	90	90	95	95	95
Base to Upper Drum Centerline	K	69	69	69	73	73	77	77	77
Base to Lower Drum Centerline	L	9	9	9	9	9	10	10	10
Base to Feedwater Connection	M	39	39	39	43	43	47	47	47
Base to Chemical Feed	N	44	44	44	48	48	52	52	52
LOCATIONS Inches									
Front Casing to Steam Nozzle	O	34	34	34	37	37	47	47	47
Flue Outlet Centerline	P	55	55	55	61	61	80	80	80
Front Casing to Upper Drum Rear	Q	81	81	81	87	87	108	108	108
Safety Valves 15 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 150 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 150 PSIG Setpoint	S	N/A	N/A	N/A	N/A	N/A	9-1/2	9-1/2	9-1/2
Bottom Drain/Blowdown	T	20	20	20	21	21	23	23	23
PIPING CONNECTIONS Inches									
Flue Gas ID	U	10	10	10	12	12	16	16	16
Flue Gas Outlet Flange	V	15	15	15	17	17	21	21	21
Flange Bolt Circle Diameter	W	12-1/2	12-1/2	12-1/2	14-1/2	14-1/2	18-1/2	18-1/2	18-1/2
Number of Bolt Holes	X	4	4	4	4	4	6	6	6
Steam Nozzle 15 PSIG Design Boiler	Y	4 flg.	4 flg.	4 flg.	6 flg.				
Steam Nozzle 150 PSIG Design Boiler	Y	2 mpt	2 mpt	2 mpt	2½ mpt	2½ mpt	3 flg.	3 flg.	3 flg.
Feedwater Makeup	Z	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼
Chemical Feed	Z ₁	½	½	½	½	½	½	½	½
Surface Blowff	BB	1	1	1	1	1	1	1	1
Bottom Drain/Blowdown 15 PSIG Design	CC	1½	1½	1½	1½	1½	2	2	2
Bottom Drain/Blowdown 150 PSIG Design	CC	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼
Safety Valves, 15 psig [Note 4]	ZZ	1 @ 2	1 @ 2	1 @ 2	1 @ 2½	1 @ 2½	1 @ 3	1 @ 3	1 @ 3
Safety Valves, 150 psig [Note 4]	ZZ	1 @ 1¼	1 @ 1¼	1 @ 1¼	1 @ 1½	1 @ 1½	2 @ 1¼	2 @ 1¼	2 @ 1¼
GENERAL DATA									
Handhole Upper Drum	AA	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6
Handhole Lower Drum	AA ₁	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5
Downcomer OD	DD	4	4	4	4	4	5	5	5
Upper Drum OD	EE	20	20	20	20	20	20	20	20
Lower Drum OD	FF	8-5/8	8-5/8	8-5/8	8-5/8	8-5/8	10-3/4	10-3/4	10-3/4
MINIMUM SERVICE CLEARANCES									
Tube removal each side	GG	28	28	28	32	32	34	34	34
Rear service area	HJ	24	24	24	24	24	24	24	24
Front service area -	HH	36	36	36	36	36	36	36	40

Dimension letters E and I are not used.

NOTES:

1. Multiply Size by 10,000 to obtain BTU/hr input of the boiler.
2. Add 4 inches to each side of the base frame dimension to account for optional seismic anchor pads on each side.
3. For unit sizes beloww 700, the ALWCO [auxiliary low water cutoff] is a probe device in lieu of the column.
4. Connections shown are for valve outlet connection at the standard set point, do not reduce outlet pipe size.



Table B1-3. FLX Steam Dimensions Sizes 550-1200

		BOILER SIZE - NOTE 1							
		550	600	700	800	900	1000	1100	1200
LENGTHS Inches									
Overall	A	139	145	168	168	168	200	200	205
Boiler Base Frame	B	94	94	116	116	116	140	140	140
Front Extension Lower Drum	C	17	17	17	17	17	19	19	19
Rear Extension Lower Drum	D	13	13	15	15	15	23	23	23
Burner Extension	F	31	37	37	37	37	37	37	43
WIDTHS Inches									
Boiler Base Frame [See Note 2]	G	48	48	54	54	54	54	54	54
Centerline to Casing	G ₁	24	24	27	27	27	27	27	27
Width to outside of Gas Train	G ₂	60	60	66	66	66	66	66	66
HEIGHTS Inches									
Base to Stack Flange	H	95	95	109	109	109	108.5	108.5	108.5
Base to Steam Nozzle	H ₁	95	95	109	109	109	109	109	109
Base to Top of Casing	J	93	93	107	107	107	107	107	107
Base to Lifting Lug	J ₁	95	95	109	109	109	109	109	109
Base to Upper Drum Centerline	K	77	77	89	89	89	89	89	89
Base to Lower Drum Centerline	L	10	10	12	12	12	12	12	12
Base to Feedwater Connection	M	47	47	59	59	59	59	59	59
Base to Chemical Feed	N	52	52	64	64	64	64	64	64
LOCATIONS Inches									
Front Casing to Steam Nozzle	O	47	47	58	58	58	58	58	58
Flue Outlet Centerline	P	80	80	100	100	100	124	124	124
Front Casing to Upper Drum Rear	Q	108	108	131	131	131	163	163	163
Safety Valves 15 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 15 PSIG Setpoint	S	N/A	N/A	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2
Safety Valves 150 PSIG Setpoint	R	4	4	4	4	4	4	4	4
Safety Valves 150 PSIG Setpoint	S	9-1/2	9-1/2	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2	10-1/2
Bottom Drain/Blowdown	T	23	23	22	22	22	22	22	22
PIPING CONNECTIONS Inches									
Flue Gas ID	U	16	16	18	18	18	24	24	24
Flue Gas Outlet Flange	V	21	21	23	23	23	29	29	29
Flange Bolt Circle Diameter	W	18-1/2	18-1/2	20-1/2	20-1/2	20-1/2	26-1/2	26-1/2	26-1/2
Number of Bolt Holes	X	6	6	8	8	8	8	8	8
Steam Nozzle 15 PSIG Design Boiler	Y	6 flg.	6 flg.	8 flg.	8 flg.	8 flg.	10 flg.	10 flg.	10 flg.
Steam Nozzle 150 PSIG Design Boiler	Y	3 flg.	3 flg.	4 flg.	4 flg.	4 flg.	6 flg.	6 flg.	6 flg.
Feedwater Makeup	Z	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	2	2	2
Chemical Feed	Z ₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Surface Blowff	BB	1	1	1	1	1	1	1	1
Bottom Drain/Blowdown 15 PSIG Design	CC	2	2	2	2	2	2	2	2
Bottom Drain/Blowdown 150 PSIG	CC	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
Safety Valves, 15 psig [Note 4]	ZZ	1 @ 3	1 @ 3	2 @ 2 1/2	2 @ 2 1/2	2 @ 2 1/2	2 @ 3	2 @ 3	2 @ 3
Safety Valves, 150 psig [Note 4]	ZZ	2 @ 1 1/4	2 @ 1 1/4	2 @ 1 1/2	2 @ 1 1/2	2 @ 1 1/2	2 @ 2	2 @ 2	2 @ 2
GENERAL DATA									
Handhole Upper Drum	AA	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6	4 x 6
Handhole Lower Drum	AA ₁	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5	4 x 5
Downcomer OD	DD	5	5	6	6	6	6	6	6
Upper Drum OD	EE	20	20	24	24	24	24	24	24
Lower Drum OD	FF	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4	10-3/4
MINIMUM SERVICE CLEARANCES									
Tube removal each side	GG	34	34	40	40	40	40	40	40
Rear service area	HJ	24	24	24	24	24	24	24	24
Front service area -	HH	40	40	40	40	40	45	45	45

Dimension letters E and I are not used.

NOTES:

1. Multiply Size by 10,000 to obtain BTU/hr input of the boiler.
2. Add 4 inches to each side of the base frame dimension to account for optional seismic anchor pads on each side.
3. For unit sizes beloww 700, the ALWCO [auxiliary low water cutoff] is a probe device in lieu of the column.
4. Connections shown are for valve outlet connection at the standard set point, do not reduce outlet pipe size.



Table B1-4. FLX Steam Ratings Sizes 150-500

Boiler SIZE	150	200	250	300	350	400	450	500
Ratings [Notes A and B]								
Nominal Steam Capacity (lbs. steam/hr from & at 212°)	1,237	1,649	2,062	2,474	2,887	3,299	3,711	4,124
Rated Steam Capacity [kg/hr from and at 100 C]	561	748	935	1,122	1,310	1,496	1,683	1,871
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000
Output Kcal/Hr [1,000 Kcal/h]	303	403	504	605	706	806	907	1,008
Output KW	348	464	580	696	812	928	1,044	1,160
Approximate Boiler Horsepower	36	48	60	72	84	96	108	119
Approximate Fuel Consumption [Input - Note C]								
Natural Gas [ft ³ /hr] - 15# Steam [1.03 Bar]	1,448	1,929	2,438	2,900	3,408	3,872	4,319	4,776
Natural Gas Therms/Hour - 15# Steam [1.03 Bar]	14.5	19.3	24.4	29.0	34.1	38.7	43.2	47.8
Natural Gas [m ³ /hr] - 15# Steam [1.03 Bar]	41.0	54.6	69.0	82.0	96.5	109.6	122.3	135.0
Natural Gas [ft ³ /hr] - 150# Steam [10.34 Bar]	1,487	2,021	2,558	3,043	3,559	4,017	4,519	4,979
Natural Gas Therms/Hour - 150# Steam [10.34 Bar]	14.9	20.2	25.6	30.4	35.6	40.2	45.2	49.8
Natural Gas [m ³ /hr] - 150# Steam [10.34 Bar]	42.1	57.2	72.4	86.0	100.8	113.7	128.0	141.0
Propane Gas [ft ³ /hr] - 15# Steam [1.03 Bar]	579	772	975	1,160	1,363	1,549	1,728	1,910
Propane Gas [ft ³ /hr] - 150# Steam [10.34 Bar]	595	808	1,023	1,217	1,424	1,607	1,808	1,992
Propane Gas [m ³ /hr] - 15# Steam [1.03 Bar]	16.4	21.8	27.6	32.8	38.6	43.9	48.9	54.0
Propane Gas [m ³ /hr] - 150# Steam [10.34 Bar]	16.8	22.9	28.9	34.5	40.3	45.5	51.2	56.4
No.2 Oil Fuel - gph, 15# Steam [1.03 Bar]	10.0	13.5	17.1	20.4	24.1	26.8	30.2	33.6
No.2 Oil Fuel - gph, 150# Steam [10.34 Bar]	10.3	14.0	17.6	20.9	24.3	27.7	31.7	34.5
No.2 Oil Fuel - liters/hour, 15# Steam [1.03 Bar]	37.8	51.1	64.6	77.2	91.1	101.4	114.3	127.2
No.2 Oil Fuel - liters/hour, 150# Steam [10.34 Bar]	39.1	53.0	66.7	79.0	92.1	104.8	120.0	130.6
Power Requirements - Standard [Note A and D]								
Blower Motor HP - Gas Firing	1/2	3/4	3/4	3/4	1	1	2	2
Blower Motor HP - Oil or Combination	3/4	1	1	1	1-1/2	1-1/2	2	3
Oil Pump for Oil or Combination	Direct Drive from the Blower Motor							
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60	[9.8] 4.9	[13.8] 6.9	[13.8] 6.9	[13.8] 6.9	[16] 8	[16] 8	[24] 12	
Blower Motor - Oil or Combination, [115]230/1/60	[13.8] 6.9	[16] 8	[16] 8	[16] 8	[20] 10	[20] 10	[24] 12	
Blower Motor - Gas, Oil or Combination, 230/3/60								6.8
Blower Motor - Gas, Oil or Combination, 460/3/60								3.4
Blower Motor - Gas, Oil or Combination, 575/3/60								2.7
Remote Oil Pump, [230]460/3/60								
Control Circuit @ 115/1/60	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4
Weights								
Operating Weight, lbs.	6,600	6,600	6,600	7,200	7,200	9,200	9,200	9,200
Operating Weight, kg	2,994	2,994	2,994	3,266	3,266	4,173	4,173	4,173
Water Content Normal, gallons	108	108	108	121	121	157	157	157
Water Content Normal, liters	409	409	409	458	458	594	594	594
Water Content Flooded, gallons	194	194	194	215	215	293	293	293
Water Content Flooded, liters	734	734	734	814	814	1,109	1,109	1,109
Shipping Weight, approximate lbs.	5,700	5,700	5,700	6,200	6,200	7,900	7,900	7,900
Shipping Weight, approximate kg	2,585	2,585	2,585	2,812	2,812	3,583	3,583	3,583

