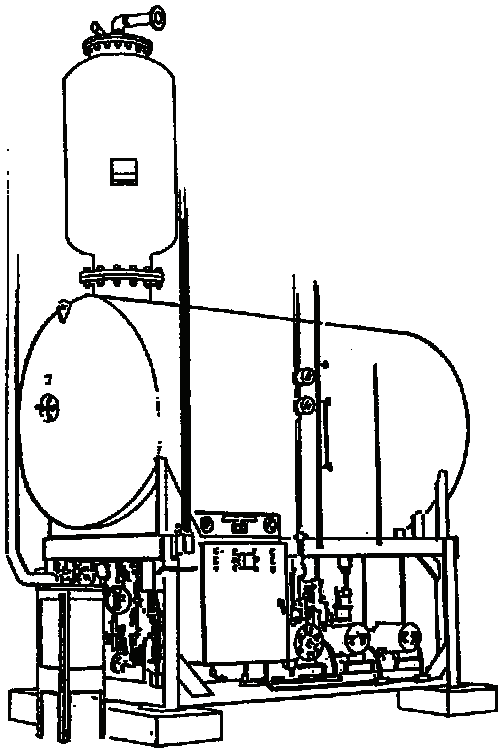
SECTION H4
BOILERMATE DEAERATORS



CONTENTS

ILLUSTRATIONS

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long-lasting boiler equipment for industrial and commercial boiler users. Built of corrosion-resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proven most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component and sizing information.

FEATURES AND BENEFITS

The following features and benefits apply to the Boilermate Deaerator product line. The Boilermate design uses a packed column to deaerate the water.

Less Mechanical Movement of Deaerator Components:

- The water spray valve is the only internal moving component within the deaerator vessel.

Two-Stage Deaeration in a Common Vessel:

- Recycle pumps are not required.
- Packaged for easy maintenance.

ASME Code Design (Section VIII):

- Assures deaerator vessel quality in materials and fabrication to meet safety requirements.

Internal Stainless Steel Vent Condenser:

- Protects deaerator vessel against corrosive gases while providing a means for removal of corrosive gases from boiler feedwater.

Self-Cleaning Water Spray Valve:

- Maintains deposit-free surface.
- Reduces maintenance requirements.

Internal Automatic-Check Valve Prevents Steam Back-Flow:

- The water spray valve is normally closed at no flow.
- Prevents steam back flow through the water spray valve at no flow conditions.

Removable Water Spray Inlet Assembly:

- Flanged assembly allows easy access for maintenance and/or inspections.

Stainless Steel Deaeration Assembly:

- Ensures a longer life of wetted materials in intimate contact with corrosive liquids and released corrosive gases.

Pressurized Tank Reduces Flashing and Minimal Venting:

- Recovery of exhaust and turbine steam.
- Saves Btu's that would normally be exhausted to atmosphere.
- Improves plant efficiency.

Auto Vent Valve Eliminates Gases at Start-Up:

- Atmospheric contamination virtually eliminated for incoming water.

Exceeds ASME Recommendations for Oxygen Level:

- Cleaver-Brooks deaerator is guaranteed to remove oxygen concentrations to 0.005 cc/liter while operating between 5 and 100% capacity.
- Carbon dioxide concentration is practically reduced to a zero.

Integral Level Control Automatically Introduces Cold Water Make-Up to Supplement Condensate Only When Necessary to Meet Boiler Demand:

- Saves Btu's by accepting condensate before cold make-up water. Maintains a minimal water level within the deaerator vessel to prevent damage to the boiler feedpumps, and to maintain system operation.

Variety of Tank Sizes to Handle Volume-Swings in Condensate Return:

- Provides flexibility for selecting a tank for specific applications to limit the loss of hot condensate to drain.

Packaged Units for Cost Effective Installation:

- Complete packages are pre-fabricated in the Cleaver- Brooks manufacturing facility to ensure piping alignment and control wiring function. The unit is partially disassembled, match marked for efficient field re-assembly.

