

OHIO SPECIAL

100-225 HP Steam



Boiler Book
03/2018



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FEATURES AND BENEFITS

The Cleaver-Brooks Ohio Special Firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks specifically for operation in the state of Ohio, under the rules and regulations for unattended units. The unique design of the Ohio Special Boiler serves your steam needs and reduces unnecessary labor costs. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firetube boilers, the following features apply to the Ohio Specials.

Unique Dimple Tube Design:

- Ensures high gas turbulence and increased efficiency without turbulators, spinners, and other high maintenance devices.
- Dimple tubes also reduce the film coefficient on the gas side to transfer more heat, thus achieving greater output with less heating surface.

358 Square Feet of Heating Surface:

- The greatest amount offered in any packaged boiler for unattended steam boiler operation in Ohio - means long life and years of service at the high efficiencies.

Low Furnace Location:

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

PRODUCT OFFERING

Cleaver-Brooks Ohio Special Firetube boilers are available high pressure steam designs. Burners are available to fire natural gas, light oil, or a combination of oil and gas.

Ohio Special Boilers include:

- Four-pass dryback design (100 hp).
- Two-pass dryback design (125 - 225 hp).
- 15 psig low pressure steam.
- 150, 200, and 250 psig high pressure steam
- Natural gas or light oil firing.

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

Boiler Options

- Drain valves.
- Additional screwed or flanged trappings.
- Surge load baffles.
- Seismic design.
- Blowdown valves.
- Non-return valves.
- Feedwater valves and regulators.
- Special doors, davited, hinged, left swing.
- Special base rails.
- Surface blowdown systems.
- Weather-proofing.

Burner/Control Options

- Special modulation controls.
- Optional flame safeguard controller.
- Lead/lag system.
- Special insurance and code requirements (e.g., IRI, FM, CSD1).
- Remote contacts.
- Additional relay points and indicator lights.
- Main disconnect.
- Elapsed time meter.
- Voltmeter/micro-ammeter.
- NEMA enclosures.
- Low fired hold controls.
- Remote emergency shut-off (115V).
- Circuit breaker.
- Day/night controls.
- Special power requirements.

Fuel Options

- Automatic fuel changeover.
- Oversized/undersized gas trains.
- Gas strainer.
- Special fuel shut-off valves.
- Special pilot.
- Alternate fuel firing.
- Special oil pumps.

DIMENSIONS AND RATINGS

For dimension and rating information for Ohio Special boilers, refer to the following tables and illustrations:

- Table 1. Model CB Ohio Special Steam Boiler Ratings.
- Table 2. Model CB Ohio Special Steam Boiler Dimensions.
- Figure 1. Space required to open rear head on Model CB Ohio Special Boilers Equipped with Davits.
- Figure 2. Lifting Lug Locations, Model CB Ohio Special Boilers.
- Figure 3. Model CB Ohio Special Boiler Mounting Piers.

PERFORMANCE DATA

For efficiency and emission data for Ohio Special Boilers, contact your local Cleaver-Brooks authorized representative.

Table 1: Model CB Ohio Special Steam Boiler Ratings

BOILER HP	100S	125S	150S	175S	200S	225S
WEIGHT IN POUNDS						
Normal Water Capacity	4625	7000	7000	8500	8500	8500
Approx Wt -15 psig	7800	9300	9300	12600	12600	12600
Approx Wt -150 psig	8500	9900	9900	13500	13500	13500
Approx Wt - 200 psig	9000	10500	10500	14200	14200	14200
Water Capacity Flooded	5420	8673	8673	10485	10485	10485
RATINGS SEA LEVEL TO 3000 FT						
Steam - lbs/hr (212°F)	3450	4313	5175	6038	6900	7763
Btu Output (1000 Btu/hr)	3348	4184	5021	5858	6695	7532
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITIES						
Light Oil gph (140,000 Btu/gal)	29.9	37.4	44.8	52.3	59.8	67.2
Nat Gas CFH (1000 Btu/cu-ft)	4184	5230	6277	7323	8369	9415
Nat Gas -Therms/hr	41.8	52.3	62.8	73.2	83.7	94.1
POWER REQUIREMENTS - ELECTRIC (60 Hz)						
Blower Motor, hp (all models)	3	5	7-1/2	10	15	20
Oil Pump Motor, hp (No. 2 Oil)	1/3	1/2	1/2	1/2	1/2	1/2
Air Compressor Motor hp (Oil Fired Only)	2	3	3	3	3	3

NOTES:

1. Standard Voltage is 230 or 460/3/60 Hz.
2. Burner control circuit Voltage is 115/1/60 Hz, 1/2 kVA load.
3. Side mounted air compressor (3 hp motor) recommended for 200S and 225S.

