

MODEL 5 BOILER

1,500 - 6,000 MBTU &
7,500-8,000 Low Water Volume
Watertube Boiler



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The Model 5 Commercial Watertube Boiler product line is used for low and high pressure steam applications. Sizes range from 1.5 to 8 MMBtu/hr. The Model 5 Boiler is an excellent choice where high outputs are required but space limitations exist. The model number designation is 1500 through 8000, representing MBtu/hr input (1,500,000 to 8,000,000 Btu/hr).

Fuel series designation is as follows:

- Series 100: No. 2 oil firing.
- Series 700: Natural gas firing.
- Series 200: No. 2 oil/natural gas firing.

Design pressure designation is stated as 15 psig, 150 psig, and 250 psig for steam, and 140 psig for hot water. For example, a Model M5P-700-2500-150 boiler designates a gas-fired, 2,500,000 Btu/hr, 150 psig, steam boiler.



FEATURES AND BENEFITS

33" Cased Width:

- Boiler fits through most standard doorways.
- Reduced installation costs.

Direct Driven, Vibration-Free Centrifugal Impeller:

- Quiet operation.
- Sound levels below 80 dbA.
- Ideal for noise critical areas such as hospitals, churches, etc.

Minimum Refractory:

- Membrane waterwalls reduce the need for refractory by 95%.
- Reduced maintenance costs and refractory repair requirements.

Membrane Waterwalls:

- Enhanced heat transfer area in compact design.
- Sealed combustion chamber improves heat transfer for high efficiency.

Small Boiler Footprint:

- Savings of up to 50% in floor space.

Weighs up to 40% less than Comparable Boilers:

- Lower freight and rigging costs.
- Reduced structural requirements.

Standard Built-in Soot Washers:

- Boiler cleaning without shutdown.
- Maintains peak boiler performance.

Packaged Forced Draft Burner:

- High pressure drop design.
- Optimum fuel and air mixing.
- Improved combustion efficiency.

Low Water Volume Design (optional):

- Meets various provincial operating engineer codes and regulations.
- Reduced operating costs.
- High and low pressure steam.

Steam Design Pressures to 500 psig:

- High performance in a compact design.
- Proven vessel design for high design pressure applications.

PRODUCT OFFERING

The Model 5 (M5) Boiler is a compact carbon steel, extended fin, watertube boiler. Heat transfer design is configured in a "3-pass" gas travel across the watertube surfaces. The pressure vessel is constructed to conform to the A.S.M.E. Code, either Section IV for low pressure steam @ 15 PSIG MAWP (maximum allowable working pressure) or Section I for MAWP greater than 15 PSIG.

The vessel (boiler) consists of two rows on each side of the vessel, of formed seamless tubes with extended fin surfaces and downcomers connected to the steam drum and lower drum. To reduce standby losses, the vessel is insulated with a fiberglass blanket and removable steel jacket.

Complete with an integral burner for either No.2 fuel oil or Natural Gas, the complete burner/boiler package is CSA International Approved, listed, and labeled.

Standard Equipment

The standard boiler/burner package is described below. Optional controls, trim, and devices may be added to meet project requirements, and some of those options are noted, following this standards list.

1. Boiler

A. Designed, constructed, and hydrostatically tested in accordance with the A.S.M.E. Boiler and Pressure Vessel Code. The complete vessel is mounted on a structural steel frame.

B. Steam drum includes a hand hole in the rear head for drum water side inspection. Connections are included for the following:

Feedwater Makeup w/internal dispersion tube.

Table B3-1. Model 5 Boiler Sizes

MODEL NO.	INPUT MBH	HEAT OUTPUT MBH	EQUIV HP	STEAM OUTPUT LB/HR	SHIPPING WEIGHT LBS
1500	1500	1200	35	1237	3100
2000	2000	1600	47	1649	3100
2500	2500	2000	59	2062	3700
3000	3000	2400	71	2474	3700
3500	3500	2800	83	2887	4100
4000	4000	3200	95	3299	4100
4500	4500	3600	107	3711	4700
5000	5000	4000	119	4124	4700
6000	6000	4800	143	4949	5400
8000 LWV	8000	6320	194	6516	6200

NOTE: Steam output from and at 212 °F.

LWV = Low Water Volume.



Surface Blowoff.

Steam Supply.

Safety Relief Valve.

C. Lower Drum includes hand holes at each end for waterside inspection. A drain/blowoff tapping is provided at the front, bottom centerline.

D. Soot washer lances are provided on each side of the vessel between the two rows of tubes for fireside cleaning. Soot washer drains are located at the bottom of the boiler, with connections to drain located on each side of the lower drum at the rear.

E. Refractory is limited to the furnace floor, lower drum, and burner throat tile. High temperature insulation is installed on the front water wall and furnace access door.

F. Two lifting eyes are provided on the top centerline of the upper drum for ease of installation.

G. Furnace inspection/access door is provided in the furnace rear wall.

The exhaust gas vent is located at the top rear centerline of the boiler. A stack thermometer is shipped loose for field installation by the installing contractor into the stack.

I. The complete vessel is fully insulated (2" fiberglass blanket) under a preformed, sectional steel jacket.

J. Factory painted using hard-finish enamel.

1. Steam Boiler Control Standard Equipment (15 to 150 psig)

A. ASME safety relief valve(s).

B. Steam pressure gauge.

C. Pressure controls:

- High limit control-manual reset.
- Operating limit control.
- High-low fire control (full modulation for gas firing).

D. D. Low water cutoff with pump control.

E. E. Water column gauge glass set and fittings.

F. F. Auxiliary low water cut-off.

G. G. Combustion air proving switch.

2. Electrical Control Panel

A. Mounted at eye level on the front head of the boiler.

B. NEMA rating 1A with gasket dust seal.

C. Contains electronic program relay and switches.

3. Miscellaneous

A. The boiler is Canadian Standards Association (CSA) approved and bears the CSA label.

Optional Equipment

Optional Equipment

For more detailed information on optional equipment, contact the local Cleaver-Brooks authorized representative. In summary, options include the following:

1. Boiler

Larger pressure gauges or specific manufacturer type.
Bottom Drain Valves for low pressure applications.
Bottom Blowoff Valves for high pressure applications.
Surface Blowoff Valve with internal collector pipe.
Feedwater Stop and Check Valves.
Steam Stop Valve.
ASME Hydro Test of Valves and Valve Piping.
Design pressures above 150 PSIG.

2. Burner/Control Options

Full Modulation Firing on Gas.
Lead/Lag Control.
Day-Night Controls.
Low Fire Hold Control.
Elapsed Time Meter.
Alarm with silence switch.
Additional Indicator Lights.
Main Power Disconnect.
Remote Oil Pump.
Optional NEMA Enclosures.
Special Fan Motor requirements (TEFC).

3. Fuel Options

Automatic Fuel Changeover (combination burner).
Propane Fuel Firing.
Special Gas Pressure Regulators.
Special fuel shut-off valves.
Dual Pilots (gas and oil).
Gas strainer.

"Guarded Plant" status equipment.

4. Low Water Volume Design Options (LWV)

5. Guarded Plant Requirements

Notice

****Not required for low pressure steam applications.***

Special Insurance Requirements

The boiler package can be equipped to meet various insurance or code requirements. Some of these insurance/code requirements are:

Factory Mutual (FM)

XL GAP (Formerly GE GAP/IRI).

A.S.M.E. CSD-1.

Factory Mutual (FM Global) - Recommended guidelines as described by FM pertain to boilers rated at greater than 2.5 MMBtu/hr input on gas and 2.8 MMBtu/hr input on oil. Boilers that are labeled and tested in accordance with an independent testing lab such as UL or CSA and are below these inputs are exempt from these recommendations.

The Model 5 boiler is CSA listed and labeled. In addition to the standard CSA requirements the following are needed to comply with FM when required.

Alarm Bell with silence switch for low water and safety shutdowns.

Low Oil Pressure Switch if the oil pump is not direct driven from the fan motor.

XL GAP (Formerly GE GAP/IRI) Recommended guidelines as described by XL GAP pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBtu/hr input. For these boilers, the requirements are the same as for A.S.M.E CSD-1 requirements. Above 12.0 MMBtu/hr input, the requirements defer to the NFPA 85 standards for single burner boilers.

A.S.M.E. CSD-1 - Recommended guidelines as described by this Code pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBtu/hr input. Above 12.0 MMBtu/hr input, the requirements defer to the NFPA 85 standards for single burner boilers. . For the sizes this Code covers, the requirements are as follows, in addition to the standard CSA package:

Low Oil Pressure Switch for oil firing all sizes.

$\frac{3}{4}$ " Pressure Control Piping

If gas supply is > 5 psig, a relief valve is required after the gas pressure regulator in the main and pilot gas trains.

Lever Handled shutoff cock for the pilot gas train.

Non-fused disconnect to remove boiler from all sources of power.

DIMENSIONS AND RATINGS

For layout purposes, the nominal dimensions and connections for the Model 5 Standard Boiler Packages are shown in Figure B3-1 and Tables B3-1 and B3-2. Low Water Volume (LWV) Package Boiler Dimensions are shown on Figure B3-2 and Table B3-3 and B3-4. Ratings of each boiler size are noted in Table B3-5.

Additional information is shown in the following figures, tables, and illustrations.

Table B3-6 Recommended steam nozzle sizes for high pressure boilers operating at lower and higher pressures.

Table B3-7 Model 5 Oil Fuel Requirements.

Figure B3-3 Standard gas train.

Tables B3-8 to B3-11 Gas pressure requirements.

Table B3-12 Safety Valve Outlet Sizes.