Internal Pump Suction Vortex Breakers:

- Eliminates the problems of loss in NPSHA and cavitation associated with the creation of vortices within pump suction piping.

PRODUCT OFFERING

Information in this section applies directly to Cleaver-Brooks packaged boilermate deaerators ranging from 1,500 lbs/hr at 50 °F makeup to 135,000 lbs/hr at 200 °F make-up. Larger capacities can be obtained by using two columns. The Boilermate deaerator product offering is shown in Figure H4-1.

The Boilermate deaerator is a pressurized packed column, low maintenance system designed to remove dissolved oxygen in boiler feed water to 0.005 cc per liter or less and eliminate carbon dioxide. A typical deaerator package includes the packed column and storage tank mounted on a stand of appropriate height along with all operating controls, feed pumps assembled and piped (typically knocked down for shipment and field assembly). The tank conforms to Section VIII of the ASME Code.

The packed column design is best for handling high-temperature returns. The column is constructed of a carbon steel casing with a stainless steel liner. Built into a flange on top of the column is a spring loaded self-cleaning water spray nozzle and an automatic and manual vent valve.

From experience, large industrial plants and utilities have learned that the most practical and economical way to remove oxygen from feedwater is through mechanical deaeration. The Boilermate deaerator economically effects oxygen removal through a design that is trouble free in performance.

Raw water, untreated and not deaerated, contains as much as ten cubic centimeters of corrosion-causing oxygen per liter. Oxygen in water corrodes and shortens the life of boiler feed lines, boilers and condensate return lines.

The Cleaver-Brooks designed deaerator assures high purity effluent by removing oxygen and other dissolved gases in boiler feed. Thus, it is the answer to long-lasting boiler equipment for industrial and commercial boiler users. Built of corrosion- resistant alloys for lifetime service, the deaerator employs those basic principles of gas removal proved to most effective and economical to every boiler owner. Contact your local Cleaver-Brooks authorized representative for component and sizing information.

The design of the Boilermate deaerator offers simplicity in both operation and service. The exchange packing, the heart of the deaerator, requires no maintenance. There are no moving parts to adjust or maintain. Installation is simple and quick.

Standard Equipment

- Boilermate column.
- Deaerator storage tank.
- Stainless steel exchange packing.
- Deaerator water inlet atomizing valve.
- Gauge glass.
- Deaerator manual and automatic vent valve.
- Steam pressure gauge.
- Feed water thermometer.
- Required tappings.

Optional Equipment

- Steam pressure reducing valve.
- Three valve bypass and strainer (PRV).
- Water level controller with make-up valve.
- Three valve bypass and strainer (MUV).
- Steam relief valves.
- High water alarm.
- Low water alarm.
- Low water pump cut off.
- High-temperature condensate diffuser tube (over 227 °F).
- Boiler feed pump and motor sets.
- Recirculation orifice or relief valve.
- Suction shutoff valve.
- Suction strainer.
- Suction flexible fitting.
- Discharge check valve.
- Discharge shutoff valve.
- Discharge pressure gauge.
- Discharge manifold.