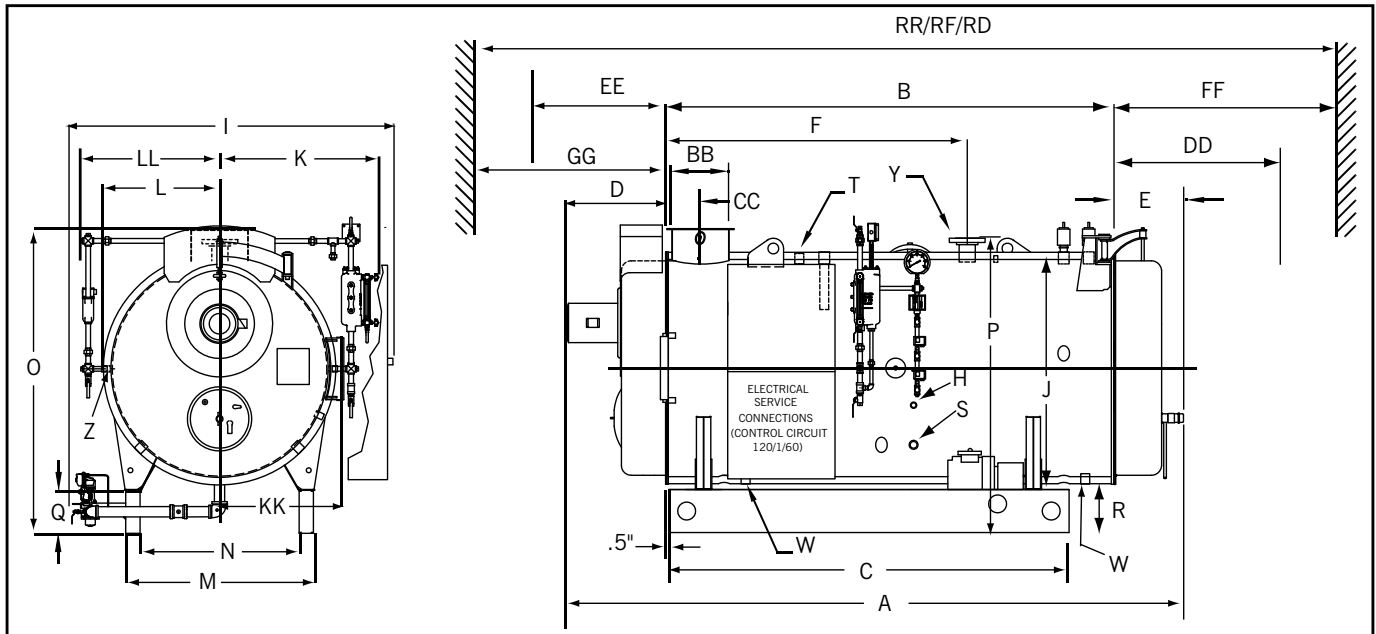


Table 2: Model CB Ohio Special Steam Boiler Dimensions

MODEL HP	DIM	100S	125S	150S	175S	200S	225S
LENGTH							
Overall	A	171-1/2	159-1/2	160-1/2	197-1/2	197-1/2	199-1/2
Shell	B	131	113	113	149	149	149
Base Frame	C	130	100	100	136	136	136
Front Head Extension (Approx)	D	22	27	28	29	29	31
Rear Head Extension	E	18-1/2	19-1/2	19-1/2	19-1/2	19-1/2	19-1/2
Flange to Nozzle (15 psig)	F	65-1/2	58	58	90	92	92
Flange to Nozzle (150 psig)	F	72.5	58	58	88	88	88
WIDTH							
Overall	I	73	85	85	85	85	85
ID Boiler	J	48	60	60	60	60	60
Center to Water Column	K	39	45	45	45	45	45
Center to Outside Hinge	KK	29	35	35	35	35	35
Center to Lagging	L	27	33	33	33	33	33
Center to Auxiliary LWCO	LL	34	40	40	40	40	40
Base-Outside	M	37-5/8	52-1/2	52-1/2	52-1/2	52-1/2	52-1/2
Base-Inside	N	29-5/8	44-1/2	44-1/2	44-1/2	44-1/2	44-1/2
HEIGHT							
Base to Vent Outlet	O	70	87	87	87	87	87
Base to Steam Outlet	P	66	82-3/8	82-3/8	82-3/8	82-3/8	82-3/8
Base Frame	Q	12	12	12	12	12	12
Base to Bottom Boiler	R	16	16	16	16	16	16
CONNECTIONS							
Chemical Feed	H	1	1	1	1	1	1
Feedwater, Right & Left	S	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
Auxiliary Connection	Z	1	1	1	1	1	1
Steam Nozzle (15 psig) ^A	Y	8 FLG	8 FLG	8 FLG	8 FLG	10 FLG	10 FLG
Steam Nozzle (150 psig) ^B	Y	4 FLG	4 FLG	4 FLG	4 FLG	4 FLG	4 FLG
Drain-Front & Rear (15 psig only)	W	1-1/2	1-1/2	1-1/2	2	2	2
Blowdown-Front & Rear (150 psig)	W	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
Surface Blow (150 psig only)	T	1	1	1	1	1	1
Vent Stack Dia. (Flanged)	BB	12	16	16	16	16	16
Flange to Center Vent	CC	7	9	9	9	9	9

Table 2: Model CB Ohio Special Steam Boiler Dimensions (Continued)

MODEL HP	DIM	100S	125S	150S	175S	200S	225S
CLEARANCES							
Rear Door Swing	DD	55	32	32	32	32	32
Front Door Swing	EE	55	67	67	67	67	67
Tube Removal, Rear	FF	123	103	103	139	139	139
Tube Removal, Front	GG	113	91	91	127	127	127
Min Room Length for Rear Tube Removal	RR	309	283	283	355	355	355
Min Room Length for Front Tube Removal	RF	299	236	236	308	308	308
Tube Removal thru Door	RD	241	212	212	248	248	248

NOTE: Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.

- A. Flanged 150 psig ANSI
- B. Flanged 300 psig ANSI

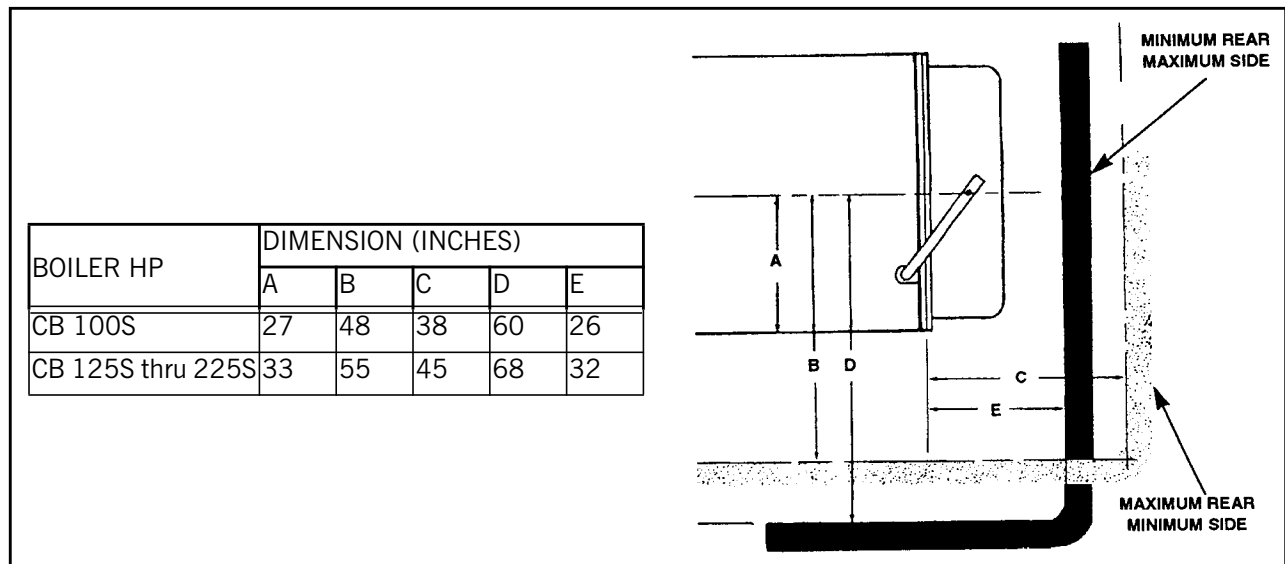


Figure 1. Space Required to Open Rear Head on Ohio Special Boilers Equipped with Davits

