

Model FLX

12.5 - 25 MMBTU



TABLE OF CONTENTS

FEATURES AND BENEFITS	3
PRODUCT OFFERING	4
Standard Equipment	5
Optional Equipment	5
DIMENSIONS AND RATINGS	6
PERFORMANCE DATA	13
Efficiency	13
Emissions	13
ENGINEERING DATA	13
Burner/Control Information	14
Outdoor Reset Control	17
SAMPLE SPECIFICATIONS	21
Steam	21
Hot Water	27

ILLUSTRATIONS

Figure 1. Dimension Diagram FLX Steam 9
 Figure 2. Dimension Diagram FLX Hot Water. 11
 Figure 3. Model FLX Tube Attachment 14
 Figure 4. Model FLX Oil Burner Supply Pump Installation 15
 Figure 5. Model FLX Clearance Requirements 18
 Figure 6. Model FLX Breeching Arrangement - Single or Multiple Boiler Installation 19

TABLES

Table 1. Model FLX Watertube Boiler Sizes 4
 Table 2. Model FLX Steam Boiler Ratings 7
 Table 3. Model FLX Hot Water Boiler Ratings 86
 Table 4. 8Steam Dimensions 9
 Table 5. Hot Water Dimensions 11
 Table 6. NOx, CO, Excess Air, and Turndown 13
 Table 7. Model FLX Maximum Flow Rates, Hot Water Boiler 16
 Table 8. Model FLX Minimum Flow Rates, Hot Water Boiler 16
 Table 9. Model FLX Minimum Over Pressure Requirements 16
 Table 10. Model FLX Burner Characteristics 16
 Table 11. Model FLX Minimum Required Gas Pressure 16
 Table 12. Model FLX Sound Levels 18
 Table 13. Recommended Steam Nozzles. 19

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 12.5 to 25 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***Patented Vessel and Tube Design:***

- Ensures that all tubes are subject to radiant heat from the burner flame.
- Creates high water-flow rates at all loads, and increases heat transfer throughout the boiler.

Large Downcomer, Located Outside the Fire Zone:

- Guarantees positive natural internal circulation, minimizing the impact of exterior pumping conditions.

True Tangent-Wall Design:

- No fins or strips to substitute for tubes.
- Ensures maximum cooling and uniform heat transfer throughout the boiler.

Five-Pass Boiler Design:

- Creates high flue gas velocities to rapidly and efficiently transfer heat to the water.
- Higher efficiencies compared to other tangent-tube designs.

Optimized Tube Designs:

- Eliminates possible damage from thermal shock stresses.
- Reduces maintenance costs.
- Prolongs equipment life.

Weldless Tube Attachment:

- Eliminates the need for rolling or welding tubes.
- Lessens repair or replacement requirements.
- Ease of tube replacement reduces downtime.

Burner hinged for easy access:

- No crane/hoist is required to remove burner and components for inspection.
- Provides easy inspection access.
- Reduces maintenance costs.

Insulated Construction:

- Reduces thermal losses.
- Increases efficiency.

Low NOx Capability:

- NOx reduction to <9 ppm available.
- Meets stringent emission requirements with no loss in operating performance.

ASME Construction:

- Ensures high quality design and manufacturing standards.
- Ensures safety and reliability.

Cleaver-Brooks Forced Draft Burner:

- Provides high pressure drop for low CO and maximum combustion performance.
- Reduces stack draft requirements.

- Optimum fuel and air mixing.
- Long-life reverse curve impeller.
- Ensures maximum combustion efficiency, as low as 10% excess air.
- Burner/Boiler by single manufacturer.

Removable Side Panels:

- Provides easy access for inspection.
- Reduces maintenance costs.
- Ensures containment of furnace gases.
- Rugged construction for durability.

25-Year Pressure Vessel Warranty:

- Guaranteed to last.
- Backed by Cleaver-Brooks.

Field Erectable (Optional):

- Complete package for ease of assembly.
- Pieces fit through standard doorway.

PRODUCT OFFERING

Information in this section applies to steam and hot water boiler sizes ranging from 12.5 to 25 MMBtu/hr input, as shown in Table 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(s) (rear downcomer for hot water, front and rear for steam boilers) connected to the top and bottom drums. The heated area of the pressure vessel is contained within a gas-tight, insulated casing that is

Table 1. Model FLX Watertube Boiler Sizes

MODEL	CAPACITY INPUT BTU/HR	HEAT OUTPUT BTU/HR	EQUIV HP
FLX-1250	12,500,000	10,000,000	300
FLX-1450	14,500,000	11,600,000	350
FLX-1650	16,500,000	13,200,000	400
FLX-1850	18,500,000	14,800,000	450
FLX-2100	21,000,000	16,800,000	500
FLX-2500	25,000,000	20,000,000	600

NOTES:

1. Standard Design Pressure: 160 psig Hot Water, 15 psig Steam, 150 psig Steam.
2. Also available in Model FLE (field erectable).
3. Optional design pressure to 250 psig steam or water for sizes 1250 and 1450, and 200 psig for 1650 through 2500.

composed of removable, formed-steel panels. The boiler/burner package is manufactured by Cleaver-Brooks and UL/cUL approved as a package.

Standard Equipment

Equipment described below is for the standard boiler offering.

1. Boiler:
 - A. All boilers are designed and constructed in accordance with the ASME Code and are mounted on an integral frame. All refractories for boiler and burner are installed.
 - B. Factory fire test.
 - C. Rear access port for furnace inspection.
2. Cleaver-Brooks ProFire™ Forced Draft Burner:
 - A. Hinged windbox assembly for easy access to burner.
 - B. Air atomizing type for No. 2 oil burner. Includes air compressor assembly (remote oil pump optional).
 - C. Stainless steel flame-retention type combustion head for gas, with IR scanner, and gas pressure regulator.
 - D. External access to flame scanner for ease of maintenance.
 - E. Parallel positioning for precise combustion control.
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, modulating, and limit controls:
 - E. High limit control - manual reset.
 - F. Operating limit control - automatic reset.
 - G. Low water cutoff/modulating pump control: CB Level Master (steam boilers)
 - H. Probe type control for hot water boilers.
 - I. Float type main and probe type auxiliary- steam.
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.

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

Hot Water Boilers with operating temperature above 250 F or operating pressure greater than 160 are constructed under Section I of the ASME Code and 'S' Stamped for high pressure water boilers.

Notice

Steam boilers with design pressure of 30 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 and greater are constructed under Section I of the ASME code and 'S' stamped for high pressure steam boilers.

Optional Equipment

For option details, contact your local Cleaver-Brooks authorized representative. In summary, options include the following:

1. Boiler Options
 - Auxiliary low water cut-off (hot water).
 - Stack thermometer.
 - Drain valves.
 - Steam Stop and Non Return valves.
 - Blowdown and Blowoff valves.
 - Feedwater valves and feedwater regulators.
 - Additional screwed tappings.
 - Packaged for field erection.
2. Burner/Control Options
 - Special burner modulation controls.
 - Low NOx burner.
 - Optional flame safeguard controller.
 - Optional remote oil pump
 - Lead/lag system.
 - High altitude design - up to 10,000 ft.
 - Special insurance and code requirements (e.g. FM, NFPA85).
 - Alarm horn/silence switch.
 - Special motor requirements (TEFC, high efficiency).
 - Remote contacts.
 - Additional relay points and indicator lights.
 - Main disconnect (fusible/circuit breaker).
 - 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.
 - LP pilot.
 - Automatic fuel changeover.

DIMENSIONS AND RATINGS

Ratings for steam and hot water boilers are shown in Table 2 and Table 3. Dimensions for steam and hot water boilers are shown in Figures 1-2 and Tables 4-5.