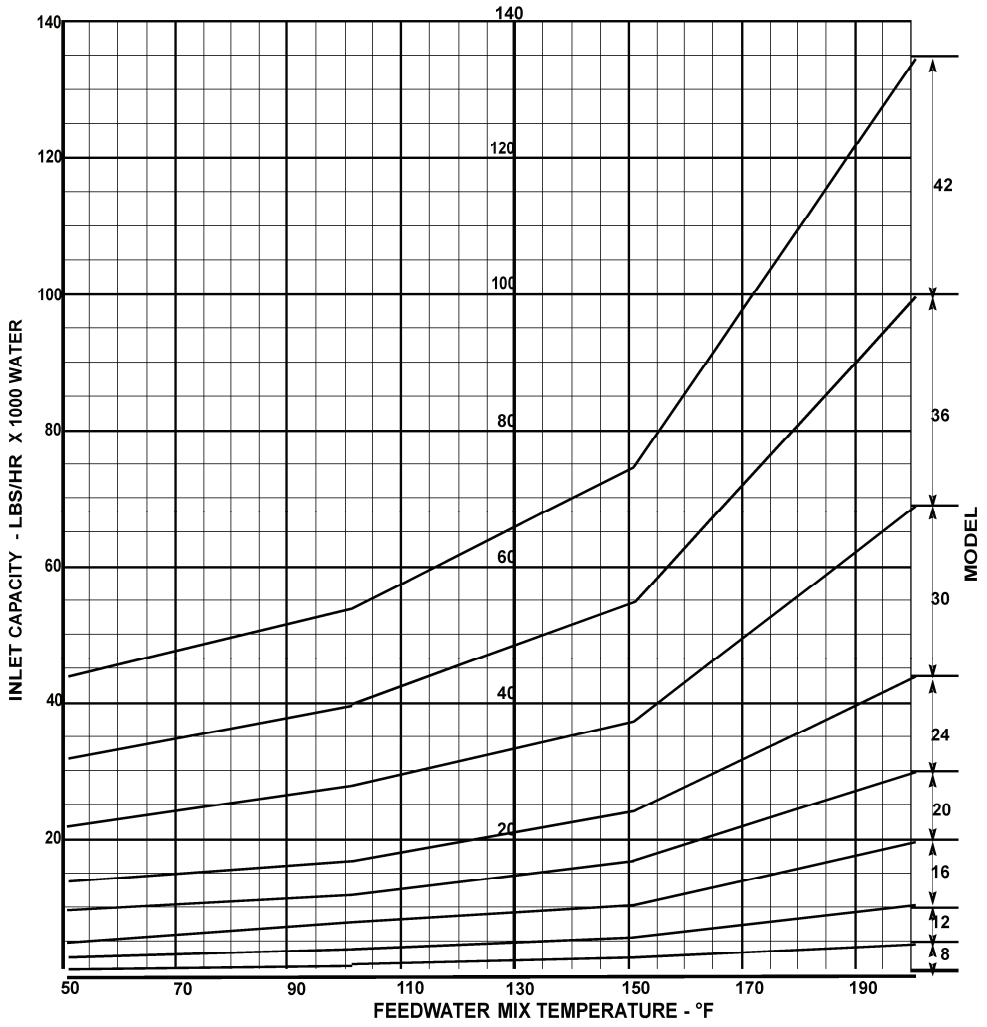
- Overflow drainer.
- Control panel.
- Chemical feed quill.
- Vacuum breaker.
- Insulation and lagging.
- Sentinel relief valve.
- Tank drain valve.
- Back pressure relief valve.
- Magnesium anode (not available with lined tanks).
- Stand.

Packaging

- Fully packaged, factory piped and wired.
- Half packaged, suitable for field erection with interconnecting piping and wiring by others.

DIMENSIONS AND RATINGS

Dimensions and ratings for Boilermate Deaerators are shown in Figure H4-2 and Figure H4-3.