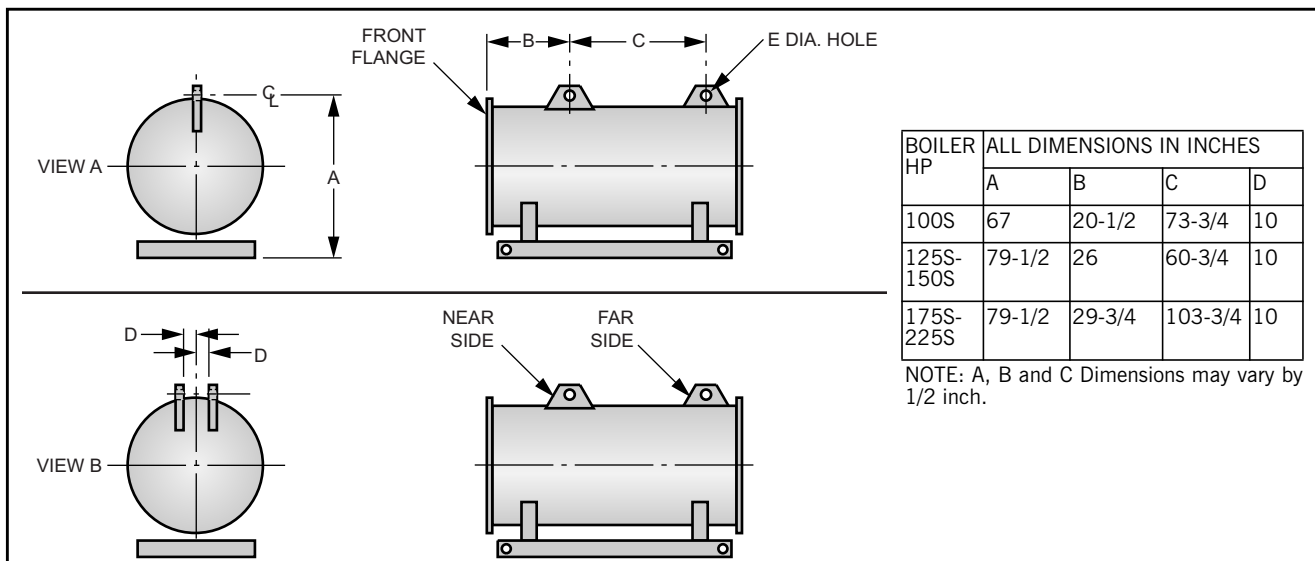


Figure 2. Model CB Ohio Special Boilers Lifting Lug Location

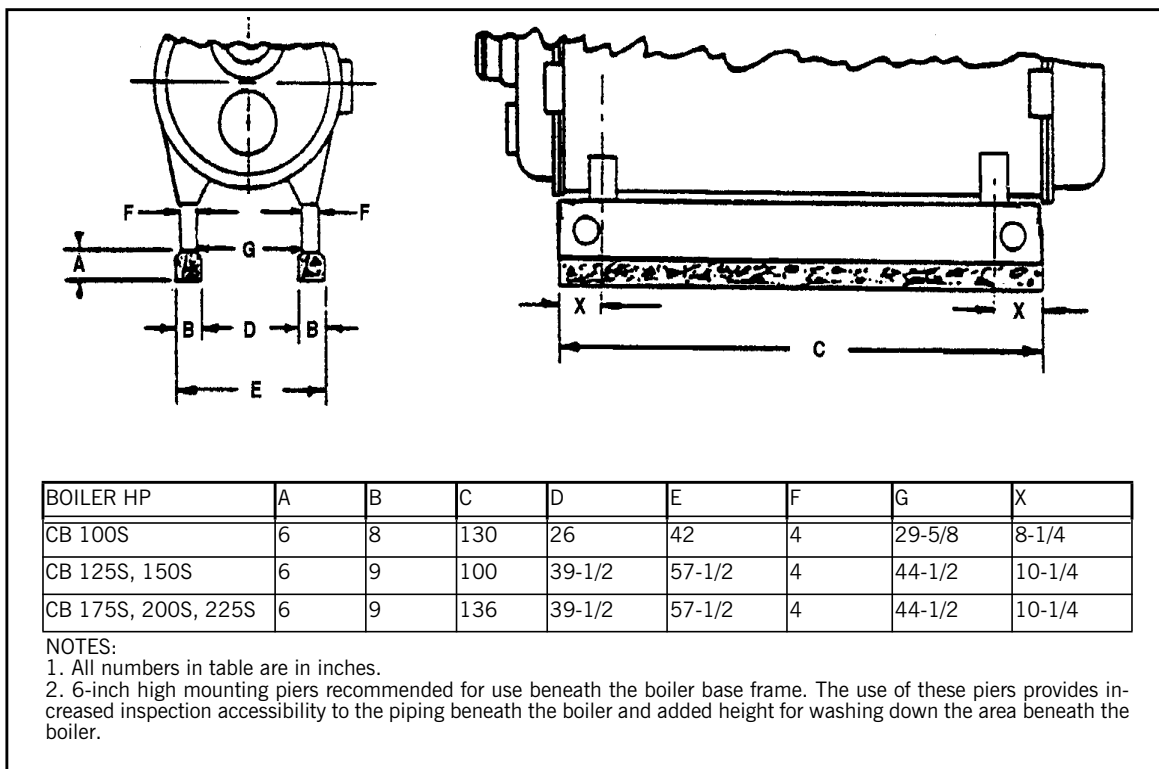


Figure 3. Model CB Ohio Special Boiler Mounting Piers

ENGINEERING DATA

The following engineering information is provided for the Ohio Special Boilers. Ohio Special boilers are designated by an “S” following the horsepower number. Additional detail is available from your local Cleaver-Brooks authorized representative.

Boiler Information

Table 3 shows heating surfaces for Model CB Ohio Special Boilers.

Table 4 shows steam volume and disengaging area for Model CB Ohio Special Boilers.

Table 5 lists quantity and outlet size for safety valves supplied on Model CB Ohio Special Boilers.

Table 6 gives recommended steam nozzle sizes based on 4000-5000 fpm steam velocity.s.