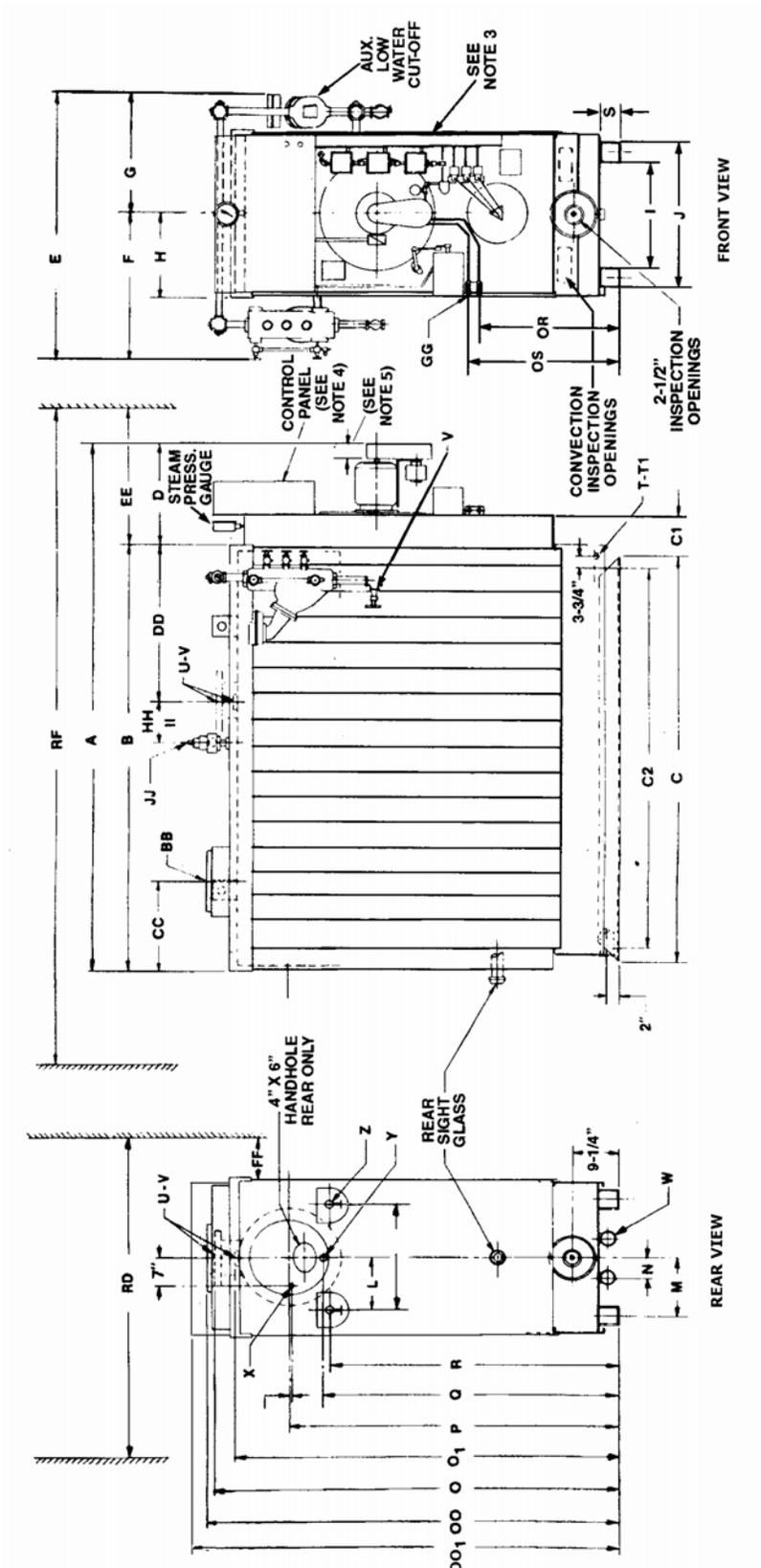


Figure B3-1. Model 5 Steam Boiler Dimension Diagram

Note 1		Boiler Size								
		1500	2000	2500	3000	3500	4000	4500	5000	6000
Lengths		All Dimensions are in Inches								
A	Overall	69.7	69.7	85.8	85.8	104.4	104.4	121.1	121.1	136.7
B	Pressure Vessel w/casing	51.25	51.25	67.375	67.375	83	83	99.625	99.625	115.25
C	Base Frame	45.5	45.5	61.1	61.1	76.75	76.75	92.4	92.4	108
C ₁	Base to Front Head	8	8	8	8	8	8	8	8	8
C ₂	Base Frame Anchor Holes	43	43	58.5	58.5	74.5	74.5	90	90	105.5
CC	Rear Casing to Stack Connection	17.2	17.2	17.7	17.7	17.7	17.7	21.8	21.8	21.8
D	Front Head Extension	13	13	13	13	16	16	16	16	16
DD	Front Casing to Steam Nozzle	16.4	16.4	24.4	24.4	30.1	30.1	36.75	36.75	44.6
HH	Steam Nozzle to Safety Valve 15#	7	7	12	12	11.5	11.5	13	13	17
	Steam Nozzle to Safety Valve 150#	8	8	12	12	17	17	17	17	17
Widths										
E	Overall	57.5	57.5	57.5	57.5	57.5	57.5	57.5	57.5	57.5
F	Center to Water Column	33	33	33	33	33	33	33	33	33
G	Center to Aux. Water Column	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
H	Center to Outside Casing	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
I	Base Frame Inside	20	20	20	20	20	20	20	20	20
J	Base Frame Outside	28	28	28	28	28	28	28	28	28
K	Soot Washers, Center to Center	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
L	Boiler Centerline to Soot Washer	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75
M	Boiler Centerline to Base Centerline	12	12	12	12	12	12	12	12	12
N	Boiler Centerline to Soot Drain	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Heights										
OO	Overall [Base to Stack Connection]	78.25	78.25	78.25	78.25	78.25	78.25	78.25	78.25	78.25
OO ₁	Base to Top of Control Panel	84.5	84.5	84.5	84.5	84.5	84.5	84.5	84.5	84.5
O	Base to Steam Nozzle 15#	73.5	73.5	73.5	73.5	76.5	76.5	76.5	76.5	76.5
O ₁	Base to Steam Nozzle 150#	73.5	73.5	73.5	73.5	73.5	73.5	76.5	76.5	76.5
P	Base to Steam Drum Centerline	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25
P ₁	Drum Centerline To Surface Blowoff, Std. Design & 15# Low Water Volume. [See Note C]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
P ₁	Drum Centerline To Surface Blowoff; High Pressure Design Low Water Volume. [See Note D]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
R	Base to Sootwasher Lance	54	54	54	54	54	54	54	54	54
S	Height of Base	4	4	4	4	4	4	4	4	4
OS	Base to Oil Supply Connection	26.625	26.625	26.625	26.625	26.625	26.625	26.625	26.625	26.625
OR	Base to Oil Return Connection	24.625	24.625	24.625	24.625	24.625	24.625	24.625	24.625	24.625

Table B3-1. Model 5 Dimensions

Connections										
BB	OD Stack - Sleeve Connection	12	12	12	12	12	12	16	16	16
T	Bottom Drum Blow Down, 15# [one]	1.25	1.25	1.25	1.25	1.5	1.5	1.5	1.5	1.5
T ₁	Bottom Drum Blow Down, 150# [one]	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
U	Steam Nozzle, 15#	4 ^A	4 ^A	4 ^A	4 ^A	6 ^B				
V	Steam Nozzle, 150#	2.5 ^A	2.5 ^A	3 ^A	3 ^A	3 ^A	3 ^A	4 ^B	4 ^B	4 ^B
W	Soot Washer Drains [Two]	2	2	2	2	2	2	2	2	2
X	Surface Blow off [One]	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Y	Feedwater Inlet [One]	1	1	1	1	1	1	1	1	1
Z	Soot Washer [Two]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
GG	Oil Supply and Return	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
JJ	Relief Valve, 15#	1.5	2	2	2	2.5	2.5	2.5	2.5	3
	Relief Valve, 150#	0.75	1	1	1	1.25	1.25	1.25	1.25	1.5
Clearances										
EE	Front Door Swing	33	33	33	33	33	33	33	33	33
FF	Tube removal each side	30	30	30	30	30	30	30	30	30
RF	Allowance for Front Door Swing and 30" Rear Aisle Space.	133	133	149	149	167	167	184	184	200
RD	Allowance for Tube Removal Each Side and Front Door Swing.	94	94	94	94	94	94	94	94	94

NOTES:

1. The above dimensions, while sufficiently accurate for layout purposes must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
 2. Allow sufficient space at rear of boiler for removal of soot washer lance.
 3. For access to the furnace, a 13" x 21" access door is provided behind the front door.
 4. Control Panel may be larger [up to 4" in height] if certain control options are provided.
- A. Connection is a Female Pipe Thread.
 B. Connection is a 150# Flange, Flat Face.
 C. When optional internal collector pipe is requested, tapping will be 4.5" from drum centerline.
 D. When optional internal collector pipe is requested, tapping will be 6.8" from drum centerline.

Table B3-2. Model 5 connection sizes and clearances

		Boiler Size	
		7500	8000
	Note 1	All Dimensions are in Inches	
	<u>Lengths</u>		
A	Overall	190.1	190.1
B	Pressure Vessel w/casing	138.7	138.7
C	Base Frame	117.4	129.9
C ₁	Base to Front	6	6
C ₂	Base Frame Anchor Holes	112.4	127.4
CC	Rear Casing to Stack Connection	21.8	21.8
D	Burner Extension	56.5	56.5
DD	Front Casing to Steam Nozzle	63	63
II	Steam Nozzle to Safety Valve 150#	17	17
	<u>Widths</u>		
E	Overall	57.5	57.5
F	Center to Water Column	33	33
G	Center to Aux. Water Column	23.5	23.5
H	Center to Outside Casing	16.5	16.5
I	Base Frame Inside	20	20
J	Base Frame Outside	28	28
K	Soot Washers, Center to Center	21.5	21.5
L	Boiler Centerline to Soot Washer	10.75	10.75
M	Boiler Centerline to Base Centerline	12	12
N	Boiler Centerline to Soot Drain	3.5	3.5
	<u>Heights</u>		
OO	Overall [Base to Stack Connection]	78.25	78.25
OO ₁	Base to Top of Control Panel	84.5	84.5
O ₁	Base to Steam Nozzle 150#	73.25	73.25
P	Base to Surface Blowoff	58.5	58.5
Q	Base to Feedwater Inlet	55.75	55.75
R	Base to Sootwasher Lance	54	54
S	Height of Base	4	4
OS	Base to Oil Supply Connection	26.625	26.625
OR	Base to Oil Return Connection	24.625	24.625

NOTES:

1. The above dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
2. Allow sufficient space at rear of boiler for removal of soot washer lance.
3. For access to the furnace, a 13" x 21" access door is provided behind the front door.
4. Control Panel may be larger [up to 4" in height] if certain control options are provided.