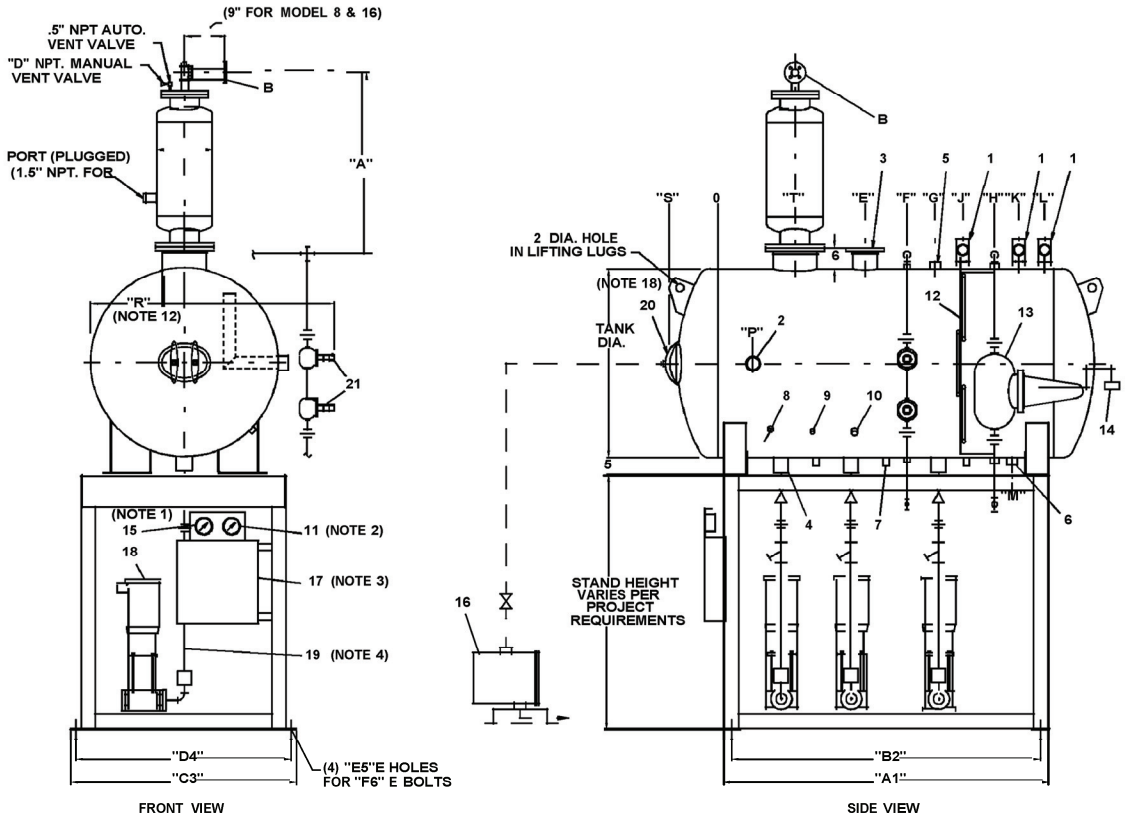


MODEL NO	*DEARERATOR CAPACITY LBS/HR							
	BM-8	BM-12	BM-16	BM-20	BM-24	BM-30	BM-36	BM-42
50°F	1,500	3,500	6,000	10,000	15,000	23,000	33,000	45,000
100°F	2,000	4,500	8,000	12,500	18,000	28,000	40,000	54,000
150°F	2,700	6,000	11,000	17,000	24,000	38,000	55,000	75,000
200°F	5,000	11,000	20,000	30,000	44,000	69,000	100,000	135,000
Weight (lbs) Including Packing	250	350	410	560	960	1,275	1,810	2,390

NOTE: Model Designation (example BM-8) is: BM = Boilermate Deaerator. 8 = size of packed column. Ratings for each column size vary with makeup water temperature.

* Capacities may be doubled by using two columns.