Table 7 shows recommended non-return valve sizes for Model CB Ohio Special Firetube Boilers.

Table 3: Model CB Ohio Special Boilers Heating Surface

BOILER HP	HEATING SURFACE (SQ-FT)	
	FIRESIDE	WATERSIDE
100S	350	388
125S-150S	358	386
175S, 200S, 225S	358	384

Table 4: Steam Volume and Disengaging Area

BOILER HP	STEAM VOLUME CU-FT		STEAM RELIEVING AREA SQ-IN	
	HIGH PRESSURE ^A	LOW PRESSURE ^B	HIGH PRESSURE ^A	LOW PRESSURE ^B
100S	14.3	23.7	4367	4975
125S, 150S	27.3	30.6	4990	5132
175S, 200S, 225S	37.2	41.6	6791	6984

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

Table 5: Safety Valve Openings

VALVE SETTING	15 PSIG STEAM		100 PSIG STEAM		125 PSIG STEAM		150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES-REQ'D	OUTLET SIZE (IN.)
100S	1	2-1/2	1	2	1	1-1/2	1	1-1/2	1	1-1/2	1	1-1/4
125S	1	2-1/2	1	2	1	2	1	2	1	1-1/2	1	1-1/2
150S	1	3	1	2-1/2	1	2	1	2	1	1-1/2	1	1-1/2
175S	1	3	1	2-1/2	1	2-1/2	1	2	1	2	1	1-1/2
200S	1	3	1	2-1/2	1	2-1/2	1	2-1/2	1	2	1	2
225S	2	2-1/2	2	2	1	2-1/2	1	2-1/2	1	2	1	2

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

**Table 6: Recommended Steam Nozzle Size
 (for 4000 - 5000 fpm nozzle velocity)**

OPERATING PRESSURE PSIG	BOILER HP					
	100S	125S	150S	175S	200S	225S
15	8	8	8	8	10	10
30	6	6	6	6	8	8
40	6	6	6	6	6	8
50	4	6	6	6	6	6
75	4	4	4	6	6	6
100	4	4	4	4	6	6
125	4	4	4	4	4	4
150	2.5	3	3	4	4	4
200	2.5	2.5	3	3	4	4

NOTES:
 1. Steam nozzle sizes given in inches.
 2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity. Spool pieces (300 psig flanges) are available in the following sizes (in inches): 3x2-1/2x30, 4x3x30, 6x4x36, 8x6x48, and 10x8x48.

Table 7: Recommended Non-Return Valve Size

BOILER HP	BOILER CAPACITY (LB/HR)	OPERATING PRESSURES (PSIG)						
		50	75	100	125	150	175	200
100S	3450	2-1/2	2-1/2	NA	NA	NA	NA	NA
125S	4313	3	2-1/2	2-1/2	2-1/2	NA	NA	NA
150S	5175	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA
175S	6038	3	3	2-1/2	2-1/2	2-1/2	2-1/2	NA
200S	6900	3*	3	3	3	3	2-1/2	2-1/2
225S	7736	3	3	3	3	3	2-1/2	2-1/2

NOTE:

Valve sizes (300# flanges) given in inches.

Standard non-return valve selections limited to a maximum 2 to 1 turndown (50% of full boiler output); selection based on typical valve sizing recommendations. For final valve selection contact your authorized C-B representative.

*Indicates pressure drop of less than 7.5 psig. All other selections are less than 6 psig pressure drop.

Table 8: Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
100S	80
125S-150S	87
175S-225S	118

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

Blowdown Water Requirements

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

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

Table 9: Gas pressure requirements, CB Ohio Special

BOILER HP	GAS TRAIN SIZE	UPSTREAM VALVE*	DOWNSTREAM*	GAS PRESSURE
100 HP	1.5 in	BB	BB	0.6 - 4.1 psi
100 HP	1.5 in	PC	PC	0.6 - 3.8 psi
125 HP	1.5 in	BB	BB	0.7 - 5.0 psi
125 HP	1.5 in	PC	PC	0.8 - 5.0 psi
150 HP	1.5 in	BB	BB	1.0 - 5.0 psi
150 HP	1.5 in	PC	PC	1.1 - 5.0 psi
175 HP	1.5 in	BB	BB	1.3 - 5.0 psi
175 HP	1.5 in	PC	PC	1.5 - 5.0 psi
175 HP	2.0 in	BB	BB	0.8 - 1.3 psi
175 HP	2.0 in	PC	PC	0.9 - 1.5 psi
200 HP	1.5 in	BB	BB	1.7 - 5.0 psi
200 HP	1.5 in	PC	PC	1.9 - 5.0 psi
200 HP	2.0 in	BB	BB	1.2 - 1.7 psi
200 HP	2.0 in	PC	PC	1.2 - 1.9 psi
225 HP	2.0 in	BB	BB	1.4 - 5.0 psi
225 HP	2.0 in	PC	PC	1.5 - 5.0 psi
225 HP	2.5 in	PC	PC	1.0 - 1.4 psi

* BB = Butter Ball; PC = Plug Cock

Standard Gas Train is highlighted

Burner Information

The Ohio Special Firetube Boiler encompasses an integral front head that includes the burner, combustion air fan, and controls as part of the boiler package design.

The integral front head provides for burner/boiler design as a single unit maximizing the compatibility between the boiler and burner.

Gas-Fired Burners

Table 9 shows regulated gas pressure requirements for gas trains for CB Ohio Special Firetube Boilers.

Table 10 shows minimum required gas pressure altitude conversion.

Table 11 shows maximum gas consumption for natural gas and propane vapor.

Table 12 shows typical gas train components, and Figure 4 shows typical gas train piping layouts for multiple boiler applications.

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

Oil-Fired Burners

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

Figure 6 shows the oil connection sizes and locations for Ohio Special Boilers firing No. 2 oil.

Figures 7 and 8 show typical oil systems and layouts.

Boiler Room Information

Figure 9 shows typical boiler room length requirements.

Figure 10 shows typical boiler room width requirements.

Stack Support Capabilities

100 hp Ohio Special Boilers can support up to 1,000 lbs without additional support.

125-225 hp Ohio Special Boilers can support up to 2,000 lbs without additional support.