Table 2. FLX 1250-2500 Steam Ratings

	Boiler Model					
	1250	1450	1650	1850	2100	2500
Ratings [Note A]						
Rated Horsepower	300	350	400	450	500	600
Rated Steam Capacity [PPH from and at 2120 F]	10,350	12,075	13,800	15,525	17,250	20,700
Output Btu/hr [1,000 Btu/h]	10,043	11,716	13,390	15,064	16,738	20,085
Output Kcal/Hr [1,000 Kcal/h]	2,530	2,952	3,374	3,796	4,218	5,061
Output KW	294	343	392	441	491	589
Approximate Fuel Consumption [Input - Note B]						
Natural Gas [ft3/hr]	12,247	14,288	16,329	18,370	20,412	24,494
Natural Gas [m3/hr]	355	414	473	533	592	711
Natural Gas [Therms/Hour]	122.5	142.9	163.3	183.7	204.1	245
Propane Gas [ft3/hr]	4,899	5,715	6,532	7,348	8,165	9,798
Propane Gas [m3/hr]	138.7	161.8	185	208.1	231.2	277.5
No.2 Oil Fuel - gph	87.5	102.1	116.6	131.2	145.8	175
No.2 Oil Fuel - liters/hour	331.2	386.5	441.4	496.6	551.9	662.4
Power Requirements - Standard [Note A & C]						
Blower Motor HP [Note D]	10/15	15	15	20	10/15	20/25
Air Compressor Motor [Oil or Combination Gas/Oil]	5	5	7.5	7.5	7.5	7.5
Oil Pump [Straight Oil or Combination Gas/Oil]	1/2	1/2	1/2	1/2	3/4	3/4
Minimum Ampacity - Standard						
Blower Motor 230/3/60 [Note D]	28/42	42	42	54	28/42	54/68
Blower Motor - 460/3/60 [Note D]	14/21	21	21	27	14/21	27/34
Blower Motor - 575/3/60 [Note D]	11/17	17	17	22	11/17	22/27
Air Compressor Motor - Oil or Combination, 230/3/60	15	15	22	22	22	22
Air Compressor Motor - Oil or Combination, 460/3/60	7.6	7.6	11	11	11	11
Air Compressor Motor - Oil or Combination, 575/3/60	6.1	6.1	9	9	9	9
Metering Oil Pump, [230]460/3/60	[2] 1.1	[2] 1.1	[2] 1.1	[2] 1.1	[3] 1.6	[3] 1.6
Metering Oil Pump, 575/3/60	0.9	0.9	0.9	0.9	1.3	1.3
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9
Weights						
Operating Weight, lbs.	19,200	20,800	26,300	27,700	38,400	43,100
Operating Weight, kg	8,709	9,435	11,929	12,564	17,418	19,550
Water Content Normal, gallons	389	423	602	638	940	1064
Water Content Normal, liters	1473	1601	2279	2415	3558	4028
Shipping Weight, approximate lbs.	16,000	17,300	21,200	22,200	30,500	34,100
Shipping Weight, approximate kg	7,257	7,847	9,616	10,070	13,834	15,467

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

D. Motor HP's and amp ratings are for uncontrolled/30ppm configurations

Table 3. FLX 1250-2500 Hot Water Ratings

	Boiler Model					
	1250	1450	1650	1850	2100	2500
Ratings [Note A]						
Rated Horsepower	300	350	400	450	500	600
Output Btu/hr [1,000 Btu/h]	10,043	11,716	13,390	15,064	16,738	20,085
Output Kcal/Hr [1,000 Kcal/h]	2,530	2,952	3,374	3,796	4,218	5,061
Output KW	294	343	392	441	491	589
Approximate Fuel Consumption [Input - Note B]						
Natural Gas [ft3/hr]	12,247	14,288	16,329	18,370	20,412	24,494
Natural Gas [m3/hr]	355	414	473	533	592	711
Natural Gas [Therms/Hour]	122.5	142.9	163.3	183.7	204.1	245
Propane Gas [ft3/hr]	4,899	5,715	6,532	7,348	8,165	9,798
Propane Gas [m3/hr]	138.7	161.8	185	208.1	231.2	277.5
No.2 Oil Fuel - gph	87.5	102.1	116.6	131.2	145.8	175
No.2 Oil Fuel - liters/hour	331.2	386.5	441.4	496.6	551.9	662.4
Power Requirements - Standard [Note A & C]						
Blower Motor HP [Note D]	10/15	15	15	20	10/15	20/25
Air Compressor Motor [Oil or Combination Gas/Oil]	5	5	7.5	7.5	7.5	7.5
Oil Pump [Straight Oil or Combination Gas/Oil]	1/2	1/2	1/2	1/2	3/4	3/4
Minimum Ampacity - Standard						
Blower Motor 230/3/60 [Note D]	28/42	42	42	54	28/42	54/68
Blower Motor - 460/3/60 [Note D]	14/21	21	21	27	14/21	27/34
Blower Motor - 575/3/60 [Note D]	11/17	17	17	22	11/17	22/27
Air Compressor Motor - Oil or Combination, 230/3/60	15	15	22	22	22	22
Air Compressor Motor - Oil or Combination, 460/3/60	7.6	7.6	11	11	11	11
Air Compressor Motor - Oil or Combination, 575/3/60	6.1	6.1	9	9	9	9
Metering Oil Pump, [230]460/3/60	[2] 1.1	[2] 1.1	[2] 1.1	[2] 1.1	[3] 1.6	[3] 1.6
Metering Oil Pump, 575/3/60	0.9	0.9	0.9	0.9	1.3	1.3
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9
Weights						
Operating Weight, lbs.	15,400	16,600	21,200	22,400	31,000	34,800
Operating Weight, kg	6,985	7,530	9,616	10,160	14,061	15,785
Water Content Normal, gallons	306	335	507	550	796	906
Water Content Normal, liters	139	152	1919	2082	3013	3430
Shipping Weight, approximate lbs.	12,800	13,800	16,900	17,700	24,300	27,200
Shipping Weight, approximate kg	5,806	6,260	7,666	8,029	11,022	12,338

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

D. Motor HP's and amp ratings are for uncontrolled/30ppm configurations

Figure 1. Dimension Diagram, FLX Steam

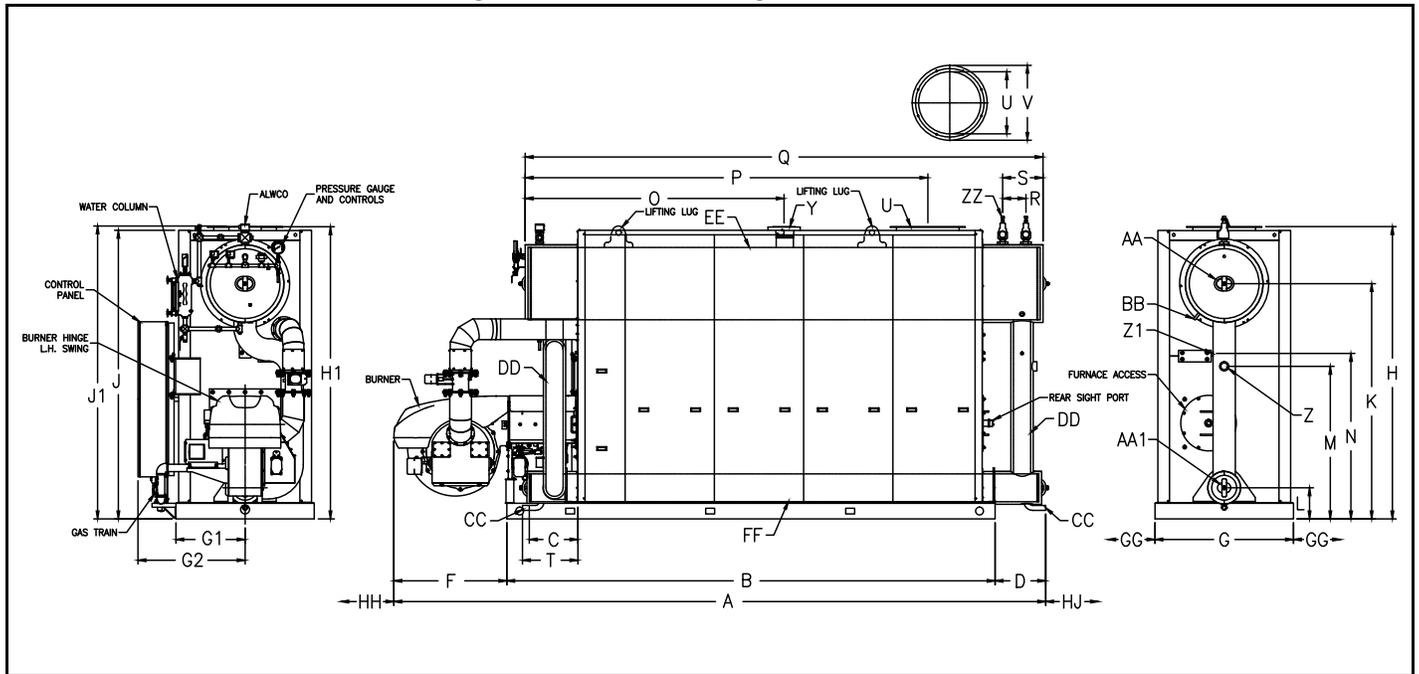


Table 4. FLX 1250-2500 Steam Dimensions

Dimension	BOILER SIZE [SEE NOTE 1]						
	1250	1450	1650	1850	2100	2500	
LENGTHS Inches							
Overall [See Note 2]	A	252	267	278.75	297.75	306.75	336.75
Boiler Base Frame	B	188.75	203.75	217.75	231.75	245.75	270.75
Front Extension Lower Drum	C	18.75	18.75	21.5	21.5	21.5	21.5
Rear Extension Lower Drum	D	19.5	19.5	22.25	22.25	22.25	22.25
Burner Extension [See Note 2]	F	43.75	43.75	38.75	43.75	38.75	38.75
WIDTHS Inches							
Boiler Base Frame [See Note 3]	G	53.5	53.5	60	60	75	75
Centerline to Casing	G1	26.75	26.75	30	30	37.5	37.5
Width to outside of Control Panel/Gas Train	G2	41.5	41.5	45	45	52.5	52.5
HEIGHTS Inches							
Base to Stack Flange	H	113	113	121	121	149	149
Base to Steam Nozzle	H1	113	113	121	121	149	149
Base to Top of Casing	J	111.5	111.5	119.5	119.5	147.5	147.5
Base to Lifting Lug	J1	113.25	113.25	121.25	121.25	149.25	149.25
Base to Upper Drum Centerline	K	91	91	99	99	125	125
Base to Lower Drum Centerline	L	12	12	12	12	15	15
Base to Feedwater Connection	M	59	59	67	67	81	81
Base to Chemical Feed	N	64	64	72	72	86	86
LOCATIONS Inches							
Front Casing to Steam Nozzle	O	100	107.5	116.75	123.75	130.75	145.75
Flue Outlet Centerline	P	155.5	170.5	187.25	201.25	215.25	245.25
Front Casing to Upper Drum Rear	Q	200.25	215.25	233.25	247.5	261.5	291.5
Safety Valves 15 PSIG Setpoint	R	9	9	[Note 4]	[Note 4]	[Note 4]	[Note 4]