Notes:

- A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.
- B. Steam ratings are listed for 0 psig and feedwater at 212 F and nominal 80% efficiency. Refer to Section B1 of the Boiler Book for ratings at operating
- C. Input calculated with Nat. Gas @ 1000 Btu/ft³, Propane @ 2500 Btu/ft³ and Oil @ 140,000Btu/gal.
- D. Standard Motors meet the requirements of UL & NEMA and include the following:

Open drip proof design	NEMA Design "B"
1.15 Service Factor	Ball Bearing
Class "B" Insulation	Continuous Duty, 40° C ambient



Table B1-5. FLX Steam Ratings Sizes 550-1200

Boiler SIZE	550	600	700	800	900	1000	1100	1200
Ratings [Notes A and B]								
Nominal Steam Capacity (lbs. steam/hr from & at 212°)	4,536	4,949	5,773	6,598	7,422	8,248	9,072	9,897
Rated Steam Capacity [kg/hr from and at 100 C]	2,057	2,245	2,619	2,993	3,367	3,741	4,115	4,489
Output Btu/hr [1,000 Btu/h]	4,400	4,800	5,600	6,400	7,200	8,000	8,800	9,600
Output Kcal/Hr [1,000 Kcal/h]	1,109	1,210	1,411	1,613	1,814	2,016	2,218	2,419
Output KW	1,276	1,392	1,624	1,856	2,088	2,320	2,552	2,784
Approximate Boiler Horsepower	131	143	167	191	215	239	263	287
Approximate Fuel Consumption [Input - Note C]								
Natural Gas [ft ³ /hr] - 15# Steam [1.03 Bar]	5,311	5,774	6,885	7,807	8,853	9,877	11,040	12,009
Natural Gas Therms/Hour - 15# Steam [1.03 Bar]	53.1	57.7	68.8	78.1	88.5	98.8	110.4	121.0
Natural Gas [m ³ /hr] - 15# Steam [1.03 Bar]	150.4	163.5	195.0	221.0	250.7	279.7	312.6	340.0
Natural Gas [ft ³ /hr] - 150# Steam [10.34 Bar]	5,481	6,059	7,032	8,165	9,286	10,230	11,287	12,444
Natural Gas Therms/Hour - 150# Steam [10.34 Bar]	54.8	60.6	70.3	81.6	92.9	102.3	113.0	124.4
Natural Gas [m ³ /hr] - 150# Steam [10.34 Bar]	155.2	171.6	199.1	231.2	263.0	289.7	319.6	352.3
Propane Gas [ft ³ /hr] - 15# Steam [1.03 Bar]	2,124	2,310	2,754	3,123	3,541	3,951	4,416	4,804
Propane Gas [ft ³ /hr] - 150# Steam [10.34 Bar]	2,192	2,424	2,813	3,266	3,714	4,092	4,515	4,978
Propane Gas [m ³ /hr] - 15# Steam [1.03 Bar]	60.1	65.4	78.0	88.4	100.3	111.9	125.0	136.0
Propane Gas [m ³ /hr] - 150# Steam [10.34 Bar]	62.0	68.6	79.6	92.5	105.2	115.9	127.8	141.0
No.2 Oil Fuel - gph, 15# Steam [1.03 Bar]	37.5	40.9	47.8	55.0	61.9	69.3	77.4	83.1
No.2 Oil Fuel - gph, 150# Steam [10.34 Bar]	38.3	41.7	49.3	57.1	64.3	71.0	79.3	86.5
No.2 Oil Fuel - liters/hour, 15# Steam [1.03 Bar]	141.9	154.8	180.9	208.2	234.3	262.3	293.0	314.6
No.2 Oil Fuel - liters/hour, 150# Steam [10.34 Bar]	145.0	157.8	186.6	216.1	243.4	268.7	300.0	327.4
Power Requirements - Standard [Note A and D]								
Blower Motor HP - Gas Firing	3	5	5	5	7-1/2	10	10	15
Blower Motor HP - Oil or Combination	3	5	5	5	7-1/2	10	10	15
Oil Pump for Oil or Combination	direct drive	3/4	3/4	3/4	1	1-1/2	1-1/2	1-1/2
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60								
Blower Motor - Oil or Combination, [115]230/1/60								
Blower Motor - Gas, Oil or Combination, 230/3/60	9.6	15.2	15.2	15.2	22	22	28	28
Blower Motor - Gas, Oil or Combination, 460/3/60	4.8	7.6	7.6	7.5	11	11	14	14
Blower Motor - Gas, Oil or Combination, 575/3/60	3.9	6.1	6.1	6.1	9	9	11	11
Remote Oil Pump, [230]460/3/60		[2.8] 1.4	[2.8] 1.4	[2.8] 1.4	[3.4] 1.7	[4.2] 2.1	[4.2] 2.1	[4.2] 2.1
Control Circuit @ 115/1/60	2.4	2.4	1.9	1.9	1.9	2.4	2.4	2.4
Weights								
Operating Weight, lbs.	9,200	9,200	12,500	12,500	12,500	14,100	14,100	14,100
Operating Weight, kg	4,173	4,173	5,670	5,670	5,670	6,396	6,396	6,396
Water Content Normal, gallons	157	157	277	277	277	289	289	289
Water Content Normal, liters	594	594	1,049	1,049	1,049	1,094	1,094	1,094
Water Content Flooded, gallons	293	293	464	464	464	562	562	562
Water Content Flooded, liters	1,109	1,109	1,756	1,756	1,756	2,127	2,127	2,127
Shipping Weight, approximate lbs.	7,900	7,900	10,200	10,200	10,200	11,700	11,700	11,700
Shipping Weight, approximate kg	3,583	3,583	4,627	4,627	4,627	5,307	5,307	5,307

Notes:

- A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.
- B. Steam ratings are listed for 0 psig and feedwater at 212 F and nominal 80% efficiency. Refer to Section B1 of the Boiler Book for ratings at operating
- C. Input calculated with Nat. Gas @ 1000 Btu/ft³, Propane @ 2500 Btu/ft³ and Oil @ 140,000Btu/gal.
- D. Standard Motors meet the requirements of UL & NEMA and include the following:

Open drip proof design	NEMA Design "B"
1.15 Service Factor	Ball Bearing
Class "B" Insulation	Continuous Duty, 40° C ambient