Table 10: Gas pressure altitude conversion

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

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

Table 11: Maximum gas consumption

BOILER HP	TYPE OF GAS AND HEAT CONTENT	
	NATURAL GAS 1000 (Btu/cu-ft)	PROPANE GAS 2550 (Btu/cu-ft)
100S	4185	1640
125S	5230	2050
150S	6280	2465
175S	7350	2870
200S	8370	3280
225S	9415	3690

Boiler Room Combustion Air

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

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

Area (sq-ft) = cfm/fpm

2. Amount of air required (cfm).
 - A. Combustion air - rated bhp x 8 cfm/bhp.
 - B. Ventilation air - rated bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).

- A. From floor to (7) foot height - 250 fpm.
- B. Above (7) foot height - 500 fpm.
- C. Duct from air supply to boiler - 1000 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 200 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $200 \times 10 = 2000$ cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required: $\text{Area} = \text{cfm} / \text{velocity} = 2000 / 250 = 8$ Sq-ft total.
- Area/Opening: $8 / 2 = 4$ sq-ft/opening (2 required).

Consult local codes, which may supersede these requirements.

Stack/Breeching Size Criteria

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

Although constant pressure at the flue gas outlet of the Ohio Special is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is $-0.25''$ W.C. to $+0.25''$ W.C.

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

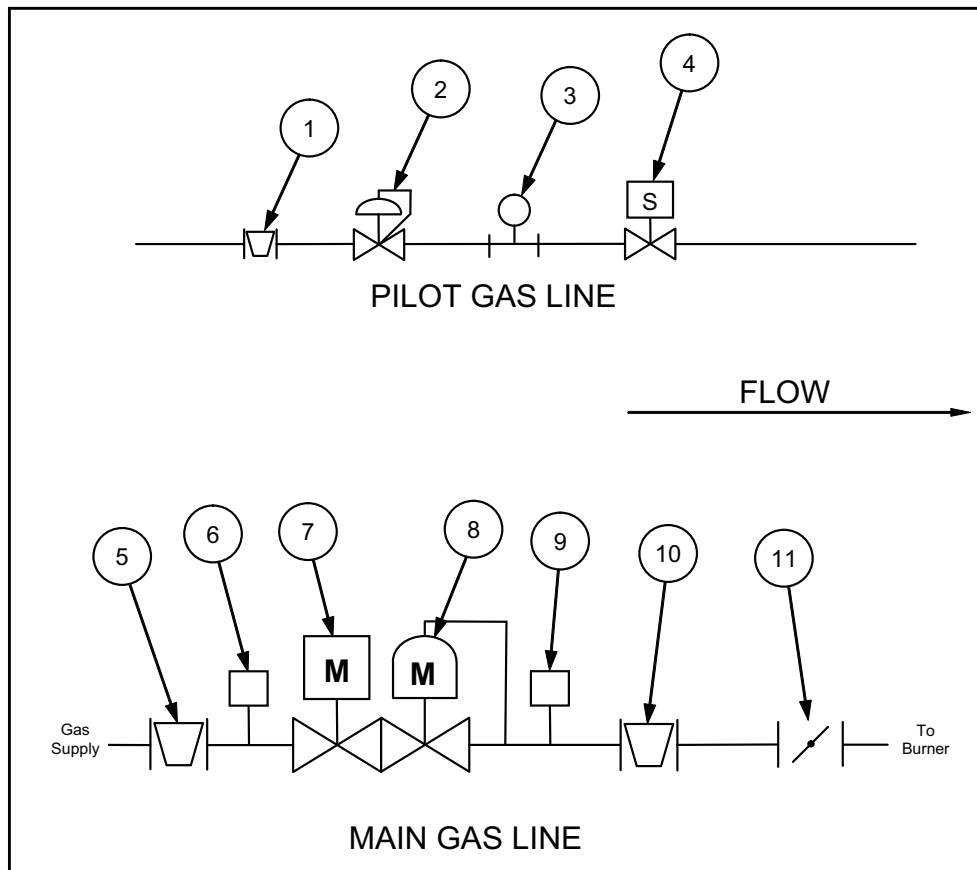


Table 12: Gas Train Components

ITEM	DESCRIPTION	UL		FM		CSD-1	
		100S	125S - 225S	100S	125S - 225S	100S	125S - 225S
1	Pilot Shut Off Cock	X	X	X	X	X	X
2	Pilot Pressure Regulator	X	X	X	X	X	X
3	Pilot Pressure Gauge	X	X	X	X	X	X
4	Gas Pilot Valve	X	X	X	X	X	X
5	Manual Shut Off Valve	X	X	X	X	X	X
6	Low Gas Pressure Switch	X	X	X	X	X	X
7	Main Gas Valve w/o POC		X		X		X
8	Regulating Gas Valve w/ POC	X	X	X	X	X	X
9	High Gas Pressure Switch	X	X	X	X	X	X
10	Manual Shut Off Valve	X	X	X	X	X	X
11	Butterfly Valve	X	X	X	X	X	X