Figure H4-1. Cleaver-Brooks Boilermate Deaerator Selection Guide



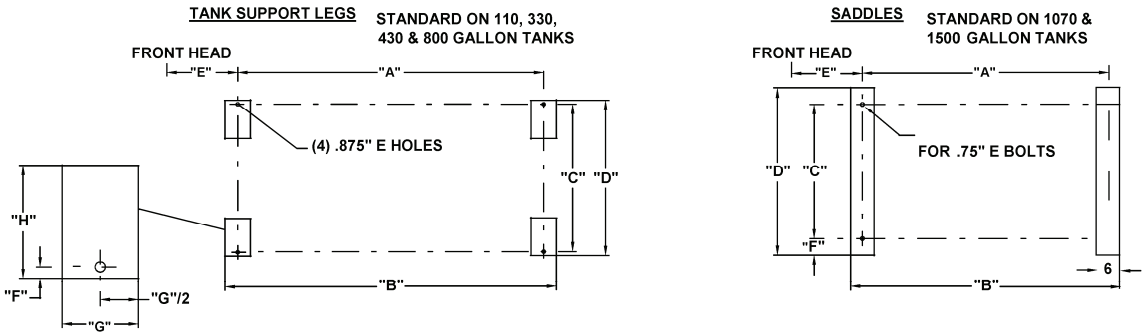
1. Mounted at dim. "M" (top of tank) on non-packaged units.
2. Tank mounted on non-packaged unit.
3. Packaged units only. Mounted on left end, right side of stand on 48" dia. 1070 gal 54" dia. 1500 gal as shown.
4. Suction piping includes strainer, gate valve and flexible connector.
5. All couplings are 3000# F.S.
6. All flanges are 150# F.F. except as noted.
7. Customer to plug all fittings not being used.
8. Mount tank above pump at elevation necessary for static head including safe allowance for piping friction as approved by pump manufacturer.
9. Tank is built to ASME Code.
10. Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension prints.
11. Add suffix "P" to Model no. for packaged units (BMP-24).
12. Dimension "R" will change depending on controls required- contact your local Cleaver-Brooks authorized representative.
13. No interconnecting piping or wiring furnished on non-packaged units unless specified, contact your local Cleaver-Brooks authorized representative for specific piping or wiring furnished on packaged assemblies.
14. Weights shown are without controls or packaging - contact your local Cleaver-Brooks authorized representative for additions.
15. Capacities other than shown as standard available by using two columns - contact your local Cleaver-Brooks authorized representative.
16. Optional tank sizes available - contact your local Cleaver-Brooks authorized representative.
17. Lifting lugs are for lifting empty tank only.
18. Manway is standard. Manufacturing may require a larger manway for fabrication. See dimensional diagram for actual size.

COLUMN DETAILS AND DIMENSIONS									
BOILERMATE MODEL NO.		8	12	16	20	24	30	36	42
A	Height	46	48.5	58	62	64	71.5	78.5	80
B	Water Inlet (150# RF Flg)	1.25	1.5	1.5	2	2	2.5	3	4
C	Column Outside Diameter	8.63	12.8	16	20	24	30	36	42
D	Manual Vent Valve Size	.5" NPT	.5" NPT	.75" NPT	.75" NPT	.75" NPT	1" NPT	1.5" NPT	2" NPT
	2" NPT Column Weight (lb)	250	350	450	600	750	850	1050	1300
	Volume Packing (Cu ft)	0.7	1.6	3.0	5.0	8.0	12.0	18.0	29.0
	Packing Weight (lb)	25	50	150	200	300	450	650	1050

Figure H4-2. Boilermate Deaerator Dimensions and Ratings – Sheet 1 of 2

RATINGS							
Cap (Gal to Overflow)		110	330	430	800	1070	1500
Tank Weight (Dry) (lb)		750	1200	1400	1900	2500	2750
Tank Weight (Flooded) (lb)		1850	4250	5300	9100	12700	15600
Tank Size (Dia x Length)		24 x 70	36 x 86	36 x 110	48 x 114	54x 127	60 x 129
TANK DIMENSIONS							
E	Steam Inlet	29	33	53		60	
F	Level Alarm	23	26	45		50	
G	High Temp Return	35	21	39		43	
H	Level Control	42	41	61		69	
J	Relief Valve	48	50	69		77	
K	Relief Valve	N/A	60	79		86	
L	Relief Valve	N/A	N/A	N/A		95	
M	Drain	36	47	76		93	
P	Overflow	Rear Hd	60	10		10	
R	Overall Width	39	51	51	63	69	75
S	Front Head	6	8	8	10	11	
T	Column	8.5	8.5	22		12	
STANDARD DIMENSIONS							
A1	Overall Length	54	61	86		101	
B2	C/L to C/L Bolt Holes	49	56	80		95	
C3	Overall Width	42	49	64		71	
D4	C/L to C/L Bolt Holes	39	46	61		68	
E5	Hole Size	0.75	1	1		1.125	
F6	Anchor Bolt Size	0.625	0.875	0.875		1	
CONNECTIONS & TRIM							
1	Relief Valve Size	Contact your local Cleaver-Brooks authorized representative					
2	Overflow Size	1.25" NPT	2" NPT	3" NPT		3" NPT	
3	Steam Inlet Size	2" NPT	3" NPT	4"-150# FF	6"-150# FF	6"-150# FF	
4	Suction Size	3" NPT	3" NPT	3" NPT		4"-150# FF	
5	High Temp Return Size	1" NPT	1.5" NPT	2" NPT		3" NPT	
6	Drain Size	2" NPT	2" NPT	2" NPT		2" NPT	
7	Recirc (1" NPT)						
8	Thermometer (.75" NPT)						
9	Sample (.5" NPT)						
10	Chem Feed (1" NPT)						
11	Thermometer						
12	Gauge Glass Assy						
13	Level Controller						
14	Make-Up Valve						
15	Pressure Gauge						
16	Overflow Drainer (Opt)						
17	Control Panel (Opt)						
18	Feed Pump/Motor (Opt)						
19	Suction Piping, (Opt)						
20	Manway, 12 x 16						
21	Level Alarms (Opt)						