Figure B1-2. FLX HW Dimension Drawing

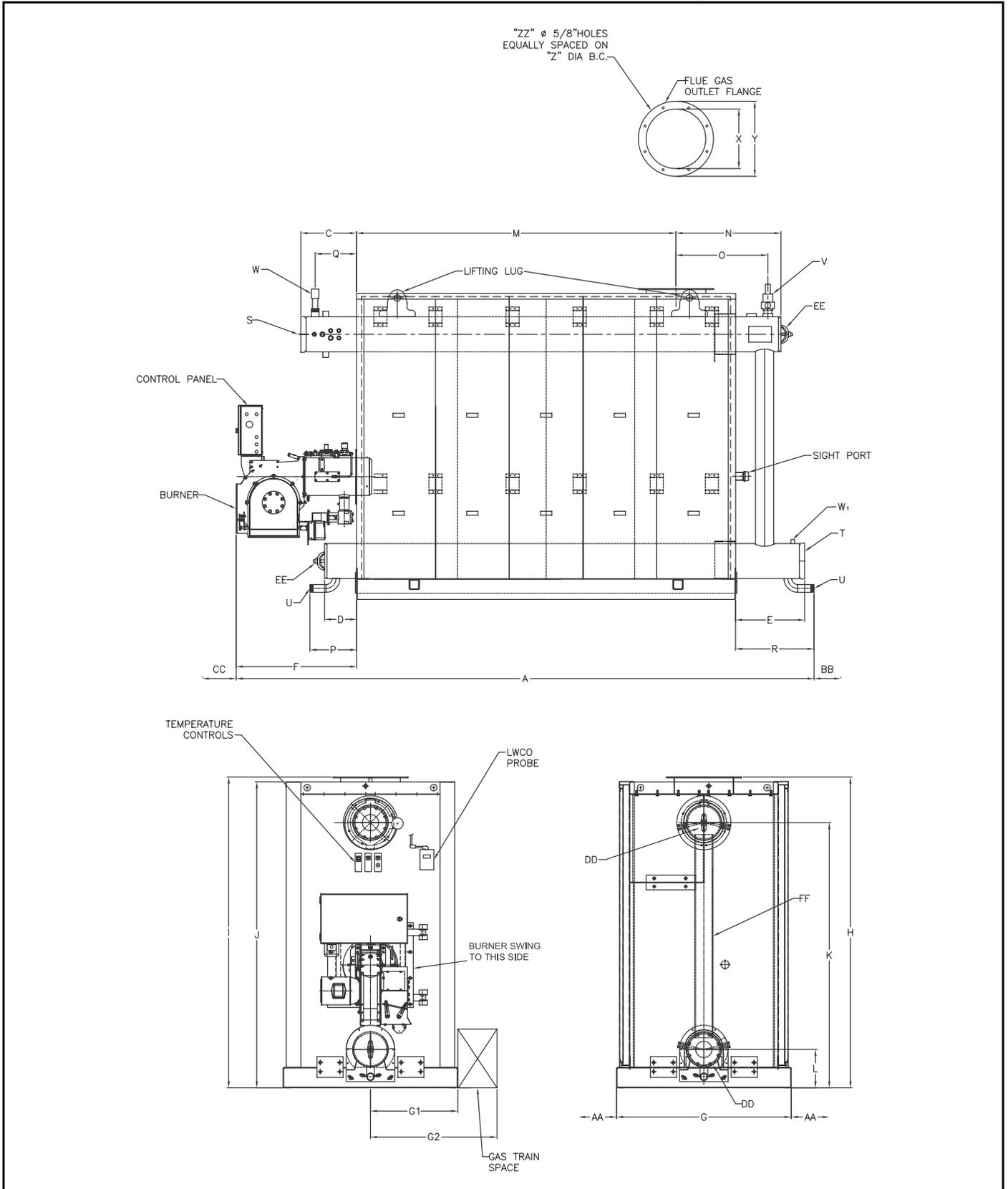


Table B1-6. FLX HW Dimensions Sizes 150-500

		BOILER SIZE [SEE NOTE 1]							
		150	200	250	300	350	400	450	500
LENGTHS Inches									
Overall Length of Boiler	A	115	115	115	120	120	146	146	146
Boiler Base Frame	B	68	68	68	74	74	95	95	95
Front Extension Upper	C	17	17	17	17	17	17	17	17
Front Extension Lower	D	11	11	11	11	11	11	11	11
Rear Extension Lower	E	20	20	20	20	20	21	21	21
Burner Extension	F	27	27	27	27	27	31	31	31
WIDTHS Inches									
Boiler Base Frame [Note 2]	G	42	42	42	46	46	48	48	48
Centerline to Casing	G₁	21	21	21	23	23	24	24	24
Centerline to outside Gas	G₂	33	33	33	35	35	36	36	36
HEIGHTS Inches									
Base to Stack Flange	H	78	78	78	82	82	86	86	86
Base to Lifting Lug	I	78	78	78	82	82	86	86	86
Base to Top of Casing	J	76	76	76	80	80	85	85	85
Base to Supply Nozzle	K	65	65	65	69	69	73	73	73
Base to Return Nozzle	L	9	9	9	9	9	10	10	10
LOCATIONS Inches									
Flue Outlet Centerline	M	54	54	54	62	62	81	81	81
Rear Extension Upper	N	28	28	28	26	26	28	28	28
Safety Valves	O	24	24	24	22	22	24	24	24
Bottom Drain see Note 3	P	15	15	15	15	15	15	15	15
Boiler Air Vent	Q	12	12	12	13	13	13	13	13
Bottom Drain Rear see	R	N/A	N/A	N/A	N/A	N/A	24	24	24
PIPING CONNECTIONS									
Supply Nozzle [Note 4]	S	3 FLG	3 FLG	3 FLG	4 FLG	4 FLG	6 FLG	6 FLG	6 FLG
Return Nozzle [Note 4]	T	3 FLG	3 FLG	3 FLG	4 FLG	4 FLG	6 FLG	6 FLG	6 FLG
Bottom Drain see Note 2	U	1½	1½	1½	1½	1½	2 @ 2	2 @ 2	2 @ 2
Safety Valves, 30 psig	V	2	2	2	2	2	2½	2½	2½
Safety Valves, 60 psig	V	1½	1½	1½	1½	1½	2	2	2
Safety Valves, 125 psig	V	1	1	1	1¼	1¼	1½	1½	1½
Safety Valves, 160 psig	V	¾	¾	¾	¾	¾	1¼	1¼	1¼
Boiler Air Vent	W	1	1	1	1	1	1	1	1
Tapping for optional	W₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Flue Gas ID	X	10	10	10	12	12	16	16	16
Flue Gas Outlet Flange	Y	15	15	15	17	17	21	21	21
Flange Bolt Circle	Z	12½	12½	12½	14½	14½	18½	18½	18½
Number of holes in bolt	ZZ	4	4	4	4	4	6	6	6
MINIMUM SERVICE									
Tube removal each side	AA	28	28	28	32	32	34	34	34
Rear service area	BB	24	24	24	24	24	24	24	24
Front service area -	CC	36	36	36	36	36	36	36	40
PERIPHERAL DATA									
Upper/Lower Drum OD	DD	8-5/8"	8-5/8"	8-5/8"	8-5/8"	8-5/8"	10-3/4"	10-3/4"	10-3/4"
Handhole Inspection	EE	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"
Rear Downcomer (NPS)	FF	4	4	4	4	4	5	5	5

- NOTES:**
1. For Btu/hr input rating, multiply model designation by 10,000.
 2. Add 4" to each side of the base frame dimension to account for optional seismic anchor pads.
 3. For Models 150 to 350 a single drain connection is provided at the front bottom drum; for Models 400 and greater, an additional drain
 4. Supply and return nozzle flanges are 150# Flat Face.
 5. Standard safety valve setting is 160 psig and options for reduced settings are noted.



Table B1 - 7. FLX HW Dimensions Sizes 550-1200

		BOILER SIZE [SEE NOTE 1]							
		550	600	700	800	900	1000	1100	1200
LENGTHS Inches									
Overall Length of Boiler	A	146	153	174	174	174	206	206	206
Boiler Base Frame	B	95	95	116	116	116	140	140	140
Front Extension Upper	C	17	17	17	17	17	17	17	17
Front Extension Lower	D	11	11	11	11	11	12	12	12
Rear Extension Lower	E	21	21	21	21	21	22	22	22
Burner Extension	F	31	37	37	37	37	44	44	44
WIDTHS Inches									
Boiler Base Frame [Note]	G	48	48	54	54	54	54	54	54
Centerline to Casing	G₁	24	24	27	27	27	27	27	27
Centerline to outside Gas	G₂	36	36	39	39	39	39	39	39
HEIGHTS Inches									
Base to Stack Flange	H	86	86	95	95	95	95	95	95
Base to Lifting Lug	I	86	86	95	95	95	95	95	95
Base to Top of Casing	J	85	85	94	94	94	94	94	94
Base to Supply Nozzle	K	73	73	81	81	81	81	81	81
Base to Return Nozzle	L	10	10	10	10	10	12	12	12
LOCATIONS Inches									
Flue Outlet Centerline	M	81	81	102	102	102	122	122	122
Rear Extension Upper	N	28	28	28	28	28	33	33	33
Safety Valves	O	24	24	24	24	24	29	29	29
Bottom Drain see Note 3	P	15	15	15	15	15	15	15	15
Boiler Air Vent	Q	13	13	13	13	13	7	7	7
Bottom Drain Rear see	R	24	24	24	24	24	19	19	19
PIPING CONNECTIONS									
Supply Nozzle [Note 4]	S	6 FLG	6 FLG	6 FLG	6 FLG	6 FLG	8 FLG	8 FLG	8 FLG
Return Nozzle [Note 4]	T	6 FLG	6 FLG	6 FLG	6 FLG	6 FLG	8 FLG	8 FLG	8 FLG
Bottom Drain see Note 2	U	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2	2 @ 2
Safety Valves, 30 psig	V	2½	2½	2 @ 2½	2 @ 2½	2 @ 2½	2 @ 2½	2 @ 2½	2 @ 2½
Safety Valves, 60 psig	V	2	2	2½	2½	2½	2½	2½	2½
Safety Valves, 125 psig	V	1½	1½	1½	1½	1½	1½	1½	1½
Safety Valves, 160 psig	V	1¼	1¼	1½	1½	1½	1½	1½	1½
Boiler Air Vent	W	1	1	1	1	1	1	1	1
Tapping for optional	W₁	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Flue Gas ID	X	16	16	18	18	18	24	24	24
Flue Gas Outlet Flange	Y	21	21	23	23	23	29	29	29
Flange Bolt Circle	Z	18½	18½	20½	20½	20½	26½	26½	26½
Number of holes in bolt	ZZ	6	6	8	8	8	8	8	8
MINIMUM SERVICE									
Tube removal each side	AA	34	34	40	40	40	40	40	40
Rear service area	BB	24	24	24	24	24	24	24	24
Front service area -	CC	40	40	40	40	45	45	45	45
PERIPHERAL DATA									
Upper/Lower Drum OD	DD	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"	10-3/4"
Handhole Inspection	EE	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"	4" x 5"
Rear Downcomer (NPS)	FF	5	5	5	5	5	5	5	5

- NOTES:**
1. For Btu/hr input rating, multiply model designation by 10,000.
 2. Add 4" to each side of the base frame dimension to account for optional seismic anchor pads.
 3. For Models 150 to 350 a single drain connection is provided at the front bottom drum; for Models 400 and greater, an additional drain
 4. Supply and return nozzle flanges are 150# Flat Face.
 5. Standard safety valve setting is 160 psig and options for reduced settings are noted.