Table B3-3. Model 5 Low Water Volume dimensions

<u>Connections</u>			
BB.	OD Stack - Sleeve Connection	18	18
T ₁	Bottom Drum Blow Down, 150# [one]	1.25	1.25
V	Steam Nozzle, 150#	6	6
W	Soot Washer Drains [Two]	2	2
X	Surface Blow off [One]	0.75	0.75
Y	Feedwater Inlet [One]	1	1
Z	Soot Washer [Two]	0.25	0.25
GG	Oil Supply and Return	0.5	0.5
JJ	Relief Valve, 150#	2	2
<u>Clearances</u>			
EE	Clearance from Control Panel	36	36
FF	Tube removal each side	30	30
RF	Allowance for Front Burner Removal and 30" Rear Aisle Space.	220	220

NOTES:

1. The above dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction via certified prints. For 200 PSIG design pressure and greater, contact Milwaukee Sales for certified prints.
2. Allow sufficient space at rear of boiler for removal of soot washer lance.
3. For access to the furnace, a 13" x 21" access door is provided behind the front door.
4. Control Panel may be larger [up to 4" in height] if certain control options are provided.

Table B3-4. Model 5 Low Water Volume connection sizes and clearances

Boiler SIZE	1500	2000	2500	3000	3500	4000	4500	5000	6000	7500 LWV	8000 LWV
Ratings [Note A]											
Rated Capacity - Steam (lbs. steam/hr from & at 212° F.)	1,237	1,649	2,062	2,474	2,887	3,299	3,711	4,124	4,949	6,186	6,600
Rated Steam Capacity [kg/hr from and at 100 C]	561.0	748.0	935.0	1,122.0	1,309.0	1,496.0	1,683	1,871.0	1,847.2	2,806	2,993.7
Output Btu/hr [1,000 Btu/h]	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,800	6,000	6,400
Output Kcal/Hr [1,000 Kcal/h]	302	403	504	605	706	806	907	1,007	1,210	1,512	1,613
Output KW	348	464	580	696	812	928	1,044	1,160	1,392	1,740	1,856
Approximate Fuel Consumption At Rated Capacity [Input - Note B]											
Natural Gas [ft ³ /hr] - 15# Steam	1,465	2,000	2,450	2,952	3,456	3,950	4,444	4,938	5,925	NA	NA
Natural Gas [ft ³ /hr] - 150# Steam	1,538	2,077	2,564	3,117	3,590	4,155	4,657	5,194	6,233	7594	8205
Natural Gas [m ³ /hr] - 15# Steam	41.5	56.6	69.4	80.8	97.9	111.9	125.8	139.8	167.7	NA	NA
Natural Gas [m ³ /hr] - 150# Steam	43.5	58.8	72.6	88.3	101.6	117.6	131.8	147.0	176.5	215	232.4
Propane Gas [ft ³ /hr] - 15# Steam	586	800	980	1,181	1,382	1,580	1,778	1,975	2,370	NA	NA
Propane Gas [ft ³ /hr] - 150# Steam	615	831	1,026	1,247	1,436	1,662	1,863	2,078	2,493	3038	3282
Propane Gas [m ³ /hr] - 15# Steam	16.6	22.6	27.7	33.4	39.1	44.7	50.3	55.9	67.1	NA	NA
Propane Gas [m ³ /hr] - 150# Steam	17.4	23.5	29.1	35.3	40.7	47.1	52.7	58.8	70.6	86	92.9
No.2 Oil Fuel - 15# Steam, gph	10	14	17	21	24	28	31	35	42	NA	NA
No.2 Oil Fuel - 150# Steam, gph	11	15	18	22	25	28.9	32	36	43	54	59
No.2 Oil Fuel - 15# Steam, lph	38	53	64	79	91	106	117	132	159	NA	NA
No.2 Oil Fuel - 150# Steam, lph	41	56	68	82	95	109	121	136	163	204	223
Power Requirements - 3 Phase 60 Hz Standard [Note C]											
Blower Motor HP - Gas Firing	2	2	2	2	2	3	3	3	5	7.5	7.5
Blower Motor HP - Oil or Comb.	2	2	2	2	3	5	3	3	5	7.5	7.5
Oil Pump for Oil or Combination	← Belt Driven from the Blower Motor →									Direct Drive from Fan Motor	
Minimum Ampacity											
Blower Motor - Gas, 230V	6	6	6	6	6	9	9	9	15	22	22
Blower Motor - Gas, 460 V	3	3	3	3	3	4.5	4.5	4.5	7.5	11	11
Blower Motor - Oil or Comb, 230 V	6	6	6	6	9	15	9	9	15	22	22
Blower Motor - Oil or Comb., 460V	3	3	3	3	4.5	7.5	4.5	4.5	7.5	11	11
Blower Motor - Gas, 575 V	1.6	1.6	1.6	1.6	1.6	2.4	2.4	2.4	4.1	6.1	6.1
Blower Motor - Oil or Comb., 575V	1.6	1.6	1.6	1.6	2.4	4.1	2.4	2.4	4.1	6.1	6.1
Control Circuit	1.7	1.7	1.7	1.9	1.9	1.9	2.4	2.4	2.4	2.5	2.5
Weights											
Operating Weight, lbs.	3,643	3,643	4,445	4,445	5,040	5,040	5,858	5,858	6,753	6,920	6,920
Operating Weight, kg	1,652	1,652	2,016	2,016	2,286	2,286	2,657	2,657	3,063	3,139	3,139
Water Content Normal, Imp.gals	54.4	54.4	74.9	74.9	94	94	116.1	116.1	135.7	71.1	71.1
Water Content Normal, liters	248	248	340	340	428	428	528	528	617	324.7	324.7
Water Content Flooded, Imp. gals	79.94	79.94	109.08	109.08	135.7	135.7	166.5	166.5	194.01		
Water Content Flooded, liters	363.4	363.4	459.9	459.9	616.9	616.9	756.9	756.9	881.99		
Shipping Weight, approximate lbs.	3,100	3,100	3,700	3,700	4,100	4,100	4,700	4,700	5,400	6,200	6,200
Shipping Weight, approximate kg	1,406	1,406	1,678	1,678	1,860	1,860	2,132	2,132	2,449	2,812	2,812

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. For altitudes above 1000 Feet, contact your local Cleaver-Brooks authorized representative for verification of capacity rating.

Table B3-5. Model 5 Steam Boiler Ratings



Table B3-6. Recommended Steam Nozzle Size (To Maintain 4000 to 5000 fpm Nozzle Velocity)

Operating Pressure (PSIG)	BOILER SIZE								
	1500	2000	2500	3000	3500	4000	4500	5000	6000
15	4	4	6	6	6	6	8	8	8
20	3	4	4	6	6	6	8	8	8
30	3	4	4	4	4	6	6	6	6
40	2-1/2	3	3	4	4	4	6	6	6
50	2-1/2	3	3	4	4	4	4	4	6
65	2-1/2	2-1/2	3	3	3	4	4	4	4
75	2-1/2	2-1/2	3	3	3	4	4	4	4
95 - 125 ^A	2-1/2	2-1/2	3	3	3	3	4	4	4
150	1-1/2	2	2	2-1/2	2-1/2	2-1/2	3	3	3
200	1-1/2	1-1/2	1-1/2	2	2	2-1/2	2-1/2	2-1/2	3
250 - 400	1-1/2	1-1/2	1-1/2	1-1/2	2	2	2	2	2-1/2

A. Standard nozzle size for 150 PSIG MAWP Boiler Design

Example 1: Size 3500, 150# boiler to operate @ 30 PSIG requires 4" steam nozzle in lieu of standard 3" nozzle.

Example 2: Size 3500, 150# boiler to operate @ 200 PSIG requires 2" steam nozzle in lieu of standard 3" nozzle.

Table B3-7. Model 5 Oil Fuel Requirements

BOILER MODEL	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000 LWV
OIL USAGE ^A (GPH)	10.7	14.3	17.9	21.4	25.0	28.6	32.7	35.7	42.8	57.2

NOTES:

1. Oil supply lines to be sized for 125 gph pumping rates.

2. Oil pump suction pressure -10" Hg to 3 psig.

A. Usage Based on #2 Fuel @ 140,000 Btu/gal.

ITEM	PART	SIZE (IN.)
SIZE 1500 - 3000		
1	Gas Inlet	1-1/2
2	Shutoff Cock	1/2
3	Main Regulator	1-1/2
4	Pilot Regulator	1/2
5	Solenoid Valve	1/2
7	Valve (POC)	1-1/2
8	Low Gas Pressure (Switch or Sensor)	1/4
9	High Gas Pressure Switch	1/4
10	Shutoff Valve	1-1/2
11	Butterfly Valve	1-1/2
SIZES 3500 TO 5000		
1	Gas Inlet	2
2	Shutoff Cock	1/2
3	Main Regulator	2
4	Pilot Regulator	1/2
5	Solenoid Valve	1/2
7	Valve (POC)	2
8	Low Gas Pressure (Switch or Sensor)	1/4
9	High Gas Pressure Switch	1/4
10	Shutoff Valve	2
11	Butterfly Valve	2
SIZE 6000 To 8000		
1	Gas Inlet	2
2	Shutoff Cock	1/2
3	Main Regulator	2-1/2
4	Pilot Regulator	1/2
5	Solenoid Valve	1/2
6	Valve (STD)	2
7	Valve (POC)	2
8	Low Gas Pressure (Switch or Sensor)	1/4
9	High Gas Pressure Switch	1/4
10	Shutoff Valve	2
11	Butterfly Valve	2