Table 4. FLX 1250-2500 Steam Dimensions (Continued)

	Dimension	BOILER SIZE [SEE NOTE 1]					
		1250	1450	1650	1850	2100	2500
Safety Valves 15 PSIG Setpoint	S	15.5	15.5	[Note 4]	[Note 4]	[Note 4]	[Note 4]
Safety Valves 150 PSIG Setpoint	R	9	9	9	9	9	9
Safety Valves 150 PSIG Setpoint	S	15.5	15.5	15.5	15.5	15.5	15.5
Bottom Drain/Blowdown	T	21.5	21.5	24.75	24.75	24.75	24.75
PIPING CONNECTIONS Inches							
Flue Gas ID	U	24	24	24	24	24	24
Flue Gas Outlet Flange	V	29	29	29	29	29	29
Flange Bolt Circle Diameter	W	26.5	26.5	26.5	26.5	26.5	26.5
Number of Bolt Holes	X	8	8	8	8	8	8
Steam Nozzle 15 PSIG Design Boiler	Y	12	12	12	12	12	12
Steam Nozzle 150 PSIG Design Boiler	Y	6	6	6	8	8	8
Feedwater Makeup	Z	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
Chemical Feed	Z1	1/2	1/2	1/2	1/2	1/2	1/2
Surface Blowff	BB	1	1	1	1	1	1
Bottom Drain/Blowdown 15 PSIG Design	CC	2	2	2	2	2	2
Bottom Drain/Blowdown 150 PSIG Design	CC	1 1/2	1 1/2	2	2	2	2
Safety Valves, 15 psig [qty and outlet size] [see Note 4]	ZZ	2 @ 3	2 @ 3	1 @ 2 1/2 2 @ 3	1 @ 2 1/2 2 @ 3	4 @ 3	4 @ 3
Safety Valves, 150 psig [qty and outlet size] [see Note 4]	ZZ	2 @ 2	1 @ 2 1/2 1 @ 2	1 @ 2 1/2 1 @ 2	1 @ 2 1/2 1 @ 2	2 @ 2 1/2	2 @ 2 1/2
GENERAL DATA							
Manway Upper Drum, 15 PSIG	AA	12x16	12x16	12x16	12x16	12x16	12x16
Handhole Upper Drum, 150 PSIG	AA	4x6	4x6	4x6	4x6	4x6	4x6
Handhole Lower Drum	AA1	4x5	4x5	4x5	4x5	4x5	4x5
Downcomer Size [NPS]	DD	6	6	8	8	8	8
Upper Drum OD	EE	28	28	28	28	32	32
Lower Drum OD	FF	10.75	10.75	10.75	10.75	12.75	12.75
MINIMUM SERVICE CLEARANCES							
Tube removal each side	GG	40	40	47	47	62	62
Rear service area	HJ	24	24	24	24	24	24
Front service area - burner removal	HH	36	36	36	36	36	36

Dimension letters E and I are not used.

Notes:

1. Multiply size by 10,000 to obtain BTU/hr input of the boiler.
2. Subtract 5 inches to the overall length (A) and burner extension (F) for FLX 1250, 1450, 1850 with uncontrolled burner.
Add 5 inches to the overall length (A) and burner extension (F) for FLX 2500 with NT burner.
3. Add 4 inches to each side of base frame width (G) to account for optional seismic anchor pads on each side.
4. Quantity and size of valves are based on the standard settings noted; quantity and size may change depending on non standard valves settings.

Figure 2. Dimension Diagram, FLX Hot Water

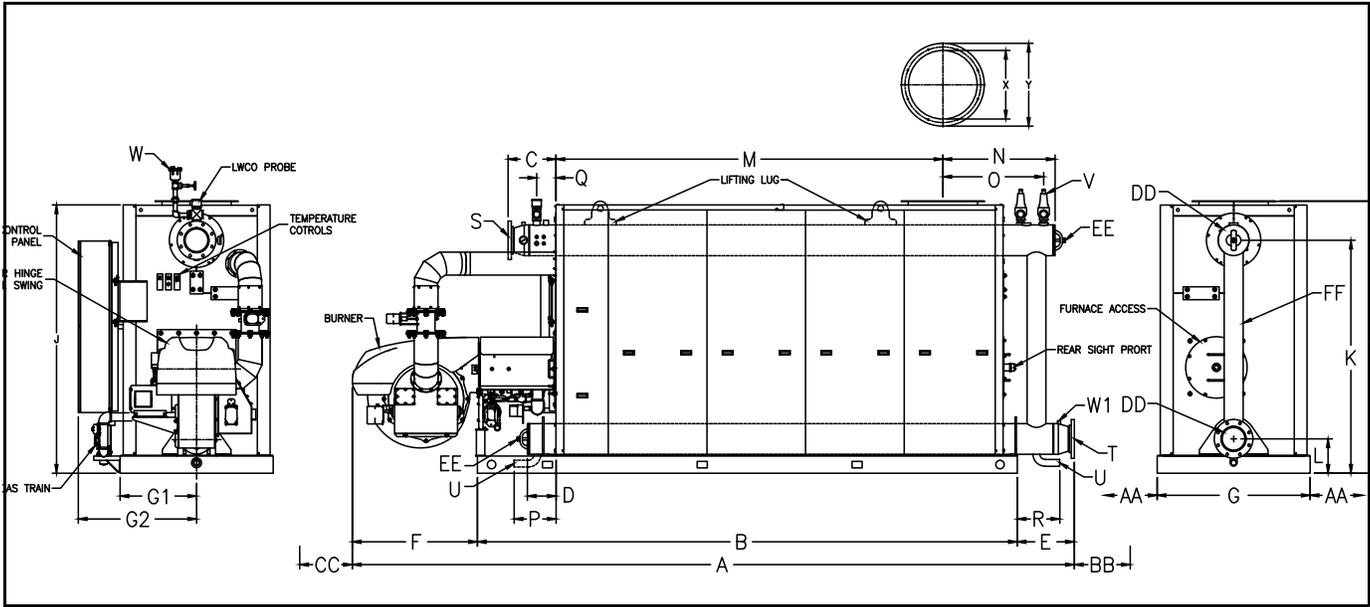


Table 5. FLX 1250-2500 Hot Water Dimensions

	Dimension	BOILER SIZE [SEE NOTE 1]					
		1250	1450	1650	1850	2100	2500
LENGTHS Inches							
Overall Length of Boiler Package [See Note 2]	A	252.5	267.5	279.25	298.25	311.25	340.25
Boiler Base Frame	B	188.75	203.75	217.75	231.75	245.75	275.75
Front Extension Upper Drum	C	16.75	16.75	16.5	16.5	17.75	17.75
Front Extension Lower Drum	D	10	10	10.75	10.75	10.75	10.75
Rear Extension Lower Drum	E	20	20	22.75	22.75	26.75	25.75
Burner Extension [See Note 2]	F	43.75	43.75	38.75	43.75	38.75	38.75
WIDTHS Inches							
Boiler Base Frame [See Note 3]	G	53.5	53.5	60	60	75	75
Centerline to Casing	G1	26.75	26.75	30	30	37.5	37.5
Centerline to outside Control Panel/ Gas Train	G2	41.5	41.5	45	45	52.5	52.5
HEIGHTS Inches							
Base to Stack Flange [overall]	H	95.5	95.5	107	107	131.5	131.5
Base to Lifting Lug	I	95.5	95.5	107	107	131.5	131.5
Base to Top of Casing	J	94	94	105.5	105.5	130	130
Base to Supply Nozzle	K	81.5	81.5	93	93	117	117
Base to Return Nozzle	L	12	12	12	12	15	15
LOCATIONS Inches							
Flue Outlet Centerline	M	135.25	150.25	164.25	178.25	192.25	222.25
Rear Extension Upper Drum	N	39.25	39.25	45.75	45.75	47.75	47.75
Safety Valves	O	35.25	35.25	41.75	41.75	43.75	43.75
Bottom Drain	P	14.75	14.75	14.75	14.75	14.75	14.75
Boiler Air Vent	Q	6.75	6.75	6.5	6.5	6.5	6.5
Bottom Drain Rear	R	14.75	14.75	16.5	16.5	20.5	19.5

Table 5. FLX 1250-2500 Hot Water Dimensions (Continued)