Figure H4-2. Boilermate Deaerator Dimensions and Ratings – Sheet 2 of 2



TANK CAPACITY (GAL.)						
MODEL	**110**	**330**	**430**	**800**	**1070**	**1500**
	LEGS	**SADDLES**				
A	48.5	55.5	80		95	
B	54	61	85.5	86.5	101	
C	22.5	29.5	29.5	38	44.75	
D	24.25	31.25	31.25	40	51.5	57
E	11	15	15	17	16	17
F	0.875	0.875	0.875	1	3.38	6.13
G	5.5	5.5	5.5	6.5	N/A	
H	7	7	7	9.75	N/A	

Figure H4-3. Boilermate Tank Supports and Saddles, Details and Dimensions

RETURN ON INVESTMENT

Payback for a pressurized deaerator verses an atmospheric boiler feed system is based on an additional capital expenditure required divided by the yearly operating cost savings. The differential in yearly operating costs are in the following areas:

- Flash steam
- Exhaust steam
- Blowdown
- Chemical treatment
- Makeup water
- Sewer
- Intangibles

Flash Steam

A percentage of the high-pressure condensate returns will flash to steam and be lost in an atmospheric vessel application. This flash steam loss can be converted to an energy loss and associated fuel cost.

Exhaust Steam

Exhaust steam cannot be recovered in an atmospheric vessel application. This exhaust steam loss can be converted to energy loss and associated fuel cost. An example would be steam turbine exhaust.

Surface Blowdown

Increased makeup water is required because of lost flash and exhaust steam. This increase in makeup water requires an increase of surface blowdown. This is directly related to cycles of concentration in the boiler. The additional blowdown loss can be converted to an energy loss and associated fuel cost. The additional surface blowdown may also result in an increase in capital expenditure for a larger blowdown heat recovery system.

Chemical Treatment

Dissolved oxygen content in an atmospheric boiler feedwater system is a function of water temperature. Lowering the dissolved oxygen content below what is naturally present, based on mixed water temperature at atmospheric pressure, requires the addition of a chemical treatment program. The most common oxygen scavenger used is sodium sulfite. Sodium sulfite reacts with dissolved oxygen as follows:

Theoretically, it takes approximately 8 ppm of sodium sulfite as Na_2SO_3 to scavenge 1 ppm of dissolved O_2

$$2Na_2SO_3 + O_2 \rightarrow 2Na_2SO_4$$

Makeup Water

Increased make-up water is required because of lost flash steam, lost exhaust steam, and additional surface blowdown. This additional makeup water can be associated to a cost. Makeup water cost should be a combination of the utility charge plus pretreatment equipment consumable costs.

Sewer

Utilities often base a sewer charge on make-up water usage. Increased makeup water usage with an associated increase in surface blowdown can affect these costs.

Intangibles

Some cost savings are difficult to calculate - in general, best practices in deaeration will prolong the life of boiler room equipment, reducing repair and maintenance costs.