Table B1 - 8 . FLX HW Ratings Sizes 150-500

Boiler SIZE	150	200	250	300	350	400	450	500
Ratings [Note A]								
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000
Output Kcal/Hr [1,000 Kcal/h]	303	403	504	605	706	806	907	1,008
Output KW	348	464	580	696	812	928	1,044	1,160
Approximate Boiler Horsepower	36	48	60	72	84	96	108	119
Approximate Fuel Consumption [Input - Note B]								
Natural Gas [ft ³ /hr]	1,423	1,917	2,423	2,883	3,388	3,803	4,289	4,748
Natural Gas [m ³ /hr]	40.3	54.3	68.6	81.6	95.9	107.7	121.4	134.4
Natural Gas Therms/Hour	14.2	19.2	24.2	28.8	33.9	38.0	42.9	47.5
Propane Gas [ft ³ /hr]	569	764	969	1,153	1,355	1,521	1,716	1,899
Propane Gas [m ³ /hr]	16.1	21.6	27.4	32.6	38.4	43.1	48.6	53.8
No.2 Oil Fuel - gph	10.1	13.5	16.9	20.2	23.6	27.0	31.5	33.5
No.2 Oil Fuel - liters/hour	38.2	51.1	64.0	76.5	89.3	102.2	119.2	126.8
Power Requirements - Standard [Note A & C]								
Blower Motor HP - Gas Firing	1/2	3/4	3/4	3/4	1	1	2	2
Blower Motor HP - Oil or Combination	3/4	1	1	1	1-1/2	1-1/2	2	3
Oil Pump for Oil or Combination	Direct Drive from the Blower Motor							
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60	[9.8] 4.9	[13.8] 6.9	[13.8] 6.9	[13.8] 6.9	[16] 8	[16] 8	[24] 12	
Blower Motor - Oil or Combination, [115]230/1/60	[13.8] 6.9	[16] 8	[16] 8	[16] 8	[20] 10	[20] 10	[24] 12	
Blower Motor - Gas, Oil or Combination, 230/3/60								6.8
Blower Motor - Gas, Oil or Combination, 460/3/60								3.4
Blower Motor - Gas, Oil or Combination, 575/3/60								2.7
Remote Oil Pump, [230]460/3/60								
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4
Weights								
Operating Weight, lbs.	4,700	4,700	4,700	5,900	5,900	7,600	7,600	7,600
Operating Weight, kg	2,111	2,111	2,111	2,667	2,667	3,422	3,422	3,422
Water Content Normal, gallons	96	96	96	108	108	180	180	180
Water Content Normal, liters	344.5	344.5	344.5	401.3	401.3	658.7	658.7	658.7
Shipping Weight, approximate lbs.	3,900	3,900	3,900	5,000	5,000	6,100	6,100	6,100
Shipping Weight, approximate kg	1,769	1,769	1,769	2,268	2,268	2,767	2,767	2,767

Notes:

- A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.
- B. Input calculated with Nat. Gas @ 1000 Btu/ft³. Propane @ 2500 Btu/ft³. and Oil @ 140,000Btu/gal.
- C. Standard Motors meet the requirements of UL & NEMA and include the following:

- Open drip proof design
- 1.15 Service Factor
- Class "B" Insulation
- NEMA Design "B"
- Ball Bearing
- Continuous Duty, 40⁰ C ambient



Table B1- 9. FLX HW Ratings Sizes 550-1200

Boiler SIZE	550	600	700	800	900	1000	1100	1200
Ratings [Note A]								
Output Btu/hr [1,000 Btu/h]	4,400	4,800	5,600	6,400	7,200	8,000	8,800	9,600
Output Kcal/Hr [1,000 Kcal/h]	1,109	1,210	1,411	1,613	1,814	2,016	2,218	2,419
Output KW	1,276	1,392	1,624	1,856	2,088	2,320	2,552	2,784
Approximate Boiler Horsepower	131	143	167	191	215	239	263	287
Approximate Fuel Consumption [Input - Note B]								
Natural Gas [ft ³ /hr]	5,239	5,740	6,760	7,667	8,798	9,698	10,775	11,788
Natural Gas [m ³ /hr]	148.3	162.5	191.4	217.1	249.1	274.6	305.1	333.8
Natural Gas Therms/Hour	52.4	57.4	67.6	76.7	88.0	97.0	108.0	118.0
Propane Gas [ft ³ /hr]	2,096	2,296	2,704	3,067	3,519	3,879	4,310	4,715
Propane Gas [m ³ /hr]	59.3	65.0	76.6	86.8	99.6	109.8	122.0	133.5
No.2 Oil Fuel - gph	36.8	40.2	47.0	53.7	60.5	68.0	74.9	81.7
No.2 Oil Fuel - liters/hour	139.3	152.1	177.9	203.3	229.0	257.4	283.5	309.3
Power Requirements - Standard [Note A & C]								
Blower Motor HP - Gas Firing	3	5	5	5	7-1/2	10	10	15
Blower Motor HP - Oil or Combination	3	5	5	5	7-1/2	10	10	15
Oil Pump for Oil or Combination	direct drive	3/4	3/4	3/4	1	1-1/2	1-1/2	1-1/2
Minimum Ampacity - Standard								
Blower Motor - Gas Firing Only, [115]230/1/60								
Blower Motor - Oil or Combination, [115]230/1/60								
Blower Motor - Gas, Oil or Combination, 230/3/60	9.6	15.2	15.2	15.2	22	22	28	28
Blower Motor - Gas, Oil or Combination, 460/3/60	4.8	7.6	7.6	7.5	11	11	14	14
Blower Motor - Gas, Oil or Combination, 575/3/60	3.9	6.1	6.1	6.1	9	9	11	11
Remote Oil Pump, [230]460/3/60		[2.8] 1.4	[2.8] 1.4	[2.8] 1.4	[3.4] 1.7	[4.2] 2.1	[4.2] 2.1	[4.2] 2.1
Control Circuit	2.4	2.4	1.9	1.9	1.9	2.4	2.4	2.4
Weights								
Operating Weight, lbs.	7,600	7,600	10,500	10,500	10,500	12,300	12,300	12,300
Operating Weight, kg	3,422	3,422	4,714	4,714	4,714	5,549	5,549	5,549
Water Content Normal, gallons	180	180	240	240	240	276	276	276
Water Content Normal, liters	658.7	658.7	863.1	863.1	863	1,018.3	1,018.3	1,018.3
Shipping Weight, approximate lbs.	6,100	6,100	8,500	8,500	8,500	10,000	10,000	10,000
Shipping Weight, approximate kg	2,767	2,767	3,856	3,856	3,856	4,536	4,536	4,536

Notes:

- A. Ratings shown for elevation to 1000 Feet. For ratings above 1000 Feet, contact your local Cleaver-Brooks Representative.
- B. Input calculated with Nat. Gas @ 1000 Btu/ft³. Propane @ 2500 Btu/ft³. and Oil @ 140,000Btu/gal.
- C. Standard Motors meet the requirements of UL & NEMA and include the following:

- Open drip proof design
- 1.15 Service Factor
- Class "B" Insulation
- NEMA Design "B"
- Ball Bearing
- Continuous Duty, 40⁰ C ambient



PERFORMANCE DATA

Efficiency Fuel-to-steam (fuel-to-water) efficiency is based on specific operating conditions (fuel, pressure, temperature). Nominal efficiency on all FLX hot water and low pressure steam boilers is 81% firing natural gas, and 84% firing No. 2 oil. For high pressure steam applications, contact your local Cleaver-Brooks representative for expected efficiencies.

Emissions Expected emissions for natural gas fired FLX boilers are shown in Table B1-4.

Table B1-10. Expected Emissions (ppm, corrected to 3% O₂), Natural Gas Fired Boiler

FLUE GAS COMPONENT	HIGH-FIRE LEVEL ^A PPM _v	LOW-FIRE LEVEL ^B PPM _v
CO	<100	<100
NO _x	≤70	≤70

NOTE: NO_x levels based on standard product offering.
 A. Based on 12% excess air.
 B. Based on 15% excess air.

Table B1-11. Model FLX Hot Water Boiler Flow Rates and Pressure Drops

MODEL NO.	T = 20°F		T = 40°F		T = 60°F		T = 80°F		T = 100°F	
	P (PSIG)	GPM	P (PSIG)	GPM						
FLX-150	1.14	122.0	0.30	61.1	0.13	41.1	0.08	30.8	0.05	24.4
FLX-200	1.14	162.3	0.30	81.1	0.13	54.1	0.08	40.6	0.05	32.5
FLX-250	1.77	202.8	0.46	101.4	0.21	67.6	0.12	50.7	0.08	40.6
FLX-300	1.85	243.4	0.48	121.7	0.22	81.1	0.12	60.9	0.08	48.7
FLX-350	2.49	284.0	0.65	142.0	0.29	94.7	0.17	71.0	0.11	56.8
FLX-400	1.35	324.5	0.35	162.3	0.16	108.2	0.09	81.1	0.06	64.9
FLX-450	1.71	365.1	0.44	182.6	0.20	121.7	0.11	91.2	0.08	73.0
FLX-500	2.03	405.7	0.54	202.8	0.25	135.2	0.14	101.4	0.09	81.1
FLX-550	2.50	446.3	0.67	223.1	0.31	148.7	0.17	111.5	0.11	89.2
FLX-600	2.99	486.8	0.77	243.4	0.35	162.3	0.20	121.7	0.13	97.4
FLX-700	1.75	567.9	0.45	284.0	0.21	189.3	0.12	142.0	0.08	113.6
FLX-800	2.27	649.1	0.59	324.5	0.27	216.4	0.15	162.3	0.10	129.8
FLX-900	2.85	730.2	0.74	365.1	0.33	243.4	0.19	182.6	0.12	146.0
FLX-1000	4.08	811.4	1.02	405.6	0.42	270.4	0.25	202.8	0.15	163.6
FLX-1100	4.42	892.6	1.15	446.2	0.48	297.4	0.28	223.0	0.18	178.4
FLX-1200	6.20	973.6	1.60	486.8	0.59	324.6	0.31	243.4	0.22	194.8



ENGINEERING DATA

Boiler Information

Flow Rates and Pressure Drops

Flow rates and pressure drops for the FLX hot water boilers are shown in Table B1-5. This table can be used to determine the boiler pressure drop in relation to full boiler output and system temperature drop.

Table B1-6 can be used to determine the maximum gpm circulating rate in relation to full boiler output and system temperature drop. The maximum gpm can be determined by knowing the boiler size and expected system temperature drop.

System Operating Parameters (Hot Water)

System over pressure requirements are shown in Table B1-7.

Minimum return water temperature is 140°F; minimum supply (boiler outlet) water temperature is 150 °F in order to prevent fireside corrosion.

System Operating Parameters (Steam Boilers)

The following operating limitations must be observed for optimum operation of the boiler:

1. Minimum make-up temperature 60 °F.
2. Maximum make-up rate (for on/off make-up control) 2.0 times the evaporation rate.
3. Minimum operating pressure 6 psig. on low pressure steam and 40 psig. on high pressure steam.
4. Maximum operating pressure 12 psig. on low pressure steam.
5. Maximum load tracking rate 0 - 100% load or 100% - 0 load, 30 seconds on low pressure steam and 20% per minute on high pressure steam.