	Dimension	BOILER SIZE [SEE NOTE 1]					
		1250	1450	1650	1850	2100	2500
PIPING CONNECTIONS Inches							
Supply Nozzle [See Note 4]	S	8	8	10	10	10	12
Return Nozzle [See Note 4]	T	8	8	10	10	10	12
Bottom Drain	U	2	2	2	2	2	2
Safety Valves, 30 psig [qty and outlet size] [Note 5]	V	2 @ 2-1/2	2 @ 2-1/2	1 @ 2 2 @ 2-1/2	1 @ 2 2 @ 2-1/2	4 @ 2-1/2	4 @ 2-1/2
Safety Valves, 60 psig [qty and outlet size] [Note 5]	V	1 @ 2 1 @ 2-1/2	1 @ 2 1 @ 2-1/2	1 @ 2 1 @ 2-1/2	1 @ 2 1 @ 2-1/2	1 @ 2 2 @ 2-1/2	1 @ 2 2 @ 2-1/2
Safety Valves, 125 psig [qty and outlet size] [Note 5]	V	1 @ 2-1/2	1 @ 2-1/2	1 @ 2-1/2	1 @ 2-1/2	1 @ 2 1 @ 2-1/2	1 @ 2 1 @ 2-1/2
Safety Valves, 160 psig [qty and outlet size] [Note 5]	V	1 @ 2	1 @ 2	1 @ 1 1 @ 2	1 @ 1 1 @ 2	2 @ 2	2 @ 2
Boiler Air Vent	W	2	2	2	2	2	2
Tapping for optional temp sensor.	W1	1/2	1/2	1/2	1/2	1/2	1/2
Flue Gas ID	X	24	24	24	24	24	24
Flue Gas Outlet Flange	Y	29	29	29	29	29	29
Flange Bolt Circle Diameter	Z	26.5	26.5	26.5	26.5	26.5	26.5
Number of holes in bolt circle.	ZZ	8	8	8	8	8	8
MINIMUM SERVICE CLEARANCES							
Tube removal each side	AA	40	40	47	47	62	62
Rear service area	BB	24	24	32	32	32	38
Front service area - burner removal	CC	36	36	36	36	36	36
PERIPHERAL DATA							
Upper/Lower Drum OD	DD	10.75	10.75	10.75	10.75	12.75	12.75
Handhole Inspection	EE	4x5	4x5	4x5	4x5	4x5	4x5
Rear Downcomer Size [NPS]	FF	6	6	8	8	8	8

Notes:

1. Multiply size by 10,000 to obtain BTU/hr input of the boiler.
2. Subtract 5 inches to the overall length (A) and burner extension (F) for FLX 1250, 1450, 1850 with uncontrolled burner.
Add 5 inches to the overall length (A) and burner extension (F) for FLX 2500 with NT burner.
3. Add 4 inches to each side of base frame width (G) to account for optional seismic anchor pads on each side.
4. Supply and return nozzle flanges are Class 150 Flat Face.
5. Quantity and size of valves are based on the standard valve settings noted; quantity and size may change for non standard settings.

PERFORMANCE DATA**Emissions**

Expected emissions for natural gas fired FLX boilers are shown in Table 6.

Table 6. NO_x, CO, Excess Air, and Turn Down

Boiler Model	Uncontrolled NO _x			30 ppm NO _x		
	Turn Down	CO - ppm	Excess Air	Turn Down	CO - ppm	Excess Air
FLX-1250	10:1	50	See Note A	7:1	150/50 ^B	20%
FLX-1450	10:1	50	See Note A	7:1	150/50 ^B	20%
FLX-1650	10:1	50	See Note A	7:1	150/50 ^B	20%
FLX-1850	10:1	50	See Note A	7:1	150/50 ^B	20%
FLX-2100	10:1	50	See Note A	7:1	150/50 ^B	20%
FLX-2500	10:1	50	See Note A	7:1	150/50 ^B	20%

Notes:

"A" 45% Excess air required at low fire, 15% excess air at 50, 75, 100% rate

"B" 150 ppm CO at low fire, 50 ppm CO at 25-100% rate

ENGINEERING DATA**System Operating Parameters (Hot Water)**

System over pressure requirements are shown in Table 3.

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:

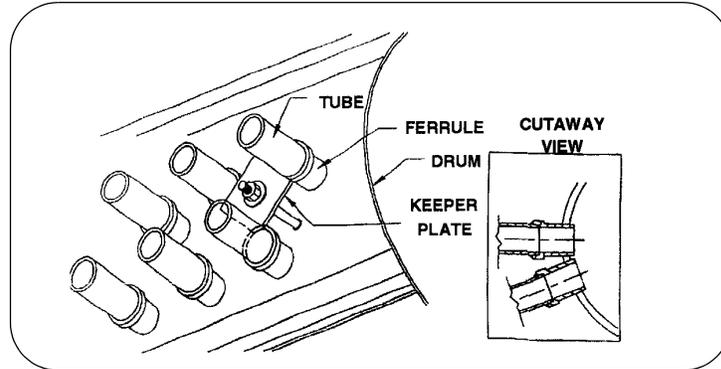
1. Minimum make-up temperature 60 °F.
2. Maximum make-up rate (for on/off make-up control) 2.0 times the evaporation rate.
3. Minimum operating pressure 6 psig. on low pressure steam and 40 psig. on high pressure steam.
4. Maximum operating pressure 12 psig. on low pressure steam.
5. Maximum load tracking 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.

Tube Attachment

Construction of the Flexible Watertube Boiler includes a special tube-to-drum attachment that requires no welding or rolling (see Figure 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 3. Model FLX Tube Attachment

Burner/Control Information

Burner Characteristics

Burner information is shown in Table 5. Note that the model selection may vary due to application-specific factors (altitude, gas pressure, etc.).

Minimum Required Gas Pressures

Approximate gas pressure required at rated input is shown in Table 6. 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 4 shows a typical fuel oil supply arrangement. Oil lines must be sized for the burner and burner supply oil pump capacities.

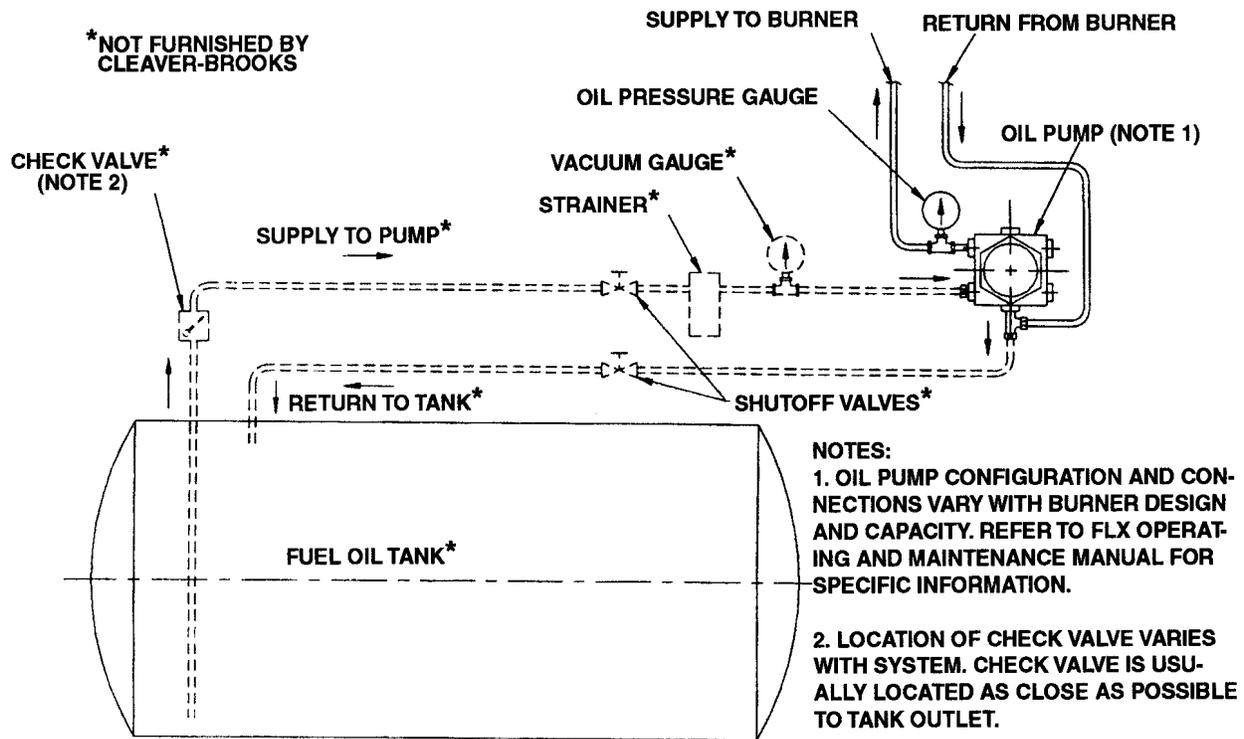


Figure 4. Model FLX Oil Burner Supply Pump Installation

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.