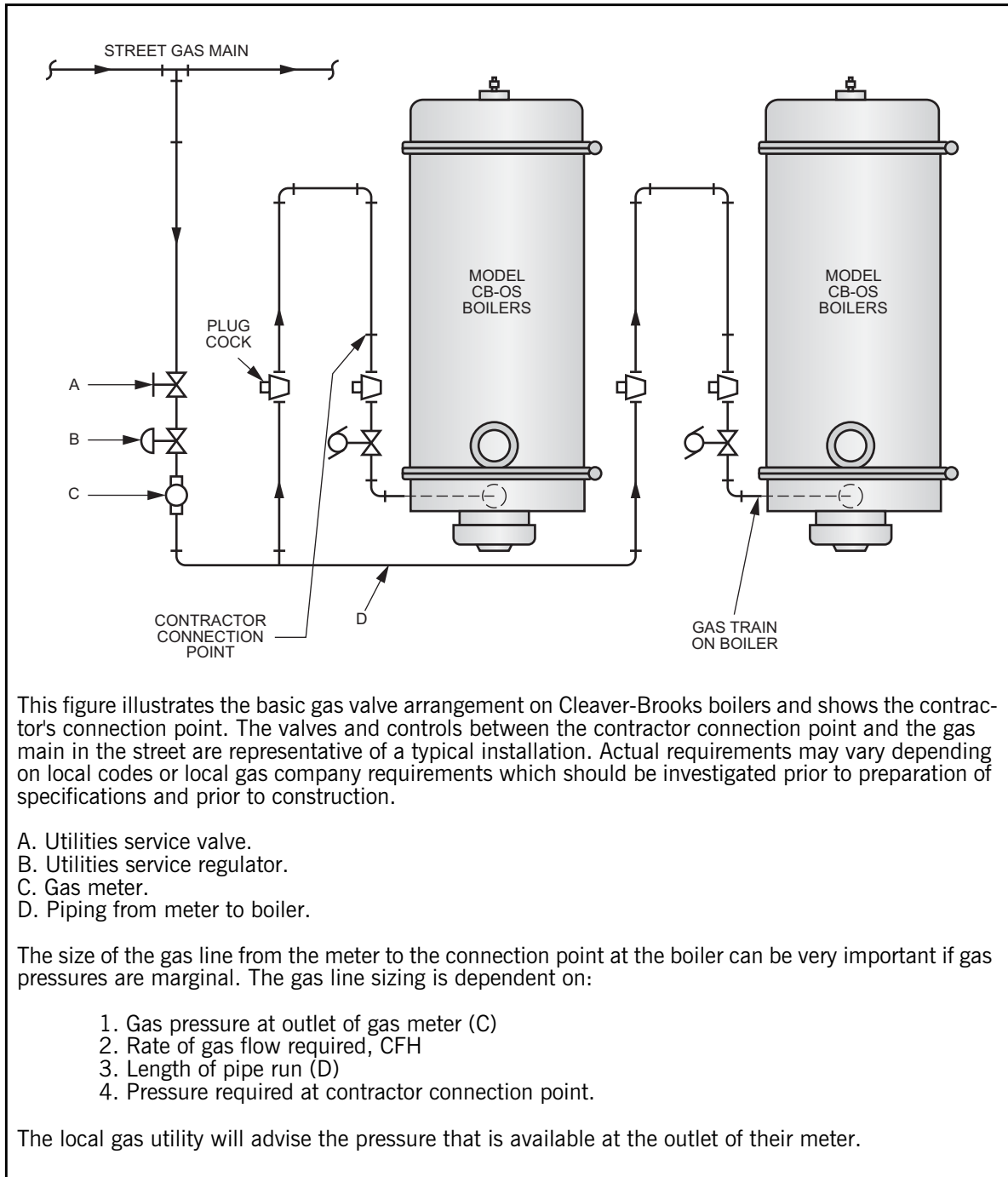


Figure 4. Typical Gas Piping Layout

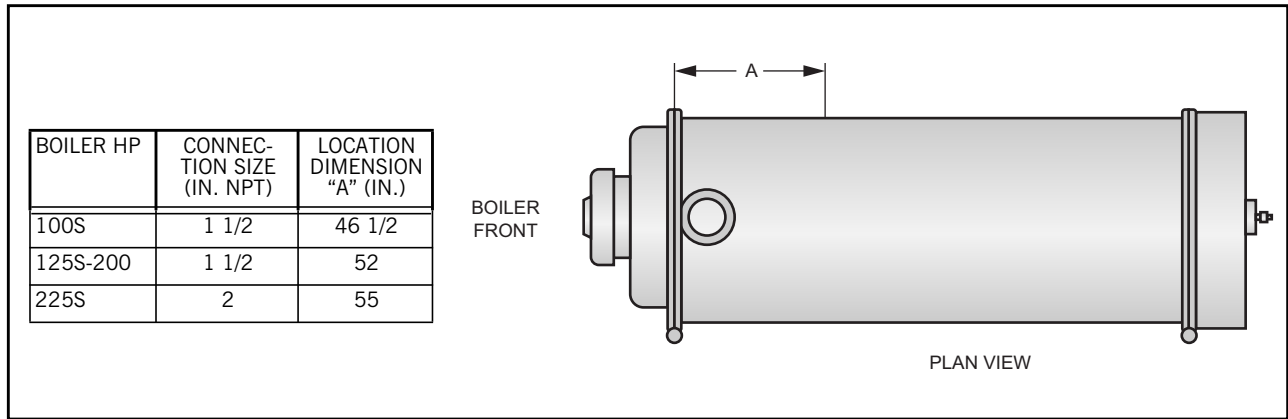


Figure 5. Standard Gas Train Connection Size and Location

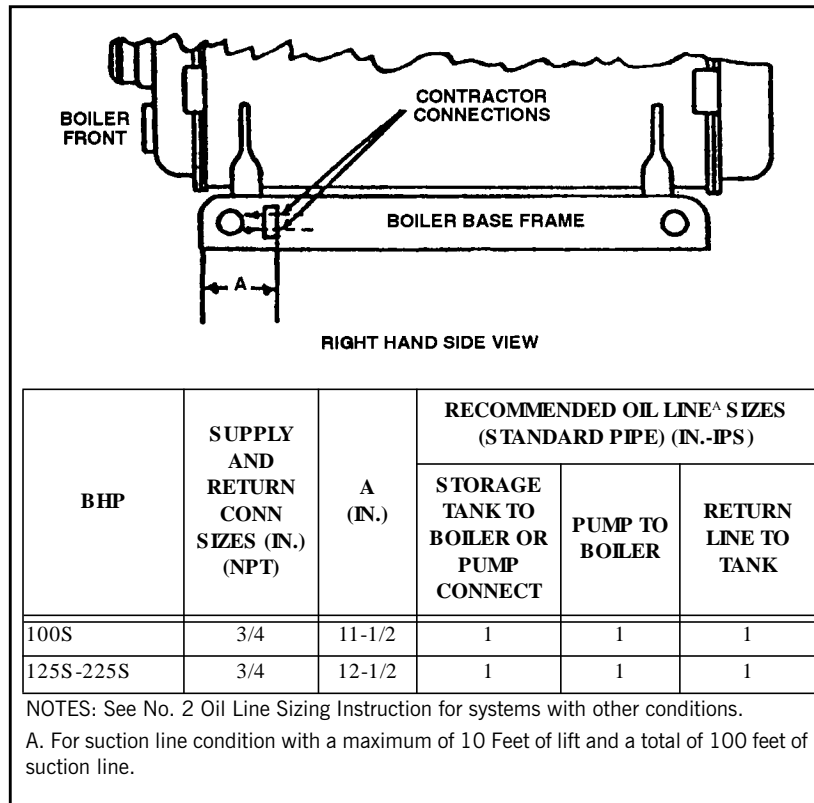