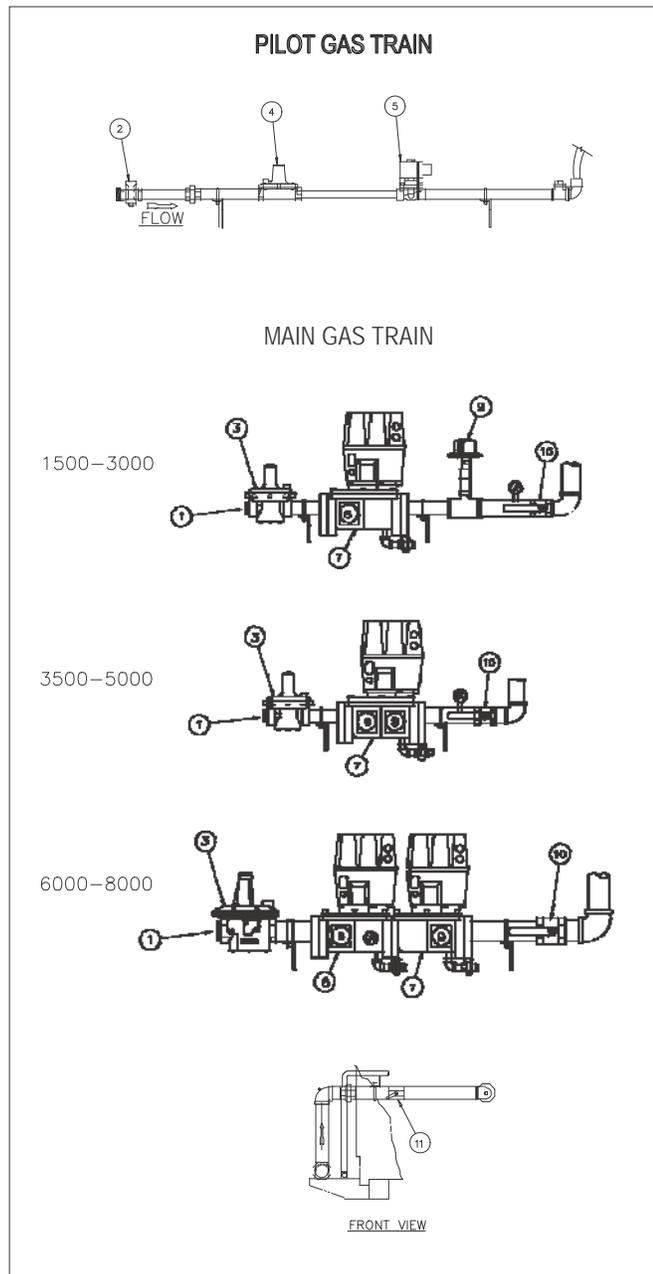


Figure B3-3. Standard Gas Train Model 5

Table B3-8. Model M5 minimum required Natural Gas pressure at entrance to the standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	1.5	1.5	4.3	28.0	1500
2000	1.5	1.5	8.4	28.0	2000
2500	1.5	1.5	11.3	28.0	2500
3000	1.5	1.5	14.9	28.0	3000
3500	2.0	2.0	10.0	28.0	3500
4000	2.0	2.0	11.9	28.0	4000
4500	2.0	2.0	11.5	28.0	4500
5000	2.0	2.0	16.0	28.0	5000
6000	2.0	2.0	20.4	28.0	6000
8000 LW V	2.5	19.9	19.9	28.0	8000

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
 Natural Gas @ 1000 Btu/cu-ft, specific gravity @ 0.65

Table B3-9. Model M5 minimum required Natural Gas pressure at entrance to the oversized standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	2.0	2.0	2.3	28.0	1500
2000	2.0	2.0	4.8	28.0	2000
2500	2.0	2.0	6.5	28.0	2500
	2.5	2.5	5.7		
3000	2.0	2.0	9.0	28.0	3000
	2.5	2.5	6.8		
	3.0	3.0	6.0		
3500	2.5	2.5	9.7	28.0	3500
	3.0	3.0	7.1		
4000	2.5	2.5	11.8	28.0	4000
	3.0	3.0	8.5		
4500	2.5	2.5	9.8	28.0	4500
	3.0	3.0	5.6		
5000	2.5	2.5	12.9	28.0	5000
	3.0	3.0	7.1		
	4.0	4.0	5.6		
6000	2.5	2.5	17.5	28.0	6000
	3.0	3.0	10.0		
	4.0	4.0	7.9		
8000 LW V	3.0	3.0	9.8	28.0	8000
	4.0	4.0	5.6		

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
 Natural Gas @ 1000 Btu/cu-ft, specific gravity @ 0.65

Table B3-10. Model M5 minimum required Propane Gas pressure at entrance to the standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	1.5	1.5	6.7	28.0	600
2000	1.5	1.5	10.5	28.0	800
2500	1.5	1.5	13.3	28.0	1000
3000	1.5	1.5	17.0	28.0	1200
3500	2.0	2.0	14.3	28.0	1400
4000	2.0	2.0	16.5	28.0	1600
4500	2.0	2.0	14.8	28.0	1800
5000	2.0	2.0	16.4	28.0	2000
6000	2.0	2.0	19.6	28.0	2400
8000 LWV	2.0	2.0	19.6	28.0	3200

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.

Propane @ 2500 Btu/cu-ft, specific gravity @ 1.6

Table B3-11. Model M5 minimum required Propane Gas pressure at entrance to the oversized standard UL, FM & XL GAP gas trains (upstream of gas pressure regulator).

BOILER SIZE	INLET PIPE SIZE (inches)	HONEYWELL VALVE SIZE (inches)	PRESSURE REQUIRED		REQUIRED FUEL FLOW (SCFH)
			MIN ("W.C.)	MAX ("W.C.)	
1500	2.0	2.0	5.9	28.0	600
2000	2.0	2.0	9.0	28.0	800
2500	2.0	2.0	10.8	28.0	1000
	2.5	2.5	10.5		
3000	2.0	2.0	13.8	28.0	1200
	2.5	2.5	12.9		
	3.0	3.0	12.6		
3500	2.5	2.5	13.6	28.0	1400
	3.0	3.0	12.6		
4000	2.5	2.5	15.8	28.0	1600
	3.0	3.0	14.5		
4500	2.5	2.5	13.8	28.0	1800
	3.0	3.0	12.1		
5000	2.5	2.5	14.8	28.0	2000
	3.0	3.0	12.5		
	4.0	4.0	12.0		
6000	2.5	2.5	18.0	28.0	2400
	3.0	3.0	15.0		
	4.0	4.0	14.1		
8000 LWV	2.5	2.5	13.8	28.0	3200
	3.0	3.0	12.1		

Note: For altitude above 1000 feet, contact your local Cleaver-Brooks representative.
 Propane @ 2500 Btu/cu-ft, specific gravity @ 1.6

Table B3-12. Safety Valve Outlet Sizes

Boiler Size	SAFETY VALVE SETTING					
	15 PSIG STEAM			150 PSIG STEAM		
	VALVES REQ'D	OUTLET SIZE (IN.)**	VALVE CAPACITY	VALVES REQ'D	OUTLET SIZE (IN.)**	VALVE CAPACITY
1500	1	2	3161 lbs/hr	1	1	1651 lbs/hr
2000	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
2500	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
3000	1	2	3161 lbs/hr	1	1-1/4	2585 lbs/hr
3500	1	2	3161 lbs/hr	1	1-1/2	4240 lbs/hr
4000	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
4500	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
5000	1	2-1/2	4676 lbs/hr	1	1-1/2	4240 lbs/hr
6000	1	3	6942 lbs/hr	1	2	6596 lbs/hr
8000 LWV	NA	NA	NA	1	2	

** Female Pipe Thread Connection [FPT]

PERFORMANCE DATA

Efficiency

Efficiency data provided in Table B3 - 13 is based on low pressure steam operation. For high pressure steam operation contact your local Cleaver-Brooks authorized representative for expected efficiency data.

Table B3-13. Predicted Efficiency, 10 PSIG operating (includes radiation and convection losses)

Boiler Size	Gas Fuel		Oil Fuel	
	Firing Rate		Firing Rate	
	Low Fire	High Fire	Low Fire	High Fire
1500	81.6	81.9	84.1	84.4
2000	81.1	80.0	83.6	82.5
2500	81.6	81.5	84.1	84.0
3000	81.3	80.3	83.8	82.8
3500	81.6	81.5	84.1	84.0
4000	81.3	80.7	83.8	83.0
4500	81.1	80.9	83.6	83.4
5000	81.3	80.0	83.8	82.5
6000	81.6	79.8	84.1	82.4

Emissions

The following tables denote typical emission levels for Natural Gas and No. 2 Oil. Please contact your local Cleaver-Brooks authorized representative if an emission guarantee is required.

Notice

The data in these tables represent typical emission levels only. Please contact your local Cleaver-Brooks authorized representative if an emission guarantee is required, or for emission level information not shown in these tables.

Table B3-14. Model 5 Emission Data, Natural Gas

POLLUTANT		UNCONTROLLED
CO	ppm ^A	200
	lb/MMBtu	0.15
NOx	ppm ^A	100
	lb/MMBtu	0.12
SOx	ppm ^A	1
	lb/MMBtu	0.001
HC/VOCs	ppm ^A	40
	lb/MMBtu	0.016
PM	ppm ^A	–
	lb/MMBtu	0.01

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

Table B3-15. Emission Data, No. 2 Oil

POLLUTANT		UNCONTROLLED ^B
CO	ppm ^A	90
	lb/MMBtu	0.07
NOx	ppm ^A	187
	lb/MMBtu	0.248
SOx	ppm ^A	278
	lb/MMBtu	0.515
HC/VOCs	ppm ^A	50
	lb/MMBtu	0.025
PM	ppm ^A	–
	lb/MMBtu	0.025

NOTES:
 A. ppm levels corrected to 3% O₂ dry basis.
 B. Based on the following fuel oil constituents.
 Fuel-bound nitrogen = 0.05% (max) by weight.
 Sulfur = 0.5% (max) by weight.
 Ash = 0.01% (max) by weight.



ENGINEERING DATA

The following engineering information is provided for the Model 5 steam boiler. Additional information may be obtained from your local Cleaver-Brooks authorized representative.

Feedwater

Steam boilers require make-up water for steam production. This make-up can be a combination of condensate return and raw make-up, 100% condensate return or 100% raw make-up. Proper treatment of make-up water and boiler water is essential to the longevity and performance of the boiler. Table B3-23 depicts the rate of make-up required and Table B3-22 shows the recommended water quality guidelines.

As a minimum, raw make-up should be piped into a water softener and then to a feed tank, which also can be the container that receives the system condensate returns. Chemical feed is recommended to be fed via a quill into the water make-up line feeding the boiler.

Blowdown

As steam is produced; unwanted solids are left behind in the boiler water and become concentrated within the vessel. If these constituents are allowed to adhere to the heat transfer surfaces, they will impede the flow of energy into the water. Their removal requires proper blowdown that will include bottom and possibly surface blowoff. For proper TDS control, surface blowoff with a TDS monitoring device is recommended. Local codes will dictate the manner of treating the blowdown affluent.

Boiler Stacks

General - The Model 5 boiler operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore, the stack must be a positive pressure design.

Proper design and installation of the flue gas venting is critical to efficient and safe operation of the burner. The vent should be designed with proper supports and clearances from combustible materials. Use insulated vent pipe spacers where the vent passes through walls and roofs.

The design of the stack and breeching must provide the required draft at each boiler stack connection. Although constant pressure at the flue gas outlet is not required, it is necessary to size the breeching and stack to limit flue gas pressure variations. Consideration of the draft must be given where lengthy runs of breeching are employed or unusually high stacks. Please note: the allowable pressure range for design of the stack and breeching is negative 0.25" w.c. (-62 Pa) to a positive 0.25" w.c. (+62 Pa) for proper light offs and combustion. NOTE: This pressure range does not pertain to the boiler room, that is, the boiler room must be neutral or slightly positive, never negative when using air from the boiler room for combustion.