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 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

Table 7. Model FLX Maximum Flow Rates (GPM), Hot Water Boiler

MODEL NO.	SYSTEM TEMPERATURE DROP °F									
	10	20	30	40	50	60	70	80	90	100
FLX-1250	2010	1005	670	503	403	335	287	251	223	201
FLX-1450	2350	1175	784	587	470	392	336	294	261	235
FLX-1650	2680	1340	895	670	535	447	383	335	298	268
FLX-1850	3012	1506	1005	753	603	502	430	377	335	301
FLX-2100	3350	1675	1120	838	670	558	479	419	372	335
FLX-2500	4020	2010	1340	1005	805	670	575	502	448	402

NOTE: To avoid fireside condensation, return water temperature must be > 140°F.

Table 9. 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 8. Model FLX Minimum Flow Rates (GPM), Hot Water Boiler

MODEL NO.	SYSTEM TEMPERATURE DROP °F									
	10	20	30	40	50	60	70	80	90	100
FLX-1250	235	120	80	60	50	40	35	30	30	30
FLX-1450	250	125	85	65	55	45	40	35	35	35
FLX-1650	275	140	95	70	60	50	45	40	40	40
FLX-1850	315	160	105	80	65	55	50	45	50	50
FLX-2100	340	175	115	85	70	60	55	60	60	60
FLX-2500	415	210	140	105	85	70	60	60	60	60

NOTE: To avoid fireside condensation, return water temperature must be > 140°F.

Table 10. Model FLX Burner Characteristics

Boiler Size	Fuel Series			Standard Voltage
	700	100	200	
	ProFire Burner Model			
1250	PF-EVG-125	PF-EVL-125	PF-EVLG-125	460/3/60
1450	PF-EVG-145	PF-EVL-145	PF-EVLG-145	460/3/60
1650	PF-EVG-165	PF-EVL-165	PF-EVLG-165	460/3/60
1850	PF-EVG-185	PF-EVL-185	PF-EVLG-185	460/3/60
2100	PF-EVG-210	PF-EVL-210	PF-EVLG-210	460/3/60
2500	PF-EVG-250	PF-EVL-250	PF-EVLG-250	460/3/60

PF: ProFire Series
 EV: Burner Design
 G: Fuel, Gas Only
 L: Fuel, Light Oil Only
 LG: Fuel, Light Oil or Gas
 xxx: Burner Input Rating, MBTU/hr

- Notes: 1 Burner Model shown is subject to change and is based on actual application factors such as altitude, gas pressure, emissions, etc.
 2 Standard voltage for Canadian applications is 575/3/60.
 3 Burner operation is full modulation with linkage-less control.
 4 Burners for Low Nox emissions will include the letter N in the model.

Table 11. Model FLX Minimum Required Gas Pressure

MODEL NO.	STD GAS TRAIN SIZE (IN.) Note 3	MIN. GAS PRESSURE (IN.W.C.) Note 4
FLX-1250	2	3
FLX-1450	2	3
FLX-1650	2.5	3
FLX-1850	2.5	3
FLX-2100	3	3
FLX-2500	3	3

- 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.

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 5. The top view shaded sections in Figure 5 show areas that must be kept clear of field installed connections to the boiler for access or maintenance purposes.

Combustion Air Requirements

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. Generally 10 CFM air required per BHP, with natural gas @ 1000 BTU/ft³ and No. 2 oil @ 140,000 BTU/gal.

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. Breeching size for multiple boilers should take into account the volume of flue gas that will flow through successive additions of boilers and breeching runs. Do not merely size the breeching for multiple boilers relative to the exhaust connection of each boiler.

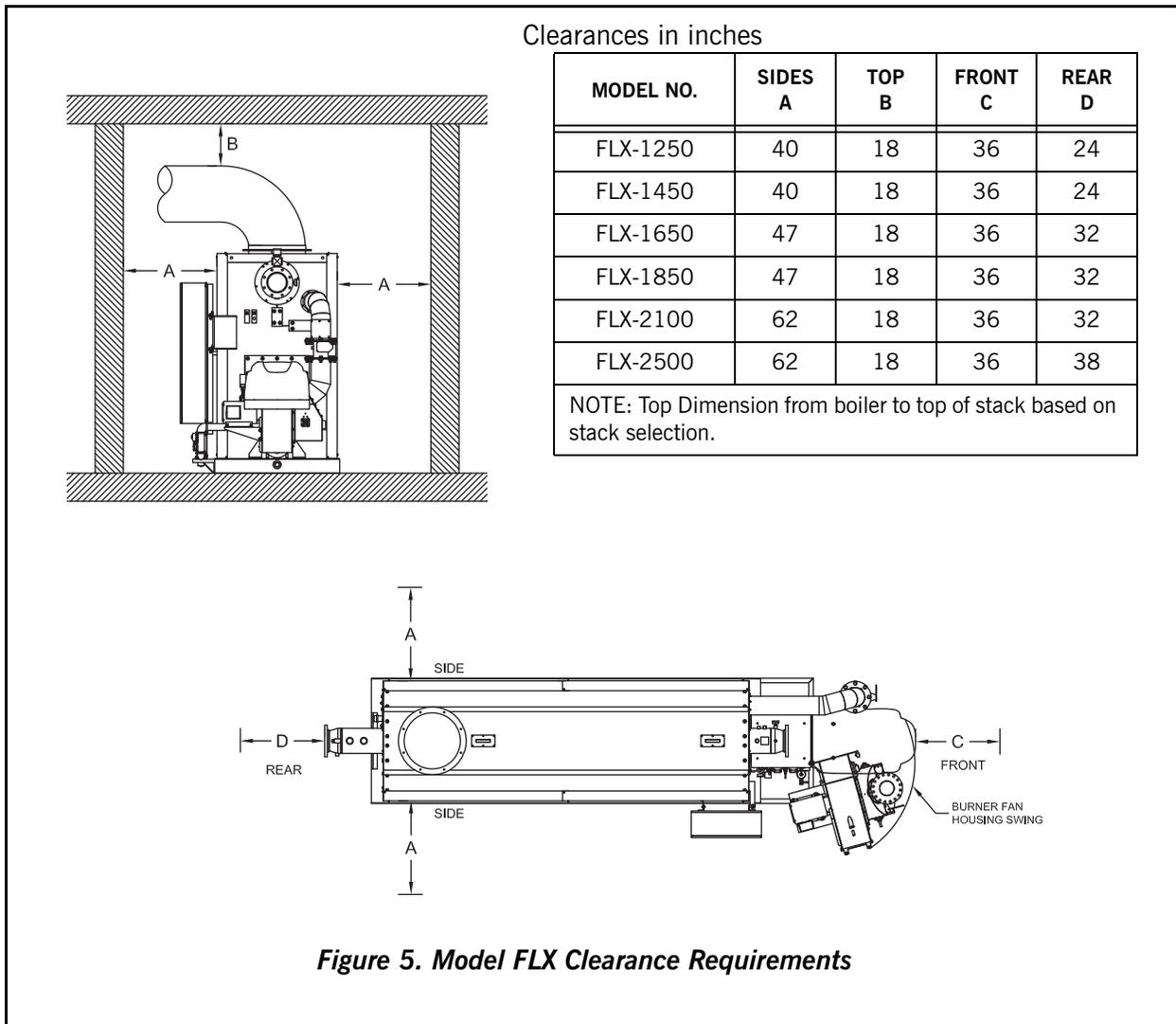
Stack Support Capabilities

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

Table 12. Sound Levels

SOUND LEVEL FIRING RATE	MODEL NO.					
	1250	1450	1650	1850	2100	2500
Low Fire (dBA)	78	78	78	78	78	78
High Fire (dBA)	85	85	85	85	85	85

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.



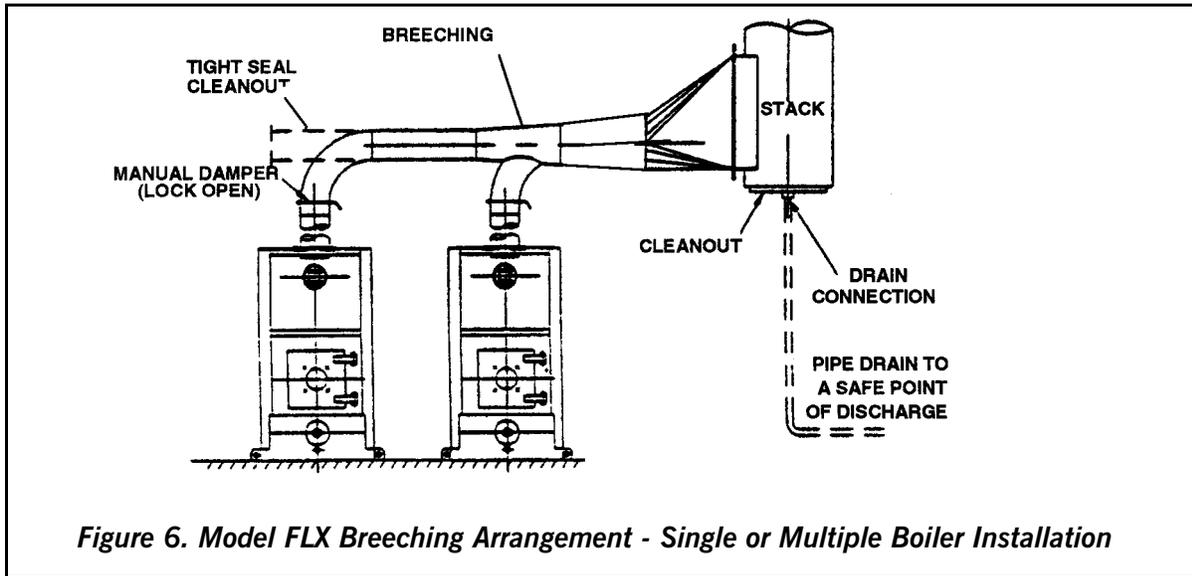


Figure 6. Model FLX Breeching Arrangement - Single or Multiple Boiler Installation