Figure 6. No. 2 Oil Connection Size, Location and Recommended Line Sizes

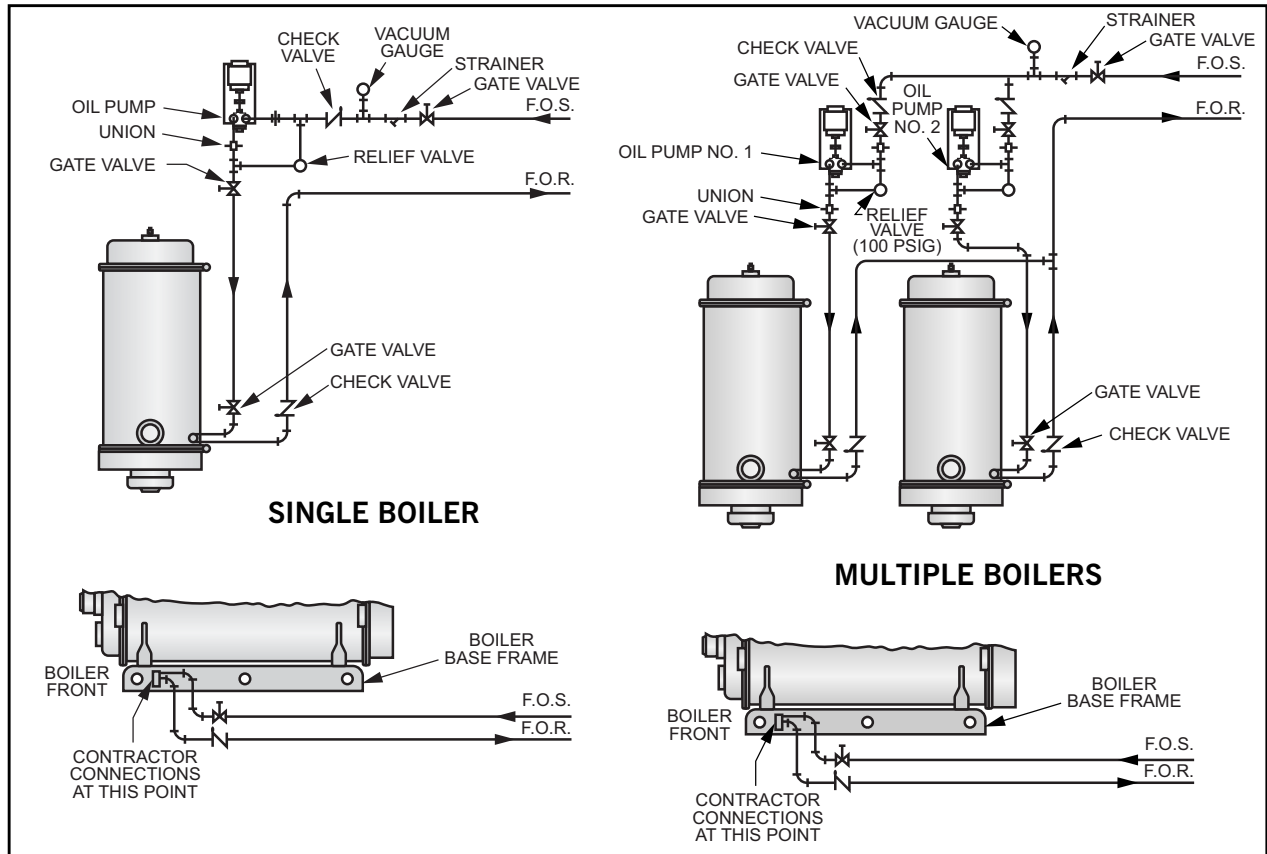


Figure 7. No. 2 Oil Piping, Remote Oil Pump

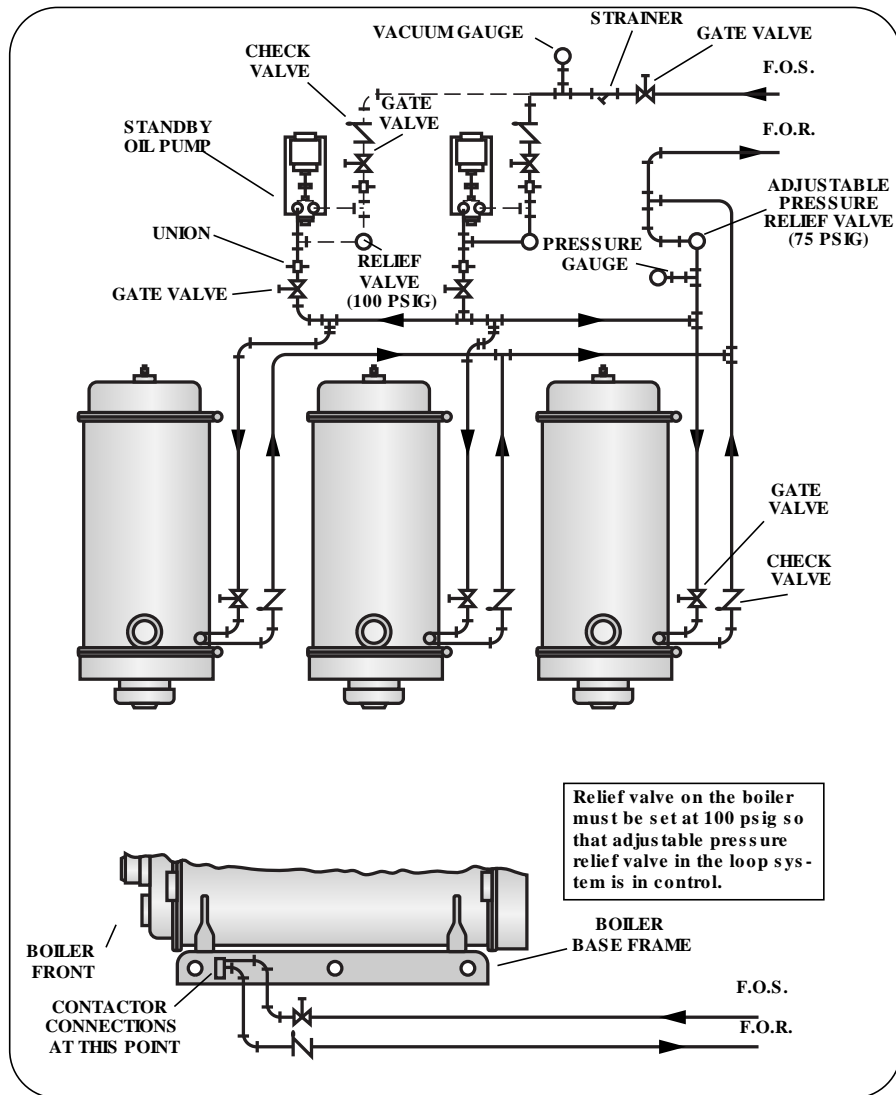


Figure 8. No. 2 Oil Piping, Multiple Boiler Installation