When two or more Model 5 boilers are connected to a common breeching/stack, one should evaluate the affects of pressure variations that may occur during boiler sequencing while boilers are firing. It may be determined that some type of mechanical draft system be employed to ensure proper draft at each boiler is maintained.

Combustion Air - The burner for each boiler must be supplied with adequate volume of uncontaminated air to support proper combustion and equipment ventilation. Air shall be free of chlorides, halogens, fluorocarbons, construction dust or other

contaminants that are detrimental to the burner or boiler heating surfaces.

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA 54 (National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B149/1 and B149.2 for Canadian installations.

Engineered Design - When determining boiler room air requirements for the boiler, the "Engineered Design" method may be used. Following this method, consideration must be given to the size of the boiler room, airflow, and air velocity as follows:

Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler. Refer to Figure B3 - 4.

Air supply openings can be louvered for weather protection, but they should not be covered with a fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.

A vent fan in the boiler room is not recommended as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.

It is forbidden to have the total area of the air supply openings at less than one square foot.

Size the openings by using the formula ($\text{Area in ft}^2 = \text{cfm}_a / \text{fpm}_a$), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.

Amount of air required (cfm):

Combustion Air = Maximum boiler horsepower (bhp) times 8 cfm.

Ventilation Air = Maximum boiler horsepower (bhp) times 2 cfm.

Total Air = 10 cfm per bhp (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).

Acceptable air velocity in the boiler room (fpm):

From floor to 7 feet high = 250 fpm.

Above 7 feet from boiler room floor = 500 fpm.

Example of required air openings (Engineered Method):

Determine the area of the boiler room air supply openings for (2) size 4500 Model 5 boilers at 750 feet elevation; each have a rating of 107 boiler horsepower. The air openings will be 5 feet above the floor level.

The total boiler horsepower (bhp): $107 \times 2 = 214$ bhp.

From (F.3) above, total air required = $214 \text{ bhp} \times 10 = 2140$ cfm.

Air Velocity: From (G.1) above = 250 fpm.

Area required: From the formula in E above, $2140 \text{ cfm} / 250 \text{ fpm} = 8.56$ square feet total.

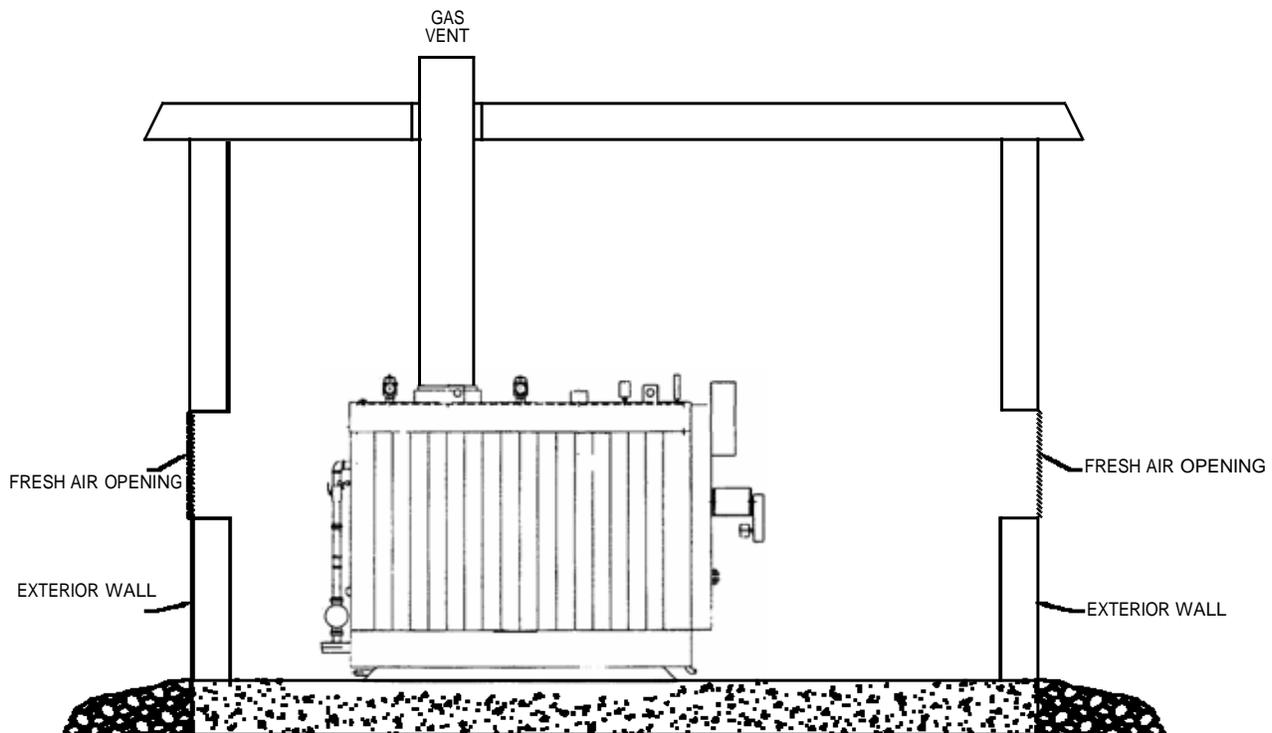
Area opening: 8.56 divided by 2 = 4.28 ft² per opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

See Table B3-24 for combustion air and flue gas flow.

Figure B3-4. Boiler Room Air Flow - "Engineered Design"



Oil Piping

General - Oil operation of the Model 5 boiler requires proper oil to the standard burner mounted oil pump. As the combustion of oil utilizes mechanical pressure atomization, line sizing to the pump must be sufficient to provide 125 gph of oil to the suction side of the pump.

Oil Train Components - Oil flow to the burner is controlled by four solenoid valves. The oil flows through a primary or safety shutoff valve into a manifold block. This valve and the low fire valve are energized simultaneously by the flame safeguard control and when opened, allow flow of oil to the low fire nozzle.

As the damper motor moves to high fire position, the damper motor end switches close to energize in sequence, the intermediate and then high fire oil valve. The purpose of the intermediate valve is to smooth the transition from low to high fire by balancing the oil input with increasing flow of air.

High fire rating of the burner is obtained when all three nozzles are firing, assuming proper oil pressure and normally sized nozzles.

Gas Piping

General - The Model 5 boiler requires appropriate gas supply pressure and volume for proper operation and long burner life. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation

must follow these guidelines and of the local authorities that have installation jurisdiction.

Gas Train Components - Model 5 boilers are equipped with a gas train that meets the requirements of UL as standard. These components also comply with the recommendations of FM, XL GAP (formerly IRI/GE GAP) and ASME CSD-1. The gas train and its components have been designed and tested to operate for the highest combustion efficiency.

Gas Pressure Requirements - For proper and safe operation, each Model 5 boiler requires a stable gas pressure supply. The pressure requirements are listed in previous sections for standard gas train size, and oversized trains for reduced available pressure.

Gas Piping - Model 5 units are standardly equipped with a gas pressure regulator. If upstream pressure to the standard regulator will be greater than 1 psig, an additional upstream regulator should be provided with a pressure relief valve.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c., a "full lockup" type regulator is recommended along with proper overpressure protection. In addition to the regulator, a plug type or "butterball" type gas shutoff cock should be provided upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the boiler gas train during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Gas Supply Pipe Sizing - For proper operation of a single unit or multiple units, we recommend that the gas pipe be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. The gas supplier (utility) should be consulted to confirm that sufficient volume and normal pressure are provided to the building at the discharge side of the gas meter or supply pipe. (For installations of new boilers into an existing building, gas pressure should be measured with a manometer to ensure sufficient pressure is available).

A survey of all connected gas using devices should be made. If appliances other than the boiler are connected to the gas supply line, then a determination should be made of how much flow volume (cfh = cubic feet per hour) will be demanded at one time and the pressure drop requirements when all appliances are operating.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final connection. As a minimum guideline, gas piping Tables B3 - 16 through B3 - 20 should be used. The data in these tables is from the NFPA source book, 2006 edition.

Table B3-16. Gas line capacity - Schedule 40 metallic pipe

Pipe Size							
Nominal	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	1.049	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)						
10	514	1,060	1,580	3,050	4,860	8,580	17,500
20	363	726	1,090	2,090	3,340	5,900	12,000
30	284	583	873	1,680	2,680	4,740	9,660
40	243	499	747	1,440	2,290	4,050	8,290
50	215	442	662	1,280	2,030	3,590	7,330
60	195	400	600	1,160	1,840	3,260	6,640
70	179	368	552	1,060	1,690	3,000	6,110
80	167	343	514	989	1,580	2,790	5,680
90	157	322	482	928	1,480	2,610	5,330
100	148	304	455	877	1,400	2,470	5,040
125	131	269	403	777	1,240	2,190	4,460
150	119	244	366	704	1,120	1,980	4,050
175	109	209	336	648	1,030	1,820	3,720
200	102	185	313	602	960	1,700	3,460
**Fuel: Natural Gas							
**Inlet Pressure: Less than 2.0 psi							
**Pressure Drop: 0.30" w.c.							
**Specific Gravity: 0.60							

Table B3-17. Gas line capacity - Schedule 40 metallic pipe

Pipe Size							
Nominal	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)						
10	678	1,390	2,090	4,020	6,400	11,300	23,100
20	466	957	1,430	2,760	4,400	7,780	15,900
30	374	768	1,150	2,220	3,530	6,250	12,700
40	320	657	985	1,900	3,020	5,350	10,900
50	284	583	873	1,680	2,680	4,740	9,600
60	257	528	791	1,520	2,430	4,290	8,760
70	237	486	728	1,400	2,230	3,950	8,050
80	220	452	677	1,300	2,080	3,670	7,490
90	207	424	635	1,220	1,950	3,450	7,030
100	195	400	600	1,160	1,840	3,260	6,640
125	173	355	532	1,020	1,630	2,890	5,890
150	157	322	482	928	1,480	2,610	5,330
175	144	296	443	854	1,360	2,410	4,910
200	134	275	412	794	1,270	2,240	4,560
**Fuel: Natural Gas							
**Inlet Pressure: Less than 2.0 psi							
**Pressure Drop: 0.50" w.c.							
**Specific Gravity: 0.60							

Table B3-18. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	57,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	954	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
1000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
**Fuel: Natural Gas									
**Inlet Pressure: 2.0 psi									
**Pressure Drop: 1.0 psi									
**Specific Gravity: 0.60									

Table B3-19. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	75,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,300	20,300	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,300
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
500	283	593	1,120	2,290	3,430	6,610	10,300	18,600	38,000
1000	195	407	897	1,380	2,360	4,550	7,240	12,000	26,100
1500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
**Fuel: Natural Gas									
**Inlet Pressure: 3.0 psi									
**Pressure Drop: 2.0 psi									
**Specific Gravity: 0.60									

Table B3-20. Gas line capacity - Schedule 40 metallic pipe

Pipe Size									
Nominal	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	0.622	0.824	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
1000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400
**Fuel: Natural Gas									
**Inlet Pressure: 5.0 psi									
**Pressure Drop: 3.5 psi									
**Specific Gravity: 0.60									

Table B3-21. Sound Levels

SOUND LEVEL / FIRING RATE	BOILER SIZE (BHP)									
	1500 (35)	2000 (47)	2500 (59)	3000 (71)	3500 (83)	4000 (95)	4500 (107)	5000 (119)	6000 (143)	8000
LFG (dBA)	70	70	71	71	72	72	74	75	76	
HFG (dBA)	70	70	72	74	74	76	77	78	79	
LFO (dBA)	69	69	70	71	72	73	74	75	76	
HFO (dBA)	71	71	72	73	74	76	76	77	78	

NOTES:

1. Abbreviations: LF=Low Fire, HF=High Fire, O=Oil, G=GAS
2. Measurement: Three (3) feet from front center of boiler and 3-1/2 feet above boiler base. Measurements are decibel ratings on the A-Weighted scale, and were registered without the addition of sound attenuators, mufflers, or silencers.
3. N/A to 8000 LWV.