Table 13. Recommended steam nozzle sizes for reduced pressure

Boiler Size	Boiler Operating Pressure																					
	10	12	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	125
1250	12	12	12	10	10	8	8	8	8	8	6	6	6	6	6	6	6	6	6	6	6	6
1450	12	12	12	10	10	10	8	8	8	8	8	8	8	8	8	6	6	6	6	6	6	6
1650	12	12	12	10	10	10	10	10	8	8	8	8	8	8	6	6	6	6	6	6	6	6
1850	12	12	12	12	10	10	10	10	10	10	8	8	8	8	8	8	8	8	8	8	8	8
2100	12	12	12	12	12	10	10	10	10	10	8	8	8	8	8	8	8	8	8	8	8	8
2500	12	12	12	12	12	12	10	10	10	10	8	8	8	8	8	8	8	8	8	8	8	8

NOTE: Shaded area indicates standard nozzle size of the 150# design.

Notes

GUIDE SPECIFICATIONS

Model FLX Flextube

Steam Boilers 12.5 MMbh to 25.0 MMbh

300 Horsepower - 600 Horsepower

1.0 GENERAL BOILER DESIGN

- A. The boiler shall be a five-pass carbon steel Watertube vessel. It shall be mounted on a heavy-duty steel base frame with an integral inner and outer casing and a forced draft burner, burner management controls and boiler trim.
- B. Approvals - The complete burner/boiler package shall be Underwriters Laboratories, Inc. listed and the official UL or cUL label affixed to the package, attesting to its certification.
- C. As a factory preassembled package, the standard boiler shall receive an operational factory fire test and an ASME hydrostatic pressure test. Test data reports shall be made available to the purchaser. The boiler, upon completion shall be registered with the National Board of Boiler Inspectors and the National Board number shall be affixed to the package. Additionally the boiler shall be properly registered within the Canadian Provinces.
- D. The complete package shall be shipped ready for connections to electrical, system steam, water, fuel, blowdown, and exhaust venting. Certain items may be shipped loose to prevent their damage such as the safety valves, optional drain/blowdown valves, and gauges.
- E. As an alternate option, in lieu of a factory completed unit and shipped completely assembled, the boiler shall be provided as a field erect assembly package. The boiler manufacturer shall manufacture the boiler vessel parts and assemble the drums and tubes so that an ASME witnessed hydro test is conducted. Following the hydrostatic test, the manufacturer shall disassemble the vessel, properly marking all tubes for their location to each respective drum hole. The manufacturer shall properly place all tubes, drums, inner casing, outer casing, roof, base, front and rear walls, trim, controls, burner and any specified options into individual shipping crates and or pallets. Upon arrival at the project site, the installing contractor shall assemble the boiler in accordance with the manufacturer's instructions and direction and a field hydrostatic pressure test shall be performed by the installing contractor.

1.1 BOILER SHELL

- A. The boiler shall be constructed in accordance with the A.S.M.E. Code, Section IV for low-pressure steam of 15 PSIG design and bear the "H" Stamp or A.S.M.E. Code Section I for high pressure steam > 15 psig and bear the "S" Stamp. The vessel shall be subjected to the required inspections of this Code, conducted by an independent third party inspector and filed with the National Board. A signed inspection sheet shall be provided to the purchaser. For construction in accordance with Canadian Provincial Vessel Codes, the vessel shall be approved by the appropriate authority and include the proper Canadian Registration [CRN#] stamped on the upper drum.
 - 1. Two lifting lugs shall be secured and located on the top centerline of the upper drum for rigging purposes as standard.
 - 2. Easily removable inner and outer side panels shall provide access for inspection or replacement of all tubes. Side panels shall be limited in width to eliminate the need to remove entire side panels to access a single tube in the middle of the boiler.
 - 3. Each carbon steel bent tube shall be equipped with ferrule fittings for ease of replacement or for field assembly of the vessel; this attachment method shall not require welding of the tubes to each drum. Tubes shall be 1-1/2" OD for units through 350 HP and 2.0" OD for 400 HP and greater.

4. Boiler insulation shall consist of 1-1/2-inch Super Wool 607 #8 Density blanket and board, which shall be covered with removable 16 Gauge zinc coated inner carbon steel panels. The outer factory painted 18 Gauge sheet metal jacket shall include separate 2" fiberglass insulation. This jacket and insulation design shall permit field removal and reattachment if necessary for inspection, etc.
 5. To ensure internal water circulation an insulated rear downcomer shall be provided and an insulated front downcomer shall be provided.
 6. To permit entrained air to be removed from the lower drum, a distinct tube shall be provided and located at the rear of the boiler connected to the lower drum and to the steam drum.
 7. The combustion exhaust vent shall be located at the top rear of the boiler and shall be a flanged connection.
 8. To facilitate waterside inspection, hand holes shall be provided in the steam drum and lower drum; capped pipe plugs will not be acceptable.
 9. The pressure vessel shall be mounted on a steel base frame assembly which includes a poured refractory floor.
 10. The entire boiler and base frame shall be factory painted using a hard finish spray on enamel paint.
 11. Tube cleaning and inspection shall be accomplished from each side and via the rear furnace access door.
- B. Furnace - Integral with the vessel, the furnace shall be totally water-cooled on each side, roof and floor.
1. Access to the Furnace and furnace tubes shall be provided via the rear wall.
 2. Observation ports for flame inspection shall be provided at the rear of the burner and at the rear of the boiler.
 3. Front and rear furnace walls shall be fully insulated.

1.2 BOILER DRUM TAPPINGS/OPENINGS [STANDARD]

- A. For steam applications, the following tappings/openings shall be furnished:
1. Flanged steam supply, located on the top centerline of the upper drum. For 15 psig steam boilers the flange shall be Flat Face and the flange for the 150 psig steam boilers shall be Raised Face.
 2. Feedwater make up tapping, located in the rear downcomer.
 3. Bottom blowdown connections located at the front and rear of the boiler, lower drum.
 4. Surface Blowoff tapping located at the rear of the upper drum with an internal collector pipe.
 5. Safety relief valve tappings sized in accordance with the ASME Code.
 6. Steam pressure gauge, minimum 6" dial type and include an inspector's test gauge connection.
 7. Limit and operating control tappings.

2.0 STEAM BOILER TRIM [STANDARD]

The following controls shall be provided by the manufacturer, mounted, wired and factory functionally tested.

- A. Water level control system shall be comprised of a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows; the electronic controller shall be panel mounted and operate in ambient temperatures from 32 degrees F to 125 degrees F, the

pressure chamber shall be boiler mounted and operate to pressures of 250PSIG and the level sensor shall operate to pressures of 250PSIG and temperatures to 400 degrees F. The pressure containing components shall be constructed in accordance with ASME Code.

The pressure chamber shall have provisions for tri-cocks and sight glass. The level sensor shall have an accuracy of .01" or greater. The electronic controller shall have level and error indicating lights, alphanumeric display for messaging, reset/menu switch and the following features:

1. Continuous Level Indication
 2. Low Water Cutoff & Alarm
 3. High Water Alarm
 4. Low & High Water Warning
 5. Capable of On/Off and Full Modulating Control
 6. Continuous Monitoring of Float Operation
 7. Column Blowdown Detection and Reminder.
 8. Auto or Manual Reset
 9. Real Time Clock
 10. Alarm Annunciation
 11. Alarm History Files with Time Stamp
 12. Water column Blowdown record
 13. Auxiliary low water cutoff check
 14. RS 232 Interface
 15. Maximum contacts rating 15 amps resistive load.
 16. Analog (4-20 mA) output for remote level indication.
- B. High limit pressure control, Danfoss Series KP, manual reset for excess steam pressure shutdown of the burner.
- C. Operating Limit pressure control Danfoss Series KP, set point control for normal operating shutdown and start up of the burner.
- D. Modulating Pressure Sensor, firing rate control to provide required fuel input in accordance with system demand.
- E. Boiler Pressure Gauge complete with Inspector's Test Cock.
- F. A.S.M.E. rated safety valve set at 15 PSIG for Section IV or 150 PSIG for Section I.