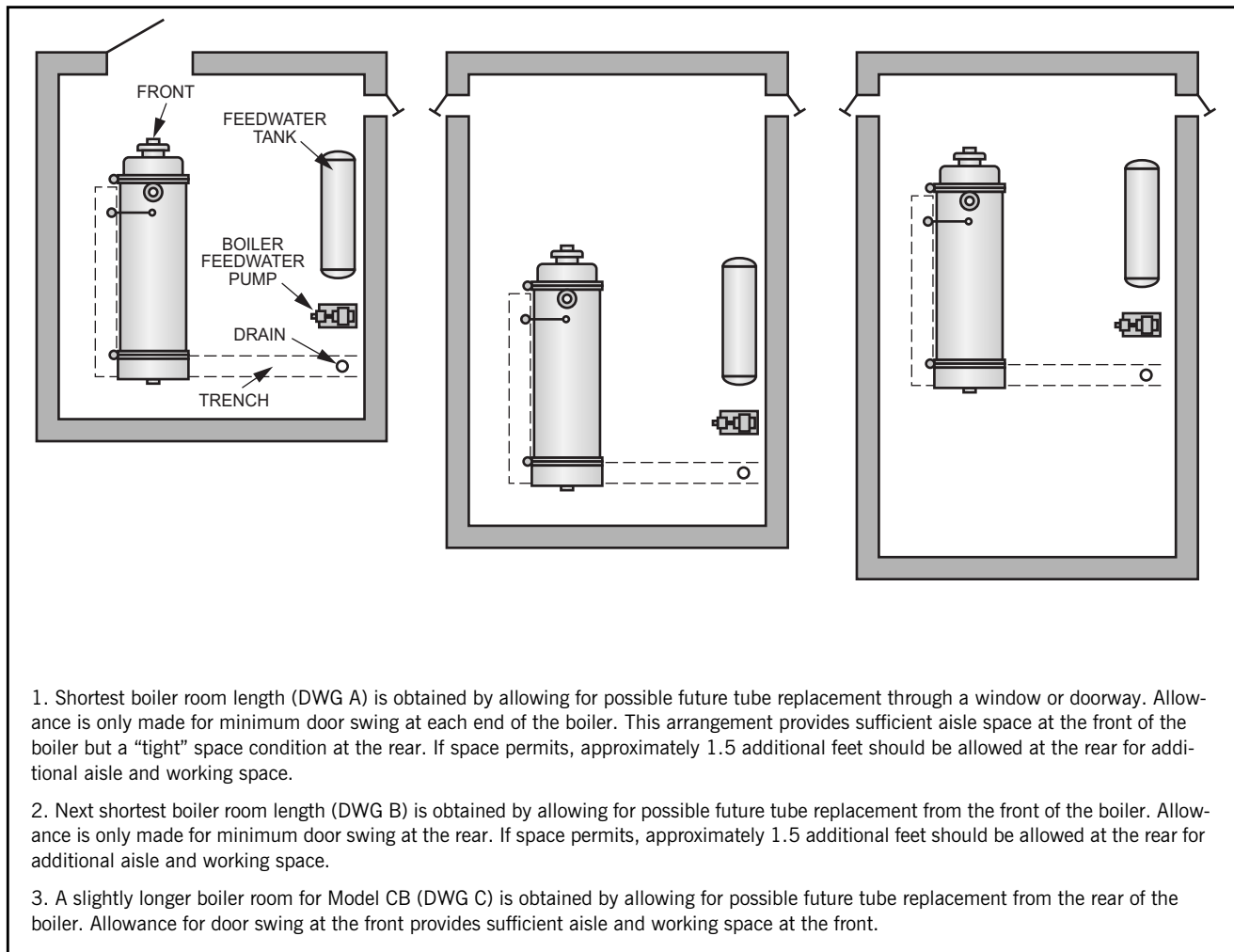


Figure 9. Boiler Room Length (Typical Layouts)

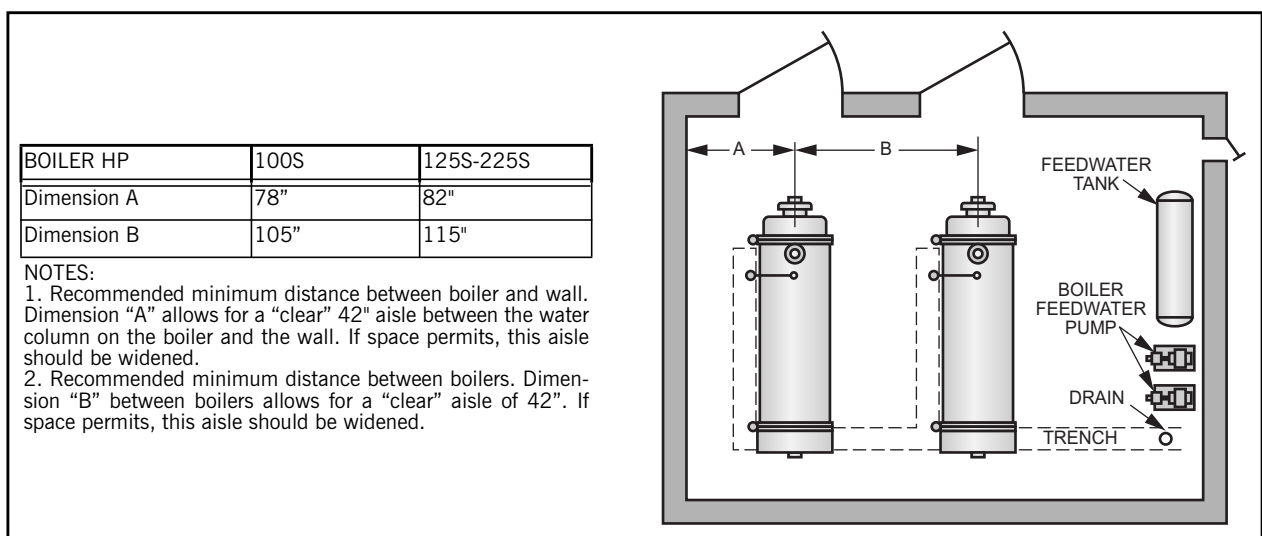


Figure 10. Boiler Room Width (Typical Layout)



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