Table B3-22. Water Quality Requirements

Parameter	Boiler Water Limit
pH	8.3 - 10.5
Iron	0.1 ppm
Oxygen	0.1 mg/liter
Specific Conductivity	2000 µmho/cm
Suspended Solids	300 ppm
Total Hardness	0 ppm as CaCO ₃

Table B3-23. Feedwater Make-up Rates

Boiler Size	Gallons/Minute
1500	2.5
2000	3.3
2500	4.1
3000	5
3500	5.8
4000	6.6
4500	7.5
5000	8.3
6000	9.9
8000	13.2

Table B3-24. Model 5 Fuel, Combustion Air, and Flue Gas Flow Rates

			Boiler Size									
			1500	2000	2500	3000	3500	4000	4500	5000	6000	8000 LWV
Fuel Consumption	Gas	cfh	1500	1500	2500	3000	3500	4000	4500	5000	6000	8000
	Oil	gph	10.72	14.29	17.86	21.43	25.00	28.57	32.14	35.71	42.85	
Combustion Air	Gas	scfh	15,480	20,640	25,800	30,960	36,120	41,280	46,440	51,600	61,920	
		lb/hr	1,207	1,609	2,012	2,414	2,817	3,219	3,621	4,024	4,828	
	Oil	scfh	17,049	22,733	28,414	34,098	39,782	45,463	51,147	56,831	68,196	
		lb/hr	1,269	1,692	2,115	2,538	2,961	3,384	3,808	4,231	5,077	
Flue Gas	Gas	scfh	17,520	23,360	29,200	35,040	40,880	46,720	52,560	58,400	70,080	
		lb/hr	1,278	1,704	2,130	2,556	2,983	3,409	3,835	4,261	5,113	
	Oil	scfh	17,914	23,886	29,855	35,827	41,799	47,769	53,741	59,713	71,655	
		lb/hr	1,357	1,809	2,261	2,714	3,166	3,618	4,070	4,523	5,427	

- Notes:
- A. Gas consumption, expressed in cubic feet per hour, is based on 1,000 Btu/cu.ft gas value.
 - B. Oil consumption, expressed in pounds per hour, is based on 140,000 Btu/gal oil value.
 - C. Oil supply lines must be sized for 125 gph pumping rate. Oil pump suction pressure to be -10" Hg to 3 psig.

Model 5 Boilers Steam Specifications

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Soot Cleaning	B3-33
Boiler Connections	B3-33
Boiler Trim/Controls	B3-33
Low Water Volume Design (LWV), 150 Psig	B3-34
Low Water Volume Design (LWV), 15 Psig	B3-34
Burner	B3-34
Gas Fired Burner	B3-35
Oil Fired Burner	B3-36
Gas-Oil Fired Burner	B3-37
Burner and Flame Failure Controller	B3-38
Burner Control Panel	B3-38

SAMPLE SPECIFICATIONS

The following sample specifications are provided by Cleaver-Brooks to assist you in specifying your customer's specific needs and application.



PART 1 GENERAL

1.1

BOILER CAPACITY

- A. The steam boiler shall be a Cleaver-Brooks Model 5, Series (100, 200, 700) rated at _____ lbs/hr or _____ boiler horsepower designed for (15, 150, 250, 350 or 500) psig steam. The maximum boiler operating pressure will be _____ psig. (Series 100 is a No.2 oil fired burner; Series 200 is a gas or No.2 oil fired burner; Series 700 is a straight gas burner).
- B. The boiler shall have a maximum output of _____ Btu/hr or _____ boiler horsepower when fired with (No.2 oil) or (natural gas @ _____ Btu/cu-ft). The boiler shall develop _____ lbs/hr when operating at _____ psig with feedwater temperature at _____ ° F. The boiler safety relief valve(s) shall be set at _____ psig.
- C. Electrical power to the boiler shall be _____ volts, _____ phase, _____ Hz. All electrical service connections shall be made to an electrical entrance box mounted on the right hand side of the boiler.

PART 2 PRODUCTS 2.1**BOILER DESCRIPTION**

- A. The boiler shall be an all steel membrane wall watertube design with 3-pass gas travel. It shall be mounted on a heavy duty steel frame with an integral forced draft burner and burner controls. The complete package, boiler-burner unit, shall be certified, tested, and labeled by CSA (Canadian Standard Association). The package shall be completely assembled and receive a factory fire test prior to shipment.
- B. The boiler shell must be constructed and hydrostatically tested in accordance with the A.S.M.E. Boiler and Pressure Vessel Code Section I or IV and receive an authorized boiler inspection. A copy of the inspection report shall be furnished to the purchaser.
- C. Two downcomers shall be located at the rear of the boiler and totally insulated from the generating tubes. The downcomers shall be 2-1/2" OD for 35 and 47 hp; 3" OD for 59 to 83 hp, and 4" OD for 95 hp and greater. Material shall be SA-178A. The 2-1/2" and 3" downcomers shall have 0.105" wall while the 4" downcomers shall have 0.135" wall. The generating tubes shall be 2" OD, SA-178 Grade A with 0.095" wall thickness.
- D. The upper drum shall be 20" OD Schedule 20, SA-53-B seamless pipe with 0.375" wall. The lower drum shall be 6" nominal pipe size, SA-53-B seamless pipe with 0.312" wall up through 150 psig design.
- E. Two lifting eyes shall be located on the top centerline of the upper drum.
- F. Refractory shall be limited to the furnace floor, lower drum, burner throat tile, and the formed rear furnace access door. High temperature insulation shall be installed on the front water wall of the furnace.
- G. Observation ports shall be provided at each end of the boiler for visual inspection of the pilot and main flame conditions.

- H. The exhaust gas vent shall be located at the top rear centerline of the boiler. A stack thermometer shall be shipped loose for field installation by the installing contractor into the stack.
- I. Inspection openings shall be provided in the convection area.
- J. The lower drum shall include capped plugs in the front and rear drum heads, and a handhole shall be provided in the rear upper drum head for waterside inspection
- K. The vessel shall be insulated with a minimum of 2" fiber glass blanket. This insulation shall be covered with a sheet metal jacket. The jacket and insulation shall be arranged for easy removal and reinstallation if required.
- L. The entire boiler jacket, base frame, and other components shall be factory painted using hard finish enamel.

2.2 SOOT CLEANING

- A. Soot washer lances shall be provided in the upper convection area of the boiler, measuring the full length of the pressure vessel. Each lance assembly shall be capable of rotating 360 degrees. This shall ensure complete washing of the convection zone while the boiler is operating in the low fire mode.
- B. Soot washer drain troughs shall be provided at the bottom of the boiler. These shall be furnished for each convection side running the full length of the boiler with 2" drain connections at the bottom rear. Inspection/cleanout openings for each trough shall be located at the front of the boiler.

2.3 BOILER CONNECTIONS

- A. The steam nozzle shall be located on the top centerline of the upper drum and sized for steam velocity not to exceed 5000 fpm.
- B. A feedwater tapping and an integral feedwater distribution pipe shall be located in the upper drum. This distribution pipe shall blend the feedwater with the boiler water.
- C. A $\frac{3}{4}$ " surface blowoff tapping shall be provided in the rear head of the upper drum.
- D. For blowdown or boiler drain, a tapping shall be provided in the bottom of the lower drum near the front of the boiler.

2.4 BOILER TRIM/CONTROLS

- A. The primary water column shall be located on the left side of the boiler when facing the burner. It shall be piped with union connections for easy removal and include a full size column blowdown valve. A gauge glass with gauge glass valves shall be mounted to the water column.
- B. A primary low water cutoff switch shall be an integral part of the water column and shall be wired into the burner control circuit to prevent burner operation in the event of an unsafe water level condition.
- C. To maintain proper and safe water level within the boiler, an integral feed pump control switch shall be included within the primary water column. This switch may be wired to a control relay for pump on/off operation or wired to control a solenoid water make-up valve.

- D. A secondary low water cutoff control of the manual reset type shall be provided on the right hand side of the boiler, when facing the burner. This control shall include a switch wired into the burner circuit to prevent burner operation in the event that the primary low water control did not function properly during an unsafe water level condition. A control blowdown valve shall be included for maintenance and periodic testing of the level device.
- E. For visual indication of the internal boiler pressure, a steam pressure gauge shall be mounted near the water column and shall include an inspector's test cock and test connection point.
- F. For burner operation, a minimum of three controls shall be provided: one auto reset type for burner start and stop control, one for burner firing rate (modulation on gas or low high low on oil), and one manual reset type for burner shutdown in the event of excessive steam pressure within the boiler.
- G. In compliance with the A.S.M.E. Code, a Code rated safety relief valve(s) shall be provided. This valve(s) may be shipped loose to prevent any damage during shipment.