Notes

SECTION H4
BOILERMATE DEAERATORS

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

1.01 General

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

PART 2 PRODUCTS

2.01 Hardware

A. Deaerator

1. Cleaver-Brooks Model _____ packed column type, pressurized, horizontal deaerator is rated at _____ pounds per hour at _____ °F mixed inlet water temperature. The system shall be of the single tank design and guarantee oxygen removal to not more than 0.005 CCS/liter in the effluent throughout all load conditions between 5 and 100 percent. Tray-type designs are not acceptable. The deaerator shall be designed for operation at 5 psig, but shall be suitable for use from 2 to 15 psig. Atmospheric operating designs are not acceptable.
2. Feedwater and condensate shall be admitted to the deaerator through a single spring-loaded, self-cleaning, adjustable stainless steel spray valve, which shall provide proper internal vent condensing and water distribution at any load between 5 and 100 percent of rated capacity. The water temperature in the primary heating and vent concentrating section is to be raised within 2 or 3 °F of steam temperature and most of the gases released. The water is then to drop down through the column's stainless steel exchange packing counterflow to the steam, which enters at the top of the storage tank and rises up through the column. The column is to be _____" in length and _____" in diameter. The column shall have a stainless liner and grid support. Hot, gas-free water is to then drop to the storage compartment to complete the cycle. The steam and non-condensables are to flow upward, through the primary heating spray, into the internal vent concentrating section, where they contact the cold influent water. Here, the steam is to be condensed to continue the cycle. Released gases are discharged to atmosphere through the vent outlet. All internal surfaces, which come in contact with un-deaerated water, shall be constructed of Type 316 stainless steel.
3. Automatic vent valve shall be thermostatically controlled to provide a fast means of venting when a sudden buildup of gases occurs, such as seen at start up. The manual vent valve shall have an orifice for continuous minimum venting. Venting rate shall not exceed 0.1 of 1% of the rated deaerator capacity at 5 psig.

Load Specifications

LOAD	PERCENTAGE	LBS/HR	TEMP	PRESSURE
Make up				25 psig Minimum
Pumped Low Temp Returns				10 psig Minimum
High Temp Returns	Not To Exceed 30%			

4. The deaerated water storage tank shall have _____ minutes of storage and have a capacity of _____ gallons measured to overflow. The tank shall be _____ diameter x _____ long. An 11" x 15" elliptical manhole shall be provided for access. All nozzles 3" and under shall be 3000 lbs forged steel couplings and over 3" shall be 150 lbs flat face flanges. Heads to be ASME torispherical type constructed of ASTM A516 GR 70 carbon steel with a minimum thickness of 0.25 inches. Shell plate to be fabricated of ASTM A36 carbon steel with a minimum thickness of 0.25 inches. The tank and column shall be designed in accordance with ASME, Section VIII of the Pressure Vessel Code for 50 psig at 650 °F and stamped accordingly. Certification shall be required. Joint efficiencies to be 70% circumferential per table UW-12, which does not require stress relieving or nondestructive examination.
5. The deaerator loads shall be as specified in the table below. Low temperature returns are defined as condensate with a temperature below that of the deaerator operating temperature. High temperature returns are defined as condensate with a temperature above that of the deaerator operating temperature.
6. Optional - The tank and column shall be factory-insulated and lagged with blanket insulation, pins, clips, and a durable steel jacket. Block-type insulation is not acceptable. The blanket insulation is to be fiberglass, 2" thick, 1 lb/cubic foot, and have a rating of R3.85. Pins are to be located on 18" centers and holding clips attached. The steel jacket or lagging shall have a shell thickness of 22 gauge (0.299") minimum and head thickness of 12 gauge (0.1046") minimum.
7. Optional - The magnesium or sacrificial anode shall provide cathodic protection against galvanic corrosion. This rod shall be 1-5/16" diameter with a 1/4" steel core to assure a good electrical contact and added strength. The design shall have a small weep hole to signal it has been consumed. Linings shall not be acceptable in this application.
8. Optional - The high temperature diffuser or sparge tube shall be located beneath the normal tank water level. The tube shall be constructed of 2 inch pipe. This tube shall provide even distribution and blending of high-temperature condensate returns.
9. Optional - The chemical feed quill shall be located beneath the normal tank water level. The quill material shall be constructed of stainless steel. The tube shall provide even distribution and blending of chemical.
10. Optional - The basic deaerator shall be equipped with the following trim and accessories. Piping on packaged units shall comply with ASME Power Piping Code B31.1.