3.0 BURNER AND BURNER CONTROLS [STANDARD]

- A. Mode of Operation - The standard burner operation shall be linkage-less full modulation with a minimum turndown as noted below.
- B. Design/Model - the burner design shall be a manufactured product of the boiler manufacturer. It shall utilize forced draft technology, wherein the fuel and air are mixed in the burner diffuser area, and shall be a ProFire Series Model EV.
1. The fan shall be direct driven by a high efficiency AC motor.
 - a. The fan shall be of airfoil type and enclosed in a fan housing.
 - b. A hinge shall be provided for fan and burner inspection.
 2. Rotary air damper shall provide combustion air control.
 - a. The burner shall be equipped with fuel air ratio control that utilizes electronic servo motors for fuel input and air input, eliminating mechanical jack shaft linkage control. The fuel/air ratio control shall be provided with a panel mounted touch screen to afford ease of burner set up and to provide burner information to the operator.

3. Burner turndown:
 - a. Standard Emissions: for standard emissions gas burners, the turndown is 7:1 (10:1 with Variable Speed Drive).
7:1 for straight oil firing with uncontrolled emissions.
Combination fuel burner's turndown is 7:1 on oil and as noted on gas.
 - b. Controlled NOx option: for gas operation, 8:1 turndown @ 30 PPM NOx.
4. A Combustion Air Proving Switch shall be provided to prove that the fan is operating properly.
5. Fuel ignition shall be of the gas pilot design utilizing an ignition transformer for spark generation. A separate gas pilot train consisting of a gas pilot regulator and gas pilot solenoid valve shall be provided in accordance with UL/cUL.
- C. Fuel - The burner shall be designed for operation with natural gas or light oil.
- D. Gas Train - In accordance with UL 795 the following components shall be furnished:
 1. Main Safety Shutoff Valves:
 - a. Dual motorized gas valves each with proof of closure switch.
 - b. Each valve is equipped with a test cock for tightness checking.
 - c. A normally open main gas vent valve shall be provided between the two motorized gas safety shutoff valves to vent any entrained gas between the two valves.
 2. Manual fuel shutoff valve - shall be located downstream of the gas valve for leak testing.
 3. Fuel Input control valve, butterfly type, driven from the servo motor.
 4. Gas Pressure Switches - one shall be provided for sensing high gas pressure and one shall be provided to sense low gas pressure. Each control shall be of the manual reset type.
 5. Gas Pressure Regulator - included with gas train.
 6. Manual Shutoff Valve - shall be provided upstream of the gas regulator to manually close off the gas supply when servicing the gas train or isolating the boiler.
- E. Oil Train - For combination gas oil units or straight oil units, light oil operation shall be of the air atomizing design. A separate air compressor module shall be mounted on the side of the boiler to provide the correct atomizing air pressure and volume; an atomizing air pressure switch shall be provided. An oil pump shall be shipped loose for oil supply. Dual Solenoid Oil Shutoff Valves shall be mounted and wired for oil safety shutoff and a Low Oil Pressure Switch shall be provided. Electro-hydraulic oil actuator with POC included.
- F. Gas Pilot Train - Shall include a pilot regulator, pilot solenoid shutoff valve, and manual gas cock. Pilot train piping shall be provided with a tee connection to the main gas train connection.
- G. Combustion Controls and Flame Safety
 1. Controls shall be an integrated system comprising a Programmable Logic Controller, 4" screen operator interface, and flame safeguard control. Control system shall provide the following functions:
 - a. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run and post purge.
 - b. Flame proving and lockout on flame failure during pilot flame proving, main flame proving, or run.
 - c. Parallel Positioning Combustion Control for Air and maximum 2 Fuels.

2. Combustion flame safeguard control shall be accomplished with a Solid State Control, which is mounted and wired in the Control Panel. The model type shall be as follows:

Burner Input	Standard Burner Firing	Flame Safeguard Gas or Gas/Oil	Flame Scanner
All Sizes	Modulation	CB780E	IR

Flame sensing shall be accomplished with an IR Scanner for gas, oil, and combination gas/oil burners.

4.0 CONTROL PANEL

A NEMA 1A rated enclosure shall be furnished and located at the front left hand side of the boiler to house the following components.

- A. Combustion Flame Safeguard Control - for sequence operation, flame supervision and safety shutdown. Model type as noted above.
- B. Fan Motor Starter with overload protection.
- C. Air Compressor Motor Starter with overload protection for straight oil or combination gas/oil fired burners.
- D. Metering Oil Pump Motor Starter with overload protection for straight oil or combination gas/oil fired burner.
- E. Remote Oil Pump Motor Starter with overload protection for straight oil or combination gas/oil fired burners.
- F. Control Circuit Transformer with fuse protection.
- G. Burner On/Off Switch.
- H. Damper positioning and manual burner operating control via the burner management control display.
- I. Terminals for control interface wiring and connections for incoming power.
- J. Indicating Lights for Power On, Flame Failure, and Fuel Valve On.
- K. Fuel selector switch for combination gas-oil fired units.

5.0 PERFORMANCE

The Model FLX Boiler shall be designed to provide the following operating performance targets for Natural Gas:

- A. Efficiency - Fuel to Steam Efficiency is 81% with an operating pressure of 100 PSIG and feedwater inlet water temperature of 220 deg. F For Low Pressure Steam, the Fuel to Steam Efficiency shall be 83%.
- B. Turndown shall be as noted above on the specified fuel.
- C. Emissions - Uncontrolled emissions or low NOx option. If equipped with a NOx option, the burner shall provide NOx reduction of <30 PPM corrected to 3% O2. 150 PPM CO for up to 50% firing rate with <30 PPM option.
- D. For NOx reduction of <30 PPM the burner shall utilize external FGR. FGR Ducting shall be factory fitted and if required to avoid shipping damage, shipped separately for field installation.
- E. Noise - Sound level shall not exceed 85 dBA at high fire when measured 3 feet in front of the burner.

6.0 WARRANTY

The package boiler shall be warranted for a period of one year from date of start-up or 18 months from shipment, whichever occurs first.

GUIDE SPECIFICATIONS
Model FLX Flextube
Water Boilers 12.5 MMbh to 2500 MMbh
300 Horsepower - 600 Horsepower

1.0 GENERAL BOILER DESIGN

- A. The boiler shall be a five-pass carbon steel Watertube vessel. It shall be mounted on a heavy-duty steel base frame with an integral inner and outer casing, a forced draft burner as integral produced by the boiler manufacturer including burner management controls and boiler trim.
- B. Approvals - The complete burner/boiler package shall be Underwriters Laboratories, Inc. listed and the official UL or cUL [Canadian Installations] label affixed to the package, attesting to its certification.
- C. As a factory preassembled package, the standard boiler shall receive an ASME hydrostatic pressure test and an operational factory fire test. Test data reports shall be made available to the purchaser. The boiler, upon completion shall be registered with the National Board of Boiler Inspectors and the National Board number shall be affixed to the package. Additionally the boiler shall be properly registered within the Canadian Provinces.
- D. The complete package shall be shipped ready for connections to electrical, system water, fuel, drain, boiler venting of entrained air, and exhaust venting. Certain items may be shipped loose to prevent their damage such as the safety valves, optional drain/blowdown valves, and gauges.
- E. As an alternate option, in lieu of a factory completed unit and shipped completely assembled, the boiler shall be provided as a field erect assembly package. The boiler manufacturer shall manufacture the boiler vessel parts and assemble the drums and tubes so that an ASME witnessed hydro test is conducted. Following the hydrostatic test, the manufacturer shall disassemble the vessel, properly marking all tubes for their location to each respective drum hole. The manufacturer shall properly place all tubes, drums, inner casing, outer casing, roof, base, front and rear walls, trim, controls, burner and any specified options into individual shipping crates and or pallets. Upon arrival at the project site, the installing contractor shall assemble the boiler in accordance with the manufacturer's instructions and direction and a field hydrostatic pressure test shall be performed by the installing contractor.

1.1 BOILER SHELL

- A. The boiler shall be constructed in accordance with the A.S.M.E. Code, Section IV for low-pressure of 160 PSIG design with a maximum design water temperature of 250 F, and bear the "H" Stamp. For units that will operate at or above 250 F degrees shall be built in accordance with the A.S.M.E. Code Section I for high pressure water >160 psig or water temperature greater than 250 F, and bear the "S" Stamp. The vessel shall be subjected to the required inspections of this Code, conducted by an independent third party inspector and filed with the National Board. A signed inspection sheet shall be provided to the purchaser. For construction in accordance with Canadian Provincial Vessel Codes, the vessel shall be approved by the appropriate authority and include the proper Canadian Registration [CRN#] stamped on the upper drum.
 - 1. Two lifting lugs shall be secured and located on the top centerline of the upper drum for rigging purposes as standard.
 - 2. Easily removable inner and outer side panels shall provide access for inspection or replacement of all tubes. Side panels shall be limited in width to eliminate the need to remove entire side panels to access a single tube in any part of the of the vessels tube bank.