2.5 LOW WATER VOLUME DESIGN (LWV), 150 PSIG

For applications requiring the use of a low water volume vessel, the following trim, controls and design shall be provided:

- A. The primary water column shall be located on the left side of the boiler when facing the burner, and shall be a McDonnell-Miller #193-7 or approved equal. It shall be piped with union connections for easy removal and include a full size column blowdown valve. A gauge glass with gauge glass valves shall be mounted to the water column.
- B. The primary water level control and water level cut-off settings shall be installed at a level that limits the total water content within the boiler to 75 U.S. Gallons (283.9 liters) or less at full operating capacity.
- C. Feedwater into the boiler shall be controlled by means of an electric proportional feedwater valve, Worchester or approved equal, complete with stop valve, check valve, and 3-valve by-pass.
- D. Controls shall be provided to comply with "Guarded Plant" status requirements.
- E. The upper and lower drums shall be properly insulated to prevent heat transfer onto these surfaces during combustion.

2.6 LOW WATER VOLUME DESIGN (LWV), 15 PSIG

For applications requiring the use of a low water volume vessel, the following trim, controls and design shall be provided:

- A. Controls shall be provided to comply with "Guarded Plant" status requirements.
- B. The upper and lower drums shall be properly insulated to prevent heat transfer onto these surfaces during combustion.

2.7 BURNER

- A. Models 1500 - 6000; all air for combustion shall be supplied by a

forced draft blower mounted in the front head (wind box) above the burner, to minimize vibration and reduce noise emissions. The impeller shall be an enclosed centrifugal fan type, properly balanced and direct connected to the motor shaft. Sound level shall not exceed 80 dBA measured 3 feet in front of the burner.

- B. Models 7500 - 8000; all air for combustion shall be supplied by a forced draft blower mounted within the fan housing of the externally mounted burner. The burner shall be a CB Profire Series V. The fan shall be a squirrel cage design, properly balanced and direct connected to the motor. Sound level shall not exceed 85 dBA measured 3 feet in front of the burner.
- C. When firing gas, the burner shall operate on the full modulation mode and shall be positioned at the low position for the ignition sequence, and shall remain in the low fire position during ignition and until main flame has been proven.
- D. For oil operation, the burner shall operate on the low-high-low principle and shall be positioned at the low position for the ignition sequence, and shall remain in the low fire position during ignition and until main flame has been proven.

2.8 GAS FIRED BURNER

- A. The burner shall be a high radiant multi-port type approved for operation on natural gas.
- B. Automatic electric ignition of the premix gas pilot shall be furnished. An ultra violet (UV) flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established. The gas pilot assembly shall include a pilot solenoid shutoff valve, pilot regulator, and manual shutoff cock.
- C. A single damper motor shall control the combustion air inlet damper and the fuel input control valve (butterfly type) via linkage connections. The damper motor shall modulate the burner in accordance with system demand, responding to the boiler mounted modulating pressure control.
- D. Gas burner piping shall include a primary safety shutoff valve, controlled by the burner flame safeguard control to start or stop the burner. The valve shall close automatically in the event of a power failure, excess steam pressure, low or high gas pressure, or a low water condition.
- E. A main gas pressure regulator shall be piped in the gas train to regulate the incoming pressure for proper burner operating pressure including an upstream manual shutoff valve.
- F. For tightness checking of the primary shutoff valve, a plugged leakage test connection and a lubricated plug cock shall be provided.
- G. The primary shutoff valve shall be of the motorized type.
- H. For sizes 6000 - 8000, a second motorized gas valve shall be provided and piped in series with the primary shutoff valve.
- I. Low and High gas pressure switches of the manual reset type shall be mounted and wired to prevent burner operation if gas pressure is above or below the settings of these switches.

- J. To prove proper air is available for pre purge and combustion, a combustion air proving switch shall be provided.

2.9 OIL FIRED BURNER

- A. The burner shall be a pressure atomizing type approved for operation with commercial grade No. 2 fuel oil.
- B. For 1500 through 6000 units,
 1. Automatic electric spark ignition for the low fire oil supply shall be provided with a 10,000 volt ignition transformer and heavy duty electrodes. The ignition period shall be monitored with an electronic scanner of the UV principle to confirm the presence of the low fire oil flame.
 2. A single damper motor shall control the combustion air inlet damper and the fuel input control valves via linkage connections. The damper motor shall operate the burner in accordance with system demand, responding to the boiler mounted low high low pressure control.
 3. For fuel input control, 4 solenoid type fuel oil valves shall be piped and wired onto the front head of the boiler. Two valves shall be used for low fire ignition and the other two for high fire operation.
 4. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, and shutoff cock.
 5. An oil pump shall be provided and shall be integral with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via belt connection to the fan motor.
- C. For 7500 - 8000 units, automatic electric ignition of the premix gas pilot shall be furnished. An ultra violet (UV) flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established. The gas pilot assembly shall include a pilot solenoid shutoff valve, pilot regulator, and manual shutoff cock.
 1. A single damper motor shall control the combustion air inlet damper and the fuel input control valve via linkage connections. The damper motor shall modulate the burner in accordance with system demand, responding to the boiler mounted modulating pressure control.
 2. For fuel input control, metering type fuel oil valve shall be piped and onto the burner housing. Two solenoid valves shall be used for safety shutoff.
 3. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, low oil pressure interlock, and shutoff cock.
 4. An oil pump shall be provided and shall be shipped loose with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via oil pump starter mounted and wired in the burner control panel.

2.10 GAS-OIL FIRED BURNER

A. A. General

1. The burner shall be a high radiant multi-port type approved for operation on natural gas and shall be a pressure atomizing type approved for operation with commercial grade No. 2 fuel oil.
2. Automatic electric ignition of the premix gas pilot shall be furnished. An ultra violet (UV) flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established. The gas pilot assembly shall include a pilot solenoid shutoff valve, pilot regulator, and manual shutoff cock.
3. A single damper motor shall control the combustion air inlet damper and the fuel input control valve via linkage connections. The damper motor shall regulate the burner in accordance with system demand, responding to the boiler mounted pressure control.
4. To prove proper air is available for pre purge and combustion, a combustion air proving switch shall be provided.

B. Gas System

1. Gas burner piping shall include a primary safety shutoff valve, controlled by the burner flame safeguard control to start or stop the burner. The valve shall close automatically in the event of a power failure, excess steam pressure, low or high gas pressure, or a low water condition.
2. A main gas pressure regulator shall be piped in the gas train to regulate the incoming pressure for proper burner operating pressure including an upstream manual shutoff valve.
3. For tightness checking of the primary shutoff valve, a plugged leakage test connection and a lubricated plug cock shall be provided.
4. The primary shutoff valve shall be of the motorized type.
5. For sizes 6000 - 8000, a second motorized gas valve shall be provided and piped in series with the primary shutoff valve.
6. Low and High gas pressure switches of the manual reset type shall be mounted and wired to prevent burner operation if gas pressure is above or below the settings of these switches.

C. Oil System

1. For 1500 through 6000 units,
 - a. For fuel input control, 4 solenoid type fuel oil valves shall be piped and wired onto the front head of the boiler. Two valves shall be used for low fire ignition and the other two for high fire operation.
 - b. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, and shutoff cock.
 - c. An oil pump shall be provided and shall be integral with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via belt connection to the fan motor.

2. For 7500 - 8000 units,
 - a. For fuel input control, metering type fuel oil valve shall be piped and onto the burner housing. Two solenoid valves shall be used for safety shutoff.
 - b. The fuel oil system shall include supply and return tubing to an oil terminal block, oil pressure gauge, low oil pressure interlock, and shutoff cock.
 - c. An oil pump shall be provided and shall be shipped loose with the burner. The pump shall include a built-in pressure relief valve and self cleaning strainer. Operation of the pump shall be via oil pump starter mounted and wired in the burner control panel.

2.11 BURNER AND FLAME FAILURE CONTROLLER

A third party listed and approved safeguard control shall be provided to control ignition, starting and stopping the burner, and provide pre-combustion and post combustion air purge. The control shall stop and prevent burner operation in the event of ignition, pilot, or main flame failures. Trial for ignition shall be limited to 10 seconds.

- A. The flame safeguard control shall be a microprocessor based burner management control system, designed to provide proper burner sequencing, ignition, and flame monitoring protection.
- B. Through SMART LED's, the control shall provide current operating status and lockout information in the event of a safety shutdown.
- C. A separate preconfigured program module shall plug in to the microprocessor control.
- D. For trouble shooting and retrieving history, a VFD format display shall be mounted onto the control. This alpha numeric display shall provide 2 lines by 16 characters per line display of operating conditions, fault conditions, flame signal strength, and burner run history.
- E. In addition to the VFD display, LED Indicator Lights shall be provided integral with the control for Fan, Open Damper, Close Damper, Auto Operation, and Ignition.
- F. The control shall be a CB120E or equal.

2.12 BURNER CONTROL PANEL

- A. The control panel shall be mounted at the front of the boiler on the burner fan housing (windbox) and conveniently located for the operator. It shall be mounted within a NEMA 1A type enclosure and include a key lock.
- B. Factory mounted and wired components and controls shall include the following:
 1. Fan Motor Starter
 2. Fan Motor Fuses
 3. Control Circuit Transformer with fuses
 4. Oil Pump Starter (size 7500 - 8000 units) firing oil.
 5. Terminals for wiring connections

6. Flame Safeguard Control
 7. Burner On/Off Switch
 8. Manual Damper Positioning Switch
 9. Indicating lights for low water, flame failure, load demand, and fuel valve on.
- C. All electrical equipment shall be in conformity with CSA. Oil, heat, and moisture resistant wire shall be used and number coded relative to the wiring diagram.

Model 5 Boilers Hot Water Specifications

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Boiler Description	B3-42
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No.2 Oil and Gas Burner	B3-45
Burner and Flame Failure Controller	B3-45
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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 5, Series _____ (100, 200, 700), _____bhp, designed for 140 psig hot water. The maximum supply temperature will be _____°F, and the minimum return water temperature will be _____°F. The minimum operating temperature of the boiler shall be 170 °F. (Series 100 - No. 2 oil; 200 - No. 2 oil and gas; 700 - gas.)
- B. The boiler shall have a maximum output of _____Btu/hr, or _____hp, when fired with No.2 oil and/or natural gas _____Btu/cu-ft. Safety relief valves shall be set at _____psig.
- C. Electrical power available will be _____volts, _____phase, _____Hz. All electrical service connections shall be made to an electrical entrance box mounted on the right hand side of the boiler.