Maximum boiler water chemistry parameters: Silica: 150 ppm; specific conductance: 3500 μ mho/cm un-neutralized; total alkalinity: 300 ppm as CaCO₃; hardness: 0; oxygen: 7 ppb; pH: 7 - 10; total iron: 0.05 ppm; oil matter: 1 ppm.

Boiler Heat Release Information

Boiler heat release information is shown in Table B1-8.

Tube Attachment

Construction of the Flexible Watertube Boiler includes a special tube-to-drum attachment that requires no welding or rolling (see Figure B1-3). The tube is fitted with a tapered ferrule, which is press-fit into the tube hole in the drum. The ferrule is welded to the tube at the factory for both new and replacement tubes, so no field welding is required. The tube is held in place with a keeper plate.

This tube attachment design reduces repair and maintenance costs, and also reduces the cost of field erection of new units.

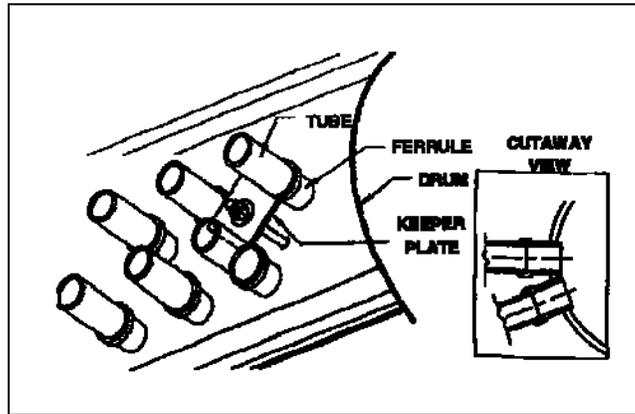


Figure B1-3. Model FLX Tube Attachment

Table B1-12. Model FLX Circulating Rates, Hot Water Boiler

MODEL NO. (HP)	SYSTEM TEMPERATURE DROP °F									
	10	20	30	40	50	60	70	80	90	100
	MAXIMUM CIRCULATING RATE - GPM									
FLX-150 (36)	243	122	81	61	49	41	35	31	27	24
FLX-200 (48)	324	162	108	81	65	54	46	41	36	32
FLX-250 (60)	404	202	135	101	81	68	58	51	45	41
FLX-300(72)	488	244	162	122	97	81	70	61	54	49
FLX-350 (84)	568	284	189	142	114	95	81	71	63	57
FLX-400 (96)	648	324	216	162	130	108	93	81	72	65
FLX-450 (108)	729	365	243	182	146	122	105	91	81	73
FLX-500 (119)	812	406	270	203	162	135	116	101	90	81
FLX-550 (131)	893	447	297	223	178	149	128	111	99	89
FLX-600 (143)	972	486	325	243	195	162	139	122	108	97
FLX-700 (167)	1136	568	379	284	227	189	162	142	126	114
FLX-800 (191)	1300	650	433	325	260	216	185	162	144	130
FLX-900 (215)	1460	730	487	365	292	243	209	183	162	146
FLX-1000 (239)	1622	811	541	406	324	270	232	203	180	164
FLX-1100 (263)	1784	893	595	446	357	297	255	223	198	178
FLX-1200 (287)	1947	974	649	487	389	325	279	243	216	195

Table B1-13. Model FLX Minimum Over Pressure Requirements

MAXIMUM OUTLET TEMPERATURE (°F)	MINIMUM SYSTEM PRESSURE (PSIG)
180	12
190	15
200	18
210	21
220	24
230	27
240	30

Table B1-15. Model FLX Burner Characteristics

MODEL NO.	BURNER MAXIMUM INPUT MBH	BURNER MODEL	FAN MOTOR (3450 RPM) VOLTAGE
FLX-150	1500	PFVLG-15	115/230/1/60
FLX-200	2000	PFVLG-20	115/230/1/60
FLX-250	2500	PFVLG-25	115/230/1/60
FLX-300	3000	PFVLG-30	115/230/1/60
FLX-350	3500	PFVLG-35	208/230/1/60
FLX-400	4000	PFVLG-40	208/230/1/60
FLX-450	4500	PFVLG-45	208-230/460/3/60
FLX-500	5000	PFVLG-50	230/460/3/60
FLX-550	5500	PFVLG-55	230/460/3/60
FLX-600	6000	PFVLG-60	460/3/60
FLX-700	7000	PFVLG-70	460/3/60
FLX-800	8000	PFVLG-80	460/3/60
FLX-900	9000	PFVLG-90	460/3/60
FLX-1000	10000	PFVLG-100	460/3/60
FLX-1100	11000	PFVLG-110	460/3/60
FLX-1200	12000	PFVLG-120	460/3/60

Notes:

- 1 Burner model selection shown is subject to changed and is based on actual application (altitude, gas pressure, reduced NOx, etc.)
- 2 Standard voltage for Canadian applications is 575/3/60.
- 3 Burner operation is Full Modulation on Elite Series and for the Econo series
- Low High Low for units 150 - 600 and modulated firing on 700 and greater.
- 4 Burner models shown are for combination gas/oil firing. For straight gas, delete the letter L, and for straight oil, delete the letter G.

Table B1-14. Model FLX Boiler Heat Release Information

MODEL NO.	FURNACE PROJECTED AREA (FT2)	FURNACE VOLUME (FT3)	FURNACE HEAT RELEASE BTU/HR (FT3)	FURNACE HEAT RELEASE BTU/HR (FT2)
FLX-150	38.4	24.2	61,983	39,063
FLX-200	38.4	24.2	82,645	52,083
FLX-250	38.4	24.2	103,306	65,104
FLX-300	48.7	34.9	85,960	61,602
FLX-350	48.7	34.9	100,287	71,869
FLX-400	70.6	54.7	73,126	56,657
FLX-450	70.6	54.7	82,267	63,739
FLX-500	70.6	54.7	91,408	70,822
FLX-550	70.6	54.7	100,548	77,904
FLX-600	70.6	54.7	109,689	84,986
FLX-700	104.6	94.6	73,996	66,922
FLX-800	104.6	94.6	84,567	76,482
FLX-900	104.6	94.6	95,137	86,042
FLX-1000	128.9	116.5	85,837	77,580
FLX-1100	128.9	116.5	94,421	85,337
FLX-1200	128.9	116.5	103,004	93,095

Table B1-16. Model FLX Minimum Required Gas Pressure

MODEL NO.	STD GAS TRAIN SIZE (IN.) Note 3	MIN. GAS PRESSURE (IN.W.C.) Note 4	MIN. GAS PRESSURE (IN.W.C.) Note 5	BURNER MODEL
FLX-150	1	11.2	12.5	PFVG-15
FLX-200	1	19.4	21.7	PFVG-20
FLX-250	1.5	12.4	15.7	PFVG-25
FLX-300	1.5	15.9	20.7	PFVG-30
FLX-350	1.5	15.5	22.0	PFVG-35
FLX-400	1.5	18.7	27.2	PFVG-40
FLX-450	2	16.0	26.7	PFVG-45
FLX-500	2	17.6	21.0	PFVG-50
FLX-550	2	22.9	27.1	PFVG-55
FLX-600	2	20.0	24.9	PFVG-60
FLX-700	2	25.2	31.9	PFVG-70
FLX-800	2.5	19.9	22.2	PFVG-80
FLX-900	2.5	24.7	27.7	PFVG-90
FLX-1000	2.5	31.6	31.6	PFVG-100
FLX-1100	2.5	37.3	37.3	PFVG-110
FLX-1200	2.5	38.2	38.2	PFVG-120

Notes:

- 1. Table is based on 1,000 Btu/cu.ft natural gas and elevation to 1000 feet.
- 2. Minimum gas pressure also applies to 200 fuel series.
- 3. As an option, the standard gas train can be replaced with an oversized design to reduce inlet gas pressure requirements.
- 4. Use this column for all U.S. Installations.
- 5. Use this column for all Canadian Installations.



**Burner/Control
Information****Burner Characteristics**

Burner information is shown in Table B1-9. Note that the model selection may vary for actual application factors (altitude, gas pressure, etc.).

Minimum Required Gas Pressures

Approximate gas pressure required at rated input is shown in Table B1-10. For oversized gas trains or altitudes above 1,000 feet, contact your local Cleaver-Brooks authorized representative.

Fuel Connections - Gas

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

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

Fuel Connections - Oil

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Figure B1-4 shows a typical fuel oil supply arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