3. Each carbon steel bent tube shall be equipped with ferrule fittings for ease of replacement or for field assembly of the vessel; this attachment method shall not require welding of the tubes to each drum. Tubes shall be 1-1/2" OD for units through 350 HP and 2.0" OD for 400 HP and greater.
 4. Boiler insulation shall consist of 1-1/2-inch Super Wool 607 #8 Density blanket and board, which shall be covered with removable 16 Gauge zinc coated inner carbon steel panels. The outer factory painted 18 Gauge sheet metal jacket shall include separate 2" fiberglass insulation. This jacket and insulation design shall permit field removal and reattachment if necessary for inspection, etc.
 5. To ensure internal water circulation an insulated rear downcomer shall be provided totally separate from the heat exchange section of the furnace or boiler tubes.
 6. To permit entrained air to be removed from the lower drum, a distinct tube shall be provided and located at the rear of the boiler connected to the lower drum and to the upper drum.
 7. To permit entrained air to be removed from the upper drum, a tapping shall be provided for piping to an expansion tank or the installation of a manual/auto vent valve
 8. The combustion exhaust vent shall be located at the top rear of the boiler and shall be a flanged connection which shall connect to the system breeching or venting system. Class "B" venting is not permitted.
 9. To facilitate waterside inspection, hand holes shall be provided in the upper drum and lower drum; capped pipe plugs will not be acceptable.
 10. The pressure vessel shall be mounted on a steel base frame assembly which includes a poured refractory floor to ensure heat will not transmit to the boiler room floor as wasted energy.
 11. The entire boiler and base frame shall be factory painted using a hard finish spray on enamel paint.
 12. Tube cleaning and inspection shall be accomplished from each side and via the rear furnace access door.
- B. Furnace - Integral with the vessel, the furnace shall be totally water-cooled on each side, roof and floor.
1. Access to the Furnace and furnace tubes shall be provided via the rear wall.
 2. Observation ports for flame inspection shall be provided at the rear of the burner and at the rear of the boiler.
 3. Front and rear furnace walls shall be fully insulated.

1.2 BOILER DRUM TAPPINGS/OPENINGS [STANDARD]

- A. For hydronic heating applications, the following tappings/openings shall be furnished:
1. Flanged water supply, located on the front of the upper drum; flanged water return located at the rear of the lower drum.
 2. Air Vent Tapping located in the upper drum.
 3. Bottom drain connections located at the front and rear of the boiler, lower drum.
 4. Safety relief valve tappings sized in accordance with the ASME Code, located on the top centerline of the upper drum.
 5. Tapping for a boiler water pressure gauge.
 6. Tapping for a boiler water outlet temperature gauge and separate tapping for an optional return water temperature gauge or optional sensor.
 7. Limit and operating control tappings.

8. Tapping for primary low water cutoff control.

2.0 WATER BOILER TRIM [STANDARD]

The following controls shall be provided by the manufacturer, mounted, wired and factory functionally tested.

- A. Primary Water level control system shall be accomplished with a probe mounted in the upper drum and wired to a solid state control relay that includes a manual reset switch and test switch.
- B. High limit temperature control, manual reset for excess water temperature shutdown of the burner.
- C. Operating Limit temperature control, set point control for normal operating shutdown and start up of the burner.
- D. Modulating Temperature Sensor, firing rate control to provide required fuel input in accordance with system demand.
- E. Boiler Water Pressure Gauge complete with Inspector's Test Cock.
- F. Boiler Water Temperature Gauge with well.
- G. A.S.M.E. rated safety valve set at 160 PSIG for Section IV and as specified for ASME Section I High Temperature Design.

3.0 BURNER AND BURNER CONTROLS [STANDARD]

- A. Mode of Operation - The standard burner operation shall be linkage-less full modulation with a minimum turndown as noted below.
- B. Design/Model - the burner and its design shall be a manufactured product of the boiler manufacturer. It shall utilize forced draft technology, wherein the fuel and air are mixed in the burner diffuser area, and shall be a ProFire Series Model EV for standard uncontrolled emissions.
 1. The fan shall be direct driven by a high efficiency AC motor.
 - a. The fan shall be of airfoil type and enclosed in a fan housing.
 - b. A hinge shall be provided for fan and burner inspection.
 2. Rotary air damper shall provide combustion air control.
 - a. The burner shall be equipped with fuel air ratio control that utilizes electronic servo motors for fuel input and air input, eliminating mechanical jack shaft linkage control. The fuel/air ratio control shall be provided with a panel mounted touch screen to afford ease of burner set up and to provide burner information to the operator.
 3. Burner turndown:
 - a. Standard Emissions: for standard emissions gas burners, the turndown is 7:1 (10:1 with Variable Speed Drive).
7:1 for straight oil firing with uncontrolled emissions.
Combination fuel burner's turndown is 7:1 on oil and as noted on gas.
 - b. Controlled NOx option: for gas operation, 8:1 turndown @ 30 PPM NOx.
 4. A Combustion Air Proving Switch shall be provided to prove that the fan is operating properly.
 5. Fuel ignition shall be of the gas pilot design utilizing an ignition transformer for spark generation. A separate gas pilot train consisting of a gas pilot regulator and gas pilot solenoid valve shall be provided in accordance with UL/cUL.
- C. Fuel - The burner shall be designed for operation with natural gas or light oil.

- D. Gas Train - In accordance with UL 795 the following components shall be furnished:
 - 1. Main Safety Shutoff Valves:
 - a. Dual motorized gas valves each with proof of closure switch.
 - b. Each valve is equipped with test cock for tightness checking.
 - c. A normally open main gas vent valve shall be provided between the two motorized gas safety shutoff valves to vent any entrained gas between the two valves.
 - 2. Manual fuel shutoff valve - shall be located downstream of the gas valve for leak testing.
 - 3. Fuel Input control valve, butterfly type, driven from the servo motor.
 - 4. Gas Pressure Switches - one shall be provided for sensing high gas pressure and one shall be provided to sense low gas pressure. Each control shall be of the manual reset type
 - 5. Gas Pressure Regulator included with gas train.
 - 6. Manual Shutoff Valve - shall be provided upstream of the gas regulator to manually close off the gas supply when servicing the gas train or isolating the boiler.
- E. Oil Train - For combination gas oil units or straight oil units, light oil operation shall be of the air atomizing design. A separate air compressor module shall be mounted on the side of the boiler to provide the correct atomizing air pressure and volume; an atomizing air pressure switch shall be provided. An oil pump shall be shipped loose for oil supply. Dual Motorized Oil Shutoff Valves each with proof of closure shall be mounted and wired for oil safety shutoff and a Low Oil Pressure Switch shall be provided. Electro-hydraulic oil actuator with POC included.
- F. Gas Pilot Train - Shall include a pilot regulator, pilot solenoid shutoff valve, and manual gas cock. Pilot train piping shall be provided with a tee connection to the main gas train connection.
- G. Combustion Controls and Flame Safety
 - 1. Controls shall be an integrated system comprising a Programmable Logic Controller, 4" screen operator interface, and flame safeguard control. Control system shall provide the following functions:
 - a. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run and post purge.
 - b. Flame proving and lockout on flame failure during pilot flame proving, main flame proving, or run.
 - c. Parallel Positioning Combustion Control for Air and maximum 2 Fuels.
 - 2. Combustion flame safeguard control shall be accomplished with a Solid State Control, which is mounted and wired in the Control Panel. The model type shall be as follows:

Burner Input	Standard Burner Firing	Flame Safeguard Gas or Gas/Oil	Flame Scanner
All Sizes	Modulation	CB780E	IR

Flame sensing shall be accomplished with an IR Scanner for gas, oil, and combination gas/oil burners.

4.0 CONTROL PANEL

A NEMA 1A rated enclosure shall be furnished and located at the front left hand side of the boiler to house the following components.

- A. Combustion Flame Safeguard Control - for sequence operation, flame supervision and safety shutdown. Model type as noted above.
- B. Fan Motor Starter with overload protection.

- C. Air Compressor Motor Starter with overload protection for straight oil or combination gas/oil fired burners.
- D. Metering Oil Pump Motor Starter with overload protection for straight oil or combination gas/oil fired burner.
- E. Remote Oil Pump Motor Starter with overload protection for straight oil or combination gas/oil fired burners.
- F. Control Circuit Transformer with fuse protection.
- G. Burner On/Off Switch.
- H. Damper positioning and manual burner operating control via the burner management control display.
- I. Terminals for control interface wiring and connections for incoming power.
- J. Indicating Lights for Power ON, Flame Failure, and Fuel Valve On.
- K. Fuel selector switch for combination gas-oil fired units.

5.0 PERFORMANCE

The Model FLX Boiler shall be designed to provide the following operating performance targets for Natural Gas:

- A. Efficiency - Fuel to Water Efficiency is 85% with an operating temperature of 180 F outlet and 160 F return.
- B. Turndown shall be as noted above on the specified fuel.
- C. Emissions - Uncontrolled emissions or low NOx option. If equipped with a NOx option, the burner shall provide NOx reduction of <30 PPM corrected to 3% O₂. 150 PPM CO for up to 50% firing rate with <30 PPM option.
- D. For NOx reduction of <30 PPM the burner shall utilize external FGR. FGR Ducting shall be factory fitted and if required to avoid shipping damage, shipped separately for field installation.
- E. Noise - Sound level shall not exceed 85 dBA at high fire when measured 3 feet in front of the burner.

6.0 WARRANTY

- A. The package boiler shall be warranted for a period of one year from date of start-up or 18 months from shipment whichever shall occur first.
- B. The pressure vessel shall be warranted against thermal shock for a period of 25 years in accordance with the Company's warranty statement.