PART 2 PRODUCTS 2.1**BOILER DESCRIPTION**

- A. The boiler shall be an all steel membrane wall watertube boiler with 3-pass gas travel. It shall be mounted on a heavy duty steel frame with integral forced draft burner and burner controls. The complete packaged boiler-burner unit shall be approved by Canadian Standard Association and shall have the CSA label affixed to the front head. The boiler shall be completely assembled and fire tested at the factory.
- B. The boiler shell must be constructed and hydrostatically tested in accordance with the ASME Boiler and Pressure Vessel Code. It must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall be furnished to the purchaser.
- C. Two lifting eyes shall be located on top of the boiler.
- D. Two downcomers shall be located at the rear of the boiler and totally insulated from the generating tubes. The generating tubes shall be 2" OD SA-178 Grade A with .095" wall thickness. The downcomers shall be 2-1/2" OD for 35 and 47 hp; 3" OD for 59 to 83 hp and 4" OD for 95 to 143 hp. Material shall be SA-178-A and the 2-1/2" and 3" downcomers shall have a 0.105" wall. The 4" downcomers shall have a 0.135" wall.
- E. The upper drum shall be 20" OD schedule 20, SA-53-B seamless pipe with .375" wall. The lower drum shall be 6" nominal pipe size, SA-53-B seamless pipe with .312" wall.
- F. Refractory shall be limited to the furnace floor, insulating the lower drum, the burner throat tile, and to the formed rear access door which unbolts for ease of entry and/or inspection. High-temperature insulation shall be installed on the front wall of the furnace.
- G. Observation ports shall be provided at each end of the boiler for visual inspection of the pilot and main flame conditions.
- H. The exhaust gas vent shall be located at the rear of the boiler on the top centerline. A stack thermometer shall be shipped loose for field installation.
- I. Inspection openings shall be provided in the convection area.

- J. The boiler insulation shall be a minimum of 2" fiber glass blanket. This insulation shall be covered with a corrugated sheet metal lagging. The lagging and insulation shall be arranged for easy removal and reinstallation if required. The entire boiler, base frame, and other components shall be factory painted before shipment using a hard finish enamel.

2.2 SOOT CLEANING

- A. Soot washer lances shall be provided in the convection area of the boiler measuring full length of the pressure vessel. Each lance shall be provided with a shutoff valve and the assembly shall be capable of rotating 360 °F. This shall ensure complete washing of the convection zone while the boiler is operating in the low fire mode.
- B. Soot washer troughs shall be provided at the bottom of the boiler. These shall be furnished for each convection side running the full length of the boiler with 2" drain connections at the boiler rear. Inspection/cleanout openings for each trough shall be located at the front of the boiler.

2.3 BOILER CONNECTIONS

- A. The hot water outlet connection shall be located on the top centerline of the boiler and the return connection shall be located at the rear of the lower drum. The design of the boiler shall provide jet induced circulation, which shall mix the return water with the hot water within the boiler.
- B. A dip tube shall be included as an integral part of the hot water outlet. An air vent tapping shall be located on the top centerline of the boiler for connection to an expansion tank.
- C. Handholes shall be provided at the end of the lower drum and in the rear of the upper drum for inspection of the water side surfaces.

2.4 BOILER TRIM

- A. The low water cutoff switch shall be a probe type, mounted in the top center-line of the boiler. It shall be wired into the burner control circuit to prevent burner operation if the boiler water falls below a proper level.
- B. 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 on excessive water temperature. The sensing elements shall be located adjacent to the outlet connection.
- C. A hot water circulating pump shall be mounted between the supply and return water connections (standard on ASME Section IV heating boilers only). This pump will blend the supply and the system return water. It will ensure a minimum continuous circulation at all times to a level of 10 boiler water changes per hour.
- D. A combination pressure-temperature gauge shall be located on the boiler.
- E. Water relief valves shall be provided of a type and size to comply with ASME Code requirements.

2.5 BURNER

A. Burner Description

1. All air for combustion shall be supplied by a forced draft blower mounted in the front head (windbox), above the burner, to minimize vibration and noise level.
2. The impeller shall be an enclosed centrifugal fan type, properly balanced and directly connected to the blower motor shaft.
3. The maximum sound level shall not exceed 80 dBA measured 3 feet in front of the boiler.
4. The oil burner shall operate on the low-high-low principle and must return to the low fire position prior to ignition.
5. The gas burner shall operate on the full modulation system and must return to the low fire position prior to ignition.
6. The burner shall remain in the low fire position during ignition and until main flame has been proven.

B. Gas Fired Burner

1. The burner shall be integral with the front head of the boiler and shall be the high radiant multi-port type approved for operation with natural, manufactured, or mixed gas.
2. Automatic electric ignition of the premix gas pilot shall be furnished. A UV flame detector shall monitor the pilot, preventing the primary fuel valve from opening until the pilot flame has been established.
3. A single damper motor shall control the combustion air damper and the butterfly gas valve. The damper motor shall regulate the fire according to system demand in response to the boiler mounted temperature/pressure control.
4. The gas burner piping system on the unit shall include a primary gas shutoff valve. It shall be controlled by the programming relay to start or stop the burner and to close automatically in the event of power failure, flame failure, excessive pressure or temperature, high or low gas pressure, or a low water condition. A lubricated shutoff cock shall be located ahead of the primary valve for manual shutoff.
5. A plugged leakage test connection and a lubricated plug cock are provided as a means for a tightness check of the primary shutoff valve.
6. A gas pressure regulator shall be factory mounted and piped for proper pressure regulation to the burner.
7. Gas Train Components
8. The primary shutoff valve shall be a motorized type. High and low gas pressure switches shall be provided.

C. No. 2 Oil Fired Burner

1. The burner shall be integral with the front head of the boiler. It shall be the pressure atomizing type approved for operation with commercial grade No.2 oil.
2. The burner shall operate on the low-high-low principle, and must return to the low-fire position prior to ignition.

3. The burner shall remain in the low-fire position during ignition, and until low fire and main flames have been proven.
4. Automatic electric ignition of the low-fire oil supply shall be provided with a 10,000 volt transformer and heavy duty electrodes. The ignition period shall be monitored with an electric scanner of the UV principle to confirm the presence of the low fire oil flame.

Notice

Optional insurance compliance may require a premix gas pilot in lieu of electric ignition.

5. The combustion air damper, low-fire, and high-fire oil valves shall be operated by a single damper control motor. This motor shall regulate the fire according to system demand in response to the boiler mounted high-low fire temperature/pressure control.

2.6 OIL SYSTEM

- A. An oil pump shall be provided. The oil pump, integral with the burner, shall include a built-in relief valve and self-cleaning strainer. The pump shall be belt driven from the blower motor.
- B. The fuel oil system shall include supply and return tubing to a terminal block, oil pressure gauge, shutoff cock, and four solenoid oil shutoff valves. These items shall be factory mounted on the front head.

2.7 NO.2 OIL AND GAS BURNER

A. General

1. The burner shall be integral with the front head of the boiler. It shall be the pressure atomizing type for oil and high radiant multi-port type for gas. The burner must be approved for operation with either commercial grade No.2 oil or natural gas.
2. The oil burner shall operate on the low-high-low principle, and must return to the low-fire position prior to ignition.
3. The gas burner shall operate on the full modulation system and must return to the low fire position prior to ignition.
4. The burner shall remain in the low-fire position during ignition and until main flame has been proven.
5. Automatic electric ignition of the premix gas pilot shall be provided. A UV flame detector shall monitor the pilot to prevent the primary fuel valve from opening until the pilot flame has been established.
6. A single damper motor shall control the combustion air damper, high and low fire oil valves, and the butterfly gas valve. The damper motor shall regulate the fire according to system demand in response to the boiler mounted high-low fire temperature/pressure control.

B. Oil System

1. An oil pump shall be included. The oil pump, integral with the burner, shall include a built-in relief valve and self-cleaning strainer. The pump shall be belt-driven from the blower motor.

2. The fuel oil system shall include supply and return tubing to a terminal block, oil pressure gauge, shutoff cock, and four solenoid oil shutoff valves. These items shall be factory mounted on the front head.

C. Gas System

1. The gas burner piping system on the unit shall include a primary gas shutoff valve. It shall be controlled by the programming relay to start or stop the burner and to close automatically in the event of power failure, flame failure, excessive pressure or temperature, high or low gas pressure, or a low water condition. A lubricated shutoff cock shall be located ahead of the primary valve for manual shutoff.
2. A plugged leakage test connection and a lubricated plug cock are provided as a means for a tightness check of the primary shutoff valve.
3. A gas pressure regulator shall be factory-mounted and piped for proper pressure regulation to the burner.

D. Gas Train Components

1. The primary shutoff valve shall be a motorized type. High and low gas pressure switches shall be provided.

2.8 BURNER AND FLAME FAILURE CONTROLLER

A combustion safeguard control shall be provided to control ignition, starting and stopping the burner and provide precombustion and postcombustion purge periods. It shall stop burner operation in the event of ignition, pilot or main flame failure. Trial for ignition shall be limited to 10 seconds.

2.9 CONTROL PANEL

- A. The control panel shall be mounted on the front head of the boiler and shall be conveniently located for the operator. It shall be a NEMA 1A rated enclosure and have a Yale key lock.
- B. Each boiler shall be factory-equipped with a flame safeguard controller that provides technology and functions equal to the Cleaver-Brooks Model CB100.
- C. Flame safeguard controller shall be microprocessor based, with self-diagnostics, non-volatile memory, and a message center with a vocabulary of 42 different messages. Messages shall scroll across an alpha-numeric display and provide sequence status and failure mode information. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence will include start, pre-purge, pilot and main fuel ignition run and post-purge cycles.
- D. Controller shall be the non-recycle type for maximum safety that will shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open.

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- E. The controller shall have a run/test switch. It will allow interruptions to sequence just after pre-purge, during pilot ignition trial, and during run cycles for adjustments to firing rate motor, damper linkages and pilot flame for turndown tests.
 - F. In addition to the above functions, the controller shall:
 - 1. Display history of operating hours and totals of completed on-off cycles.
 - 2. Provide a constant flame signal strength read-out.
 - 3. Have provisions for a remote display capability.
 - G. The panel shall contain the blower motor starter, control circuit fuses, control circuit transformer, and control switches. A damper positioning switch shall be provided to permit selection of automatic firing or manual selection of low or high fire.
 - 1. A terminal board shall be provided to which all wires entering or leaving the panel shall be connected.
 - 2. All electrical equipment shall be in conformity with the Canadian Standard Association requirements. Oil, heat and moisture resistant wire shall be used and shall be number coded.
 - 3. A low fire hold timer shall be mounted in the panel and wired to hold the boiler in a low firing mode, for a minimum of 10 minutes, each time the boiler cycles on. This low fire hold timer ensures gradual boiler warm up.