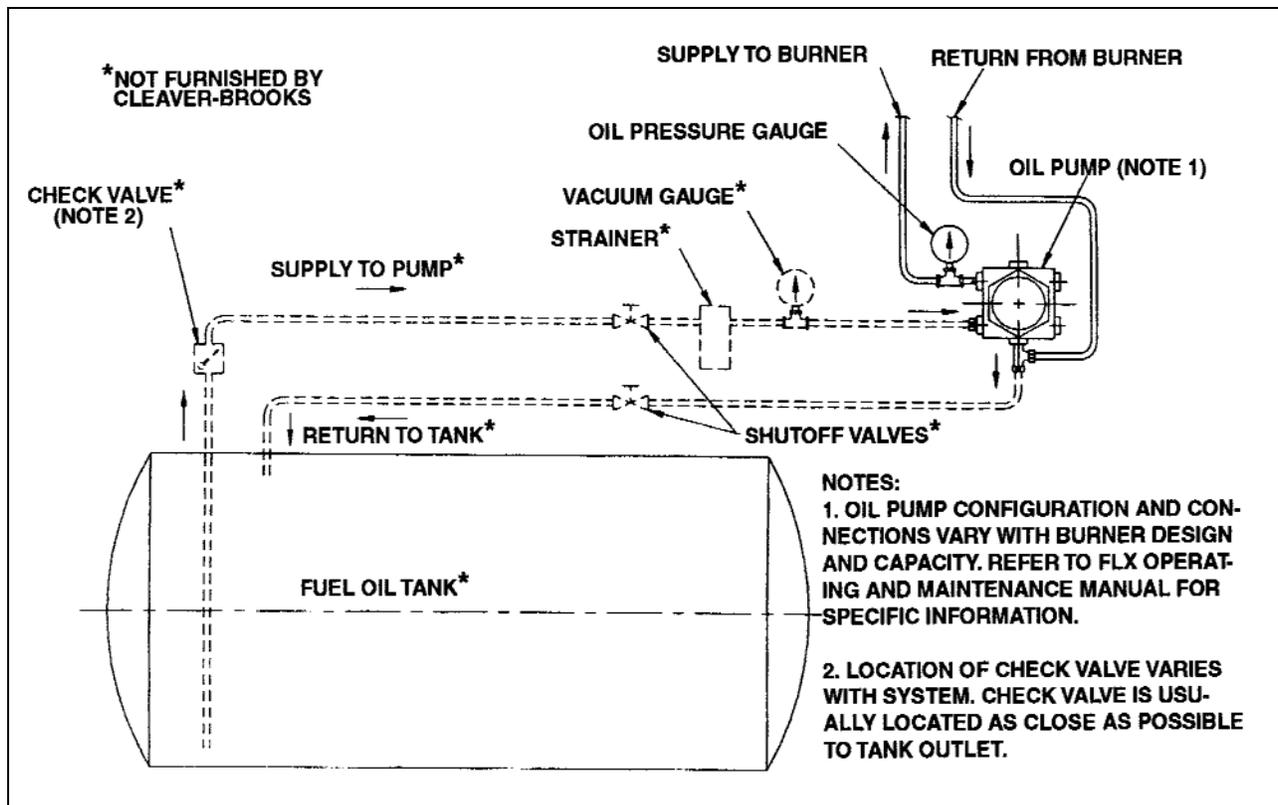


Figure B1-4. Model FLX Oil Burner Supply Pump Installation

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

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

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

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

Table B1-17. Model FLX Sound Levels

SOUND LEVEL FIRING RATE	MODEL NO.															
	150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1200
Low Fire (dBA)	75	75	76	75	75	77	78	79	79	79	81	81	83	79	82	85
High Fire (dBA)	76	76	77	76	76	78	79	80	80	80	82	82	83	81	83	86

Measurement: Three feet from front center of boiler, and 3-1/2 feet above boiler base. Measurements are decibel ratings on the A-weighted scale, registered without addition of sound attenuators, mufflers, or silencers. Sound pressure data taken on combination fuel burners firing oil. Sound pressure levels firing natural gas will be 0.5 dBA lower.

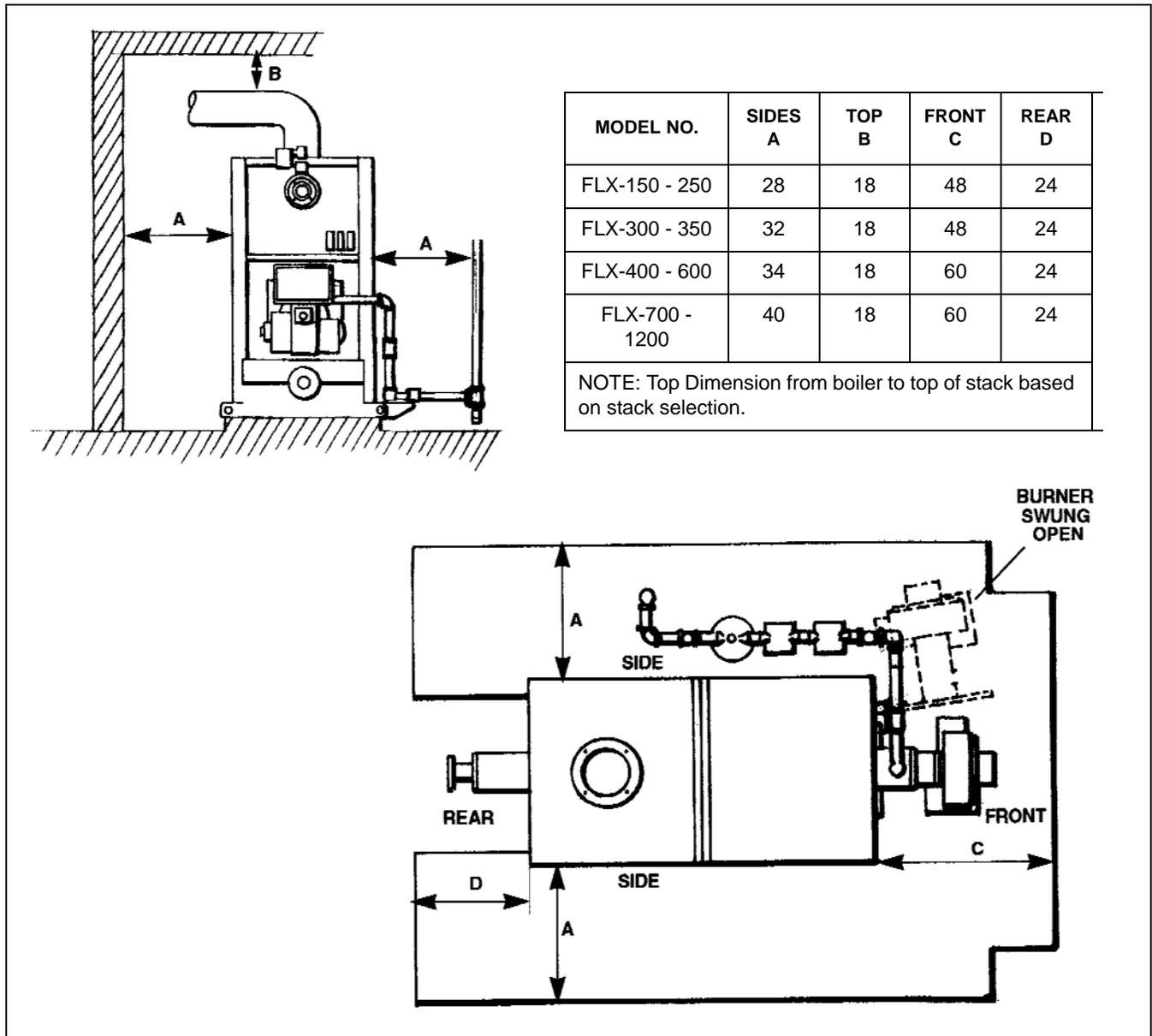


Figure B1-5. Model FLX Clearance Requirements

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

Sound Levels (dBA)

Refer to Table B1-11 for sound level information.

Outdoor Reset Control

Cleaver-Brooks does not recommend the use of outdoor controls which reset the boiler water outlet temperature below 150 °F, or the utilization of the boiler as a system thermostat.

Boiler Room Information

The boiler must be installed on a non-combustible floor. If the floor is not level, piers, or a raised pad, slightly larger in length and width than the boiler base dimensions, will make boiler installations and leveling easier. Installation on a raised pad or piers will make boiler drain connections more accessible. The floor, pad, or piers must be of sufficient load bearing strength to safely support the operating weight of the boiler and any additional equipment installed with it. Approximate operating weights for Model FLX series steam and hot water boilers are shown in Dimensions and Ratings.

After the boiler is in place it must be leveled. Both side-to-side and front-to-back level can be verified using the vertical connection between the upper and lower drums at the back of the boiler. If shims are required to level the boiler, the weight of the boiler must be evenly distributed at all points of support.

The boiler must be installed so that all components remain accessible for inspection, cleaning, or maintenance. Field-installed piping and electrical connections to the burner and boiler must be arranged to allow removal of the casing panels, and swinging of the burner.

Minimum clearances to walls or other obstructions and combustible materials are shown in Figure B1-5. The top view shaded sections in Figure B1-5 show areas that must be kept clear of field installed connections to the boiler for access or maintenance purposes.

A positive means of supplying a volume of outside air for complete fuel combustion is required. Proper ventilation of the boiler room must be provided. The amount of air required, and the required duct and air supply opening areas, are determined by the maximum fuel input rating of the burner and the altitude of the installation. Refer to Table B1-12. Air inlets must be sized in accordance with applicable engineering guidelines and regulatory code.

Breechings

For single boiler installations, use breeching of the same diameter as the vent outlet on the boiler. For multiple boiler installations, and when a number of boilers of the same size (input) are to be connected to a common breeching, use the table on Figure B1-6 to size the breeching diameter. For more information on breechings and stacks, refer to "Stacks," Section F.

Stack Support Capabilities

Flextube boilers can support up to 200 lbs without additional support.

Table B1-18. Model FLX Combustion Air Requirements

MODEL NO.		150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1200
Comb Air (Dry)	Gas (scfh)	15480	20640	25800	30960	36120	41280	46440	51600	56760	61920	72240	82560	92280	103200	113520	123840
	(lb/hr)	1207	1609	2012	2414	2817	3219	3621	4024	4426	4828	5633	6438	7243	8048	8853	9657
	Oil (scfh)	17050	22733	28414	34098	39782	45463	51146	56831	62514	68196	79562	90928	102294	113662	125028	136394
	(lb/hr)	1269	1692	2115	2538	2961	3384	3807	4231	4654	5077	5923	6769	7640	8462	9308	10154
Flue Gas (Dry)	Gas (scfh)	17520	23360	29200	35040	40880	46720	52560	58400	64240	70080	81760	93440	105120	116800	128480	140160
	(lb/hr)	1278	1704	2130	2556	2983	3409	3835	4261	4687	5113	5965	6817	7669	8521	9373	10225
	Oil (scfh)	17915	23886	29855	35827	41799	47769	53740	59713	65684	71655	83598	95541	107484	119427	131370	143312
	(lb/hr)	1357	1809	2261	2714	3166	3618	4070	4523	4975	5427	6330	7237	8142	9047	9951	10856

NOTES:

1. Natural gas @ 1000 Btu/cu-ft.
2. No. 2 oil @ 140,000 Btu/gal.

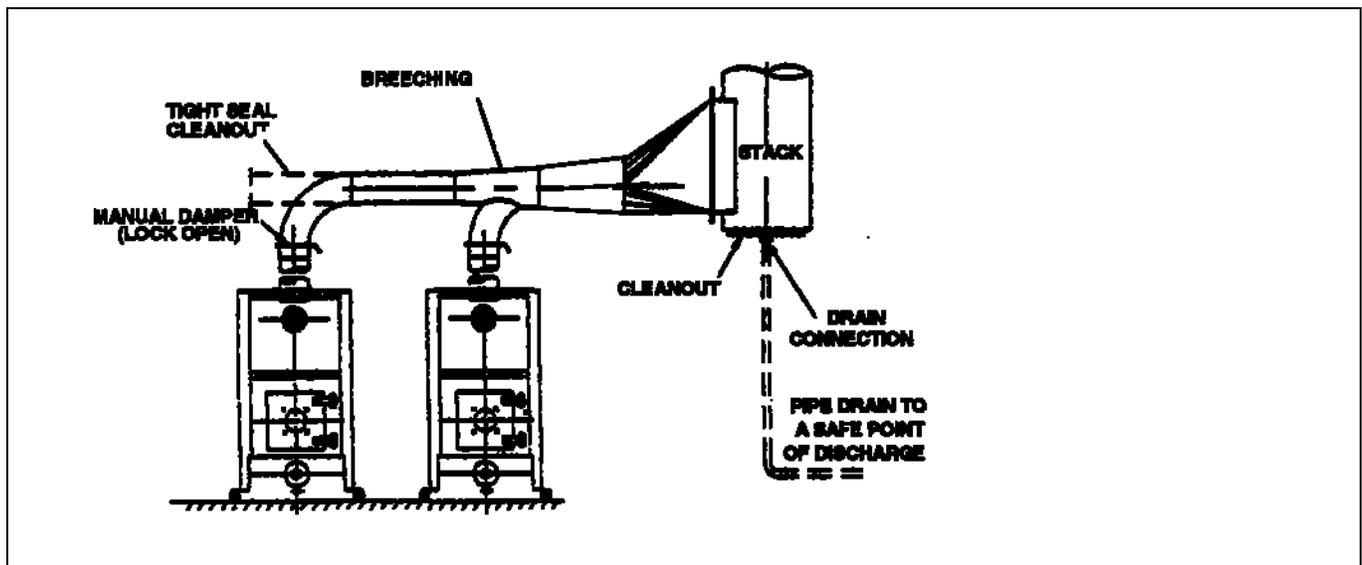


Figure B1-6. Model FLX Breaching Arrangement - Single or Multiple Boiler Installation

Notes

Model FLX Boilers

(Steam Boiler Specifications)

Boiler Capacity.....	B1-28
General Design.....	B1-28
Steam Boiler Trim.....	B1-28
Burner and Controls.....	B1-29
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Pilot Gas Train for Each Burner (Mounted, Piped, and Wired)	B1-30
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Gas Valve Train for Each Burner.....	B1-30
Burner Controls.....	B1-31
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Field Erectable.....	B1-32

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application. A separate specification is provided for hot water boiler and steam boiler packages.

PART 1 GENERAL**1.1 BOILER CAPACITY**

- A. The (low or high) pressure steam boiler shall be Cleaver- Brooks Model FLX (FLE for field erected) designed for (15 or 150) psig steam.
- B. The boiler shall have a maximum output of lbs/hr at psig when fired with No. 2 oil and/or natural gas, Btu/cu-ft. Electrical power available will be Volt, phase, Hz.

PART 2 PRODUCTS**2.1 GENERAL DESIGN**

- A. The boiler shall be of a two-drum flexible watertube design with a tangent tube waterwall furnace mounted on a heavy steel frame. Top, bottom and sides of the furnace shall be water cooled.
- B. The boiler pressure vessel shall be constructed in accordance with ASME Boiler Code, and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser. The complete packaged boiler - burner unit shall be listed by Underwriters Laboratories', and shall have the UL/cUL label affixed to the front head.
1. The boiler drums shall be furnished with handholes to facilitate boiler inspection and cleaning.
 2. Boiler tubes shall be 1.5" diameter, 0.095" wall thickness, and shall be easy to remove and replace without expanding or welding the tube attachment to the drums.
 3. The boiler shall have sufficiently sized downcomers to provide positive natural internal circulation.
 4. The burner shall be mounted on a hinged backing plate for easy access to furnace.
- C. Observation ports for the inspection of flame conditions shall be provided at rear end of the boiler and in the burner assembly at the front end.
- D. The tangent wall tubes shall be covered with 1-1/2 inches of insulation under a gas-tight, 16-gauge inner casing. There shall be 2 inches of insulation between the inner and outer casing. The outer casing shall be 20 gauge. The boiler base frame and other components shall be factory-painted before shipment, using a hard enamel finish.

2.2 STEAM BOILER TRIM

- A. The following items shall be installed on the boiler:
1. Low Water Cutoff - A low water cut-off control of the float-type shall be mounted in a water column to the upper drum. It is to be wired to the burner control circuit to prevent burner operation if the boiler water falls below proper levels.
 2. Feedwater Pump Control - The boiler feedwater pump control switch shall be included. It shall provide automatic actuation of a motor-driven feedwater pump, or solenoid valve, to maintain the boiler water level within normal limits.
 3. Steam Pressure Controls - A minimum of three controls shall be provided: one auto reset type for burner on-off control, one for burner firing rate, and one manual reset type for burner cutout in excessive steam pressure conditions.
 4. Miscellaneous - A pressure gauge shall be mounted to the boiler. Pressure controls (for regulation of burner operation) shall be mounted to the boiler. Steam relief valves shall be of a type and size to comply with ASME Code requirements (shipped loose).

2.3 BURNER AND CONTROLS

- A. The boiler shall be provided with a UL/cUL approved fuel burning system in full accordance with the requirements of state, provincial and local codes, the local gas utility, and other applicable regulatory bodies. The boiler shall be a Cleaver-Brooks Profire burner.
- B. (Option as required)
- C. The complete fuel burning system shall further be in full accordance with Factory Mutual (FM) requirements.
- D. The complete fuel burning system shall further be in full accordance with Industrial Risk Insurers (IRI) requirements.

2.4 BURNER DESCRIPTION

- A. Option (specify 1, 2, or 3)
 - 1. The burner shall include a gas burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/cu-ft of _____ gas at a pressure of _____ (lbs/sq-inch) (inches of water column) at the inlet of the burner gas control train.
 - 2. The burner shall include an oil burner having rated capacity to burn _____ gph of No. 2 fuel oil.
 - 3. The burner shall include a combination gas-oil burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/cu-ft gas at a pressure of _____ lbs/sq-inch (inches of water column) at the inlet to the burner gas control train (or _____ gph of No. 2 fuel).
- B. The burner shall be forced draft type with full firing rate modulation.
All combustion air shall be furnished by the burner fan, which shall be an integral part of the burner. Each burner motor shall not be larger than _____ hp, _____ phase.
- C. Option (specify 1, 2, or 3)
 - 1. The gas burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
 - 2. The light oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and a maximum of No. 1 smoke spot, as measured on the Bacharach Scale.
 - 3. The gas-oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion on gas firing, and a maximum of No. 1 smoke, as measured on the Bacharach Scale when burning oil. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
- D. Primary-secondary air control shall be a design function of the combustion head.
Combustion heads requiring an internal adjustment shall not be acceptable.
- E. The burner shall be equipped with an aluminum reverse curve fan for lower fan motor hp requirements and self-cleaning characteristics.

- F. A permanent observation port shall be provided in the burner to allow observation of both the pilot and main flame. Both the pilot and the flame scanner shall be easily accessible without opening or disassembling the burner.
- G. Supply voltage available shall be Volts, phase, 60 Hz. All motors shall be suitable for use on this voltage. All burner controls are to be for use on 120 volts, 1 phase, 60 hz.
- H. The burner shall be factory fire-tested to ensure proper operation before shipment.

2.5 PILOT GAS TRAIN FOR EACH BURNER (MOUNTED, PIPED, AND WIRED)

A separate pilot gas cock, gas pressure regulator, and pilot safety shutoff gas valve shall be provided for the ignition gas supply.

2.6 OIL BURNER

- A. The oil burner shall be of the mechanical pressure atomizing type. B. A two-stage oil pump shall be provided for each burner as an integral part of the burner.
- C. Two approved automatically operated safety shutoff valve(s) shall be provided in the oil supply line to the burner valves to be piped in series but wired parallel.
- D. Supply an oil pressure gauge to indicate the discharge oil pump pressure.
- E. Install a manual valve, fuel oil filter, or strainer and vacuum gauge on the suction side of the oil pump (optional).
- F. Install a fusible-link-actuated oil safety shutoff valve in the oil supply line between the oil tank and the manual gate valve at the oil pump (optional).
- G. Oil pressure monitoring shall be provided by an approved pressure switch interlocked to accomplish a non-recycling safety shutdown in the event of low oil pressure (optional).

2.7 GAS VALVE TRAIN FOR EACH BURNER

- A. Provide a pressure gauge to indicate the gas burner manifold pressure (optional).
- B. Furnish and install one manually operated, inch, ball valve upstream of all valves.
- C. Provide one inch, main gas pressure regulator (of tight shutoff type) with vent to outside atmosphere, in accordance with local codes.
Specify a tight shutoff type gas pressure regulator when the inlet gas pressure exceeds 1-1/2 psig.
- D. Provide one inch, automatically operated motorized safety gas valve.
- E. One safety shutoff valve shall be proven closed during pre-ignition by proof of valve closure interlock switch on valve.
- F. Provide a second inch, automatically operated gas safety shutoff valve to operate simultaneously with the above gas valve.
- G. A manually operated gas valve shall be located downstream of both automatic gas valves to permit leakage testing of the valves.

H. Gas pressure monitoring shall be provided by approved pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of either high or low gas pressure (optional on sizes 150-250).

2.8 BURNER CONTROLS

- A. The full modulation of the burner shall be controlled by steam pressure by means of a pressure control.
- B. An additional high limit safety pressure control of the manual reset type shall be provided to control the burner.
- C. Pre-purge and post-purge operation of the burner fan shall be provided per current UL/cUL requirements.
- D. The burner shall utilize a CB12E type flame safeguard programmer incorporating LED indicator lights to annunciate the current operating status of the burner.
- E. A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.
- F. All three-phase motors shall be controlled and protected by an automatic starter with thermal overload protection. The starter shall be inter-locked to prevent burner operation when over-load relays are tripped out.
- G. Supply a burner-mounted diaphragm air flow switch to prevent the energization of the main fuel valves in the event of insufficient combustion air, or to provide safety shutdown in the event of combustion air interruption.
- H. A factory-wired control cabinet shall be supplied and mounted on the burner. The control cabinet shall house the flame safeguard control, programming timer, burner motor starter, fuses, control circuit transformer, control switches, indicating lamps and relays as required.
- I. Provide four individual lights with nameplates on the control cabinet to indicate "call for heat," "main fuel valve on," "low water," and "main flame failure."
- J. Option (specify A or B)
1. The changing from one fuel to the other shall be manual by means of a fuel selector switch. No burner adjustments shall be required to switch from one fuel to the other.
 2. Changing from one fuel to the other shall be automatically controlled by the outdoor temperature switch, or other external device. No burner adjustment shall be required to switch from one fuel to the other.
- K. The burner shall be equipped with suitable fuel and air controls to assure smooth main flame ignition. The burner shall utilize a proportional air flow damper design, including independent low-fire and high-fire air flow shutter assemblies for ease of adjustment and consistent excess air performance throughout the firing range.
- L. Fuel-air control shall be synchronized. The fuel air drive unit shall be provided with a position indicating switch interlocked with the flame safeguard system to assure starting at the low fire position. The flame safeguard system shall further program this drive unit to provide a full open louver of sufficient time to provide a four air change pre-ignition of the combustion chamber, heat exchanger, and flue passages.

- M. Pre-ignition pure air flow rate shall not be less than 60% maximum firing rate air flow. Interlocks shall be provided to monitor and prove 60% air flow purge when air inlet louvers are automatically opened to obtain this rate.
- N. Full modulation of fuel input shall be provided. A modulating pressure control shall be supplied to modulate a burner mounted damper motor controlling both fuel and air supply by means of direct mechanical linkage.
- O. Electronic safety combustion controls shall be supplied, complete with ultra-violet flame scanner to monitor the pilot and main flame. It shall be so utilized as to provide intermittent type gas-electric ignition and pre-ignition timer. Flame rod will not be permitted for proving pilot or main flame.

PART 3 EXECUTION 3.1 WARRANTY

All equipment is to be guaranteed against defects in material and/or workmanship for a period of 12 months from the date of start-up or 18 months from the date of shipment, whichever ever comes first. In addition the boiler pressure vessel shall be warranted against damage resulting from thermal stress for a period of 20 years from date of shipment provided the boiler is operated and maintained in accordance with the conditions specified in the owner's Operator and Maintenance Manual. Refer to the FLX Boiler warranty.

3.2 FIELD ERECTABLE

The specified boiler/burner package shall be shipped disassembled for field assembly. All pieces and components must fit through a standard doorway. Assembly shall be accomplished with ordinary hand tools, with no welding or rolling required. Major casing components are to be shipped with insulation and refractory installed for ease of assembly.

Model FLX Boilers

(FLX Hot Water Boiler Specifications)

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SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application. A separate specification is provided for hot water boiler and steam boiler packages.

PART 1 GENERAL 1.1 BOILER CAPACITY

- A. The hot water boiler shall be Cleaver-Brooks Model FLX (FLE for field erected), designed for 160 psig (hot water). Maximum water temperature shall be °F, and maximum system temperature drop shall be °F.
- B. The boiler shall have a maximum output of Btu/hr when fired with No. 2 oil, and/or Btu/cu- ft when fired with natural gas. Available electrical power will be Volt, phase, Hz.

PART 2 PRODUCTS 2.1 GENERAL BOILER DESIGN

- A. The boiler shall be a two-drum, flexible watertube design with a tangent-tube waterwall furnace mounted on a heavy steel frame. Top, bottom and sides of the furnace shall be water cooled.
- B. The boiler pressure vessel must be constructed in accordance with ASME Boiler Code, and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser. The complete packaged boiler - burner unit shall be listed by Underwriters Laboratories, and shall have the UL/cUL label affixed to the front head.
1. The boiler drums shall be furnished with handholes to facilitate boiler inspection and cleaning.
 2. Boiler tubes shall be 1.5" diameter, with 0.095" wall thickness, and shall be easy to remove and replace without expanding or welding the tube attachment to the drums.
 3. The boiler shall have a sufficiently sized downcomer to provide natural internal circulation.
 4. The burner shall be mounted on a hinged backing plate for easy access to the furnace.
- C. Observation ports for the inspection of flame conditions shall be provided at the rear of the boiler, and in the burner assembly at the front.
- D. The tangent wall tubes shall be covered with 1-1/2 inches of insulation under a gas-tight, 16-gauge inner casing. There shall be 2 inches of insulation between the inner and outer casing. The outer casing shall be 20 gauge. The boiler base frame and other components shall be factory-painted before shipment, using a hard enamel finish.

2.2 HOT WATER BOILER TRIM

- A. The following items will be installed on the boiler.
1. Low Water Cut-Off: A probe-type, low water cut-off control shall be mounted in the upper drum. It is to be wired to the burner control circuit to prevent burner operation if the boiler water falls below a safe level.
 2. Miscellaneous: A combustion temperature and pressure gauge shall be mounted on the boiler. Temperature controls, for regulation of burner operation, shall be mounted on the boiler and the temperature sensing element shall be located adjacent to the boiler outlet. Water relief valves (shipped loose) shall be of a type and size to comply with ASME Code requirements.

2.3 BURNER AND CONTROLS

- A. The boiler shall be provided with a UL/cUL approved fuel burning system in full accordance with the requirements of state, provincial and local codes, the local gas utility, and other applicable regulatory bodies. The burner shall be a Cleaver-Brooks ProFire burner or approved equal.
- B. Option (specify 1.) or 2.), as required)
1. The complete fuel burning system shall be in full accordance with Factory Mutual (FM) requirements.
 2. The complete fuel burning system shall be in full accordance with Industrial Risk Insurers (IRI) requirements.
- C. Burner Description
1. Option (specify a, b, or c)
 - a. The boiler shall include a gas burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/cu-ft of _____ gas at a pressure of _____ (lbs/sq-in.) (inches of water column) at the inlet of the burner gas control train.
 - b. The boiler shall include an oil burner having rated capacity to burn _____ gph of No. 2 fuel oil.
 - c. The boiler shall include a combination gas-oil burner having rated capacity to burn _____ MMBtu/hr of _____ Btu/ cu-ft gas at a pressure of _____ (lbs/sq-in.) (inches of water column) at the inlet to the burner gas control train or _____ gph of No. 2 fuel.
 2. The burner shall be forced draft type with full firing rate modulation. All combustion air shall be furnished by the burner fan, which shall be an integral part of the burner. Each burner motor shall not be larger than _____ hp, _____ phase.
- D. Option (specify 1.), 2.), or 3.))
1. The gas burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than _____ 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
 2. B. The light oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and a maximum of No. 1 smoke spot, as measured on the Bacharach Scale.
 3. C. The gas-oil burner shall burn the specified quantity of fuel without objectionable vibration, noise, or pulsation, with not more than 15% excess air and less than 100 ppm (corrected to 3% O₂) CO in the products of combustion on gas firing, and a maximum of No. 1 smoke spot, as measured on the Bacharach Scale when burning oil. In addition, when firing gas, the burner shall be guaranteed to produce less than _____ ppm (corrected to 3% O₂) NO_x emissions.
- E. Primary-secondary air control shall be a design function of the combustion head. Combustion heads requiring an internal adjustment shall not be acceptable.
- F. The burner shall be equipped with an aluminium reverse curve fan for lower fan motor hp requirements and self-cleaning characteristics.
- G. A permanent observation port shall be provided in the burner to allow observation of both the pilot and main flame. Both the pilot and the flame scanner shall be easily accessible without opening or disassembling the burner.

H. Supply voltage available shall be _____ Volts, _____ phase, 60 Hz. All motors shall be suitable for use on this voltage. All burner controls are to be for use on 120 volts, 1 phase, 60 Hz.

I. The burner shall be factory fire-tested to ensure proper operation before shipment.

2.4 PILOT GAS TRAIN FOR EACH BURNER (MOUNTED, PIPED, AND WIRED)

A separate pilot gas cock, gas pressure regulator, and pilot safety shutoff gas valve, shall be provided for the ignition gas supply.

2.5 OIL BURNER

A. The oil burner shall be of the mechanical pressure atomizing type. B. A two-stage oil pump shall be provided for each burner as an integral part of the burner.

C. Two approved automatically operated safety shutoff valve(s) shall be provided in the oil supply line to the burner valves to be piped in series but wired parallel.

D. Supply an oil pressure gauge to indicate the discharge oil pump pressure.

E. Install a manual valve, fuel oil filter, or strainer and vacuum gauge on the suction side of the oil pump (optional).

F. Install a fusible-link-actuated oil safety shutoff valve in the oil supply line between the oil tank and the manual gate valve at the oil pump (optional).

G. Oil pressure monitoring shall be provided by an approved pressure switch interlocked to accomplish a non-recycling safety shutdown in the event of low oil pressure (optional).

2.6 GAS VALVE TRAIN FOR EACH BURNER

A. Provide a pressure gauge to indicate the gas burner manifold pressure (optional).

B. Furnish and install one manually operated, _____ inch, ball valve upstream of all valves.

C. Provide one _____ inch, main gas pressure regulator (of tight shutoff type) with vent to outside atmosphere, in accordance with local codes.

Notice

Specify a tight shutoff type gas pressure regulator when the inlet gas pressure exceeds 1-1/2 psig.

D. Provide one inch, automatically operated motorized safety gas valve. One safety shutoff valve shall be proven closed during pre-ignition by proof of valve closure interlock switch on valve.

E. Provide a second _____ inch, automatically operated gas safety shutoff valve to operate simultaneously with the above gas valve.

F. A manually operated gas valve shall be located downstream of both automatic gas valves to permit leakage testing of the valves.

G. Gas pressure monitoring shall be provided by approved pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of either high or low gas pressure (optional on sizes 150-250).

2.7 BURNER CONTROLS

- A. The full modulation of the burner shall be controlled by water temperature by means of a temperature control.
- B. An additional high limit safety temperature control of the manual reset type shall be provided to control the burner.
- C. Pre- and post- operation of the burner fan shall be provided per current UL/cUL requirements.
- D. The burner shall utilize a Fireye™ CB120E type flame safeguard programmer, incorporating LED indicator lights to annunciate the current operating status of the burner.
- E. A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.
- F. All three-phase motors shall be controlled and protected by an automatic starter with thermal overload protection. The starter shall be inter-locked to prevent burner operation when over-load relays are tripped out.
- G. Supply a burner-mounted diaphragm air flow switch to prevent energizing the main fuel valves in the event of insufficient combustion air, or to provide safety shutdown in the event of combustion air interruption.
- H. A factory-wired control cabinet shall be supplied and mounted on the burner. The control cabinet shall house the flame safeguard control, programming timer, burner motor starter, fuses, control circuit transformer, control switches, indicating lamps, and relays as required.
- I. Provide four individual lights with nameplates on the control cabinet to indicate “call for heat,” “main fuel valve on,” “low water,” and “main flame failure.”
- J. Option (specify 1.) or 2.))
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