B. Make Up Valve and Controller

1. Option (Mechanical) - _____ " inlet water regulating lever valve with _____ body and _____ connections. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. The pressure drop across the valve shall not exceed a delta-P of 10 psig. This valve shall be suitable for temperatures up to 300 °F. The valve manufacture shall be _____ Model _____. This valve shall be mechanically controlled by an external float cage with cast iron body and 8" stainless steel float. The float cage manufacturer shall be _____, Model _____.
2. Option (Electronic) - _____ " inlet water motorized regulating valve with steel body and threaded NPT connections. Motor shall be 110V bi-directional type with a permanently lubricated gear train, and be directly coupled to the valve stem. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have

teflon seats and be suitable for temperatures up to 300 °F. The motorized valve manufacturer shall be _____. This valve shall be electronically controlled by a solid state control with internally mounted capacitance probes. The electronic solid state control shall be able to set desired level point and acceptable deviation. The electronic solid state control shall include a selection for automatic and manual operating mode. The internals shall include two additional probes for high and low water alarm. The controller manufacturer shall be Cleaver-Brooks Model TW82. A solenoid valve and float switch are not acceptable. (Available only in the U.S.)

3. Option (Pneumatic) - _____ " inlet water diaphragm actuated regulating valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for 3 – 15 psig operating signal. The valve shall be normally open on loss of air. The valve Cv shall not exceed _____ and be rated for _____ gpm at _____ psig inlet pressure. Valve shall not exceed a delta-P of 10 psig. This valve shall have stainless steel trim with TFE packing and be suitable for temperature up to 410 °F. The diaphragm actuated valve manufacturer shall be _____, Model _____. This valve shall be pneumatically controlled by an external proportional type sensor. The sensor shall be a 14" displacer that produces a pneumatic output signal. The controller manufacturer shall be _____, Model _____. A filter regulator is to be provided to reduce 50 psig instrument air supply to 3 - 15 psig for proper operation.
4. Optional - The make up valve shall include a ANSI Class 125 lb three-valve bypass with inlet Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.

C. Steam Pressure Reducing Station

1. Option (Mechanical) - _____" steam pressure reducing valve with cast iron body and _____ connections. The valve shall be a self-contained unit capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. The valve shall be 250 lb class with stainless steel trim and an adjustable pilot. The valve manufacturer shall be _____ Model _____.
2. Option (Pneumatic) - _____" diaphragm actuated steam pressure reducing valve with cast iron body and _____ connections. The valve shall be globe type with proportional control and a spring opposed diaphragm actuator arranged for _____ psig operating signal. The valve shall be normally closed on loss of air. The valve shall be capable of reducing _____ psig saturated steam to the operating pressure of the deaerator at a flow rate of _____ lbs/hr. This valve shall be 250 lb class and have stainless steel trim. The diaphragm actuated valve manufacturer shall be _____ Model _____. This valve shall be pneumatically controlled by an external transmitter. The transmitter set pressure shall be adjustable. The transmitter manufacturer shall be _____, Model _____.
3. Optional - The steam pressure reducing valve shall include a three valve bypass with Y-type cast iron strainer. Strainer screen to be removable and of stainless steel construction.
4. Optional - Quantity _____, _____" relief valves sized to relieve full capacity of the pressure reducing valve in the event of its failure. Valves to meet Paragraph UG-125 of ASME Unfired Pressure Vessel Code, Section VIII. Valve body to be of bronze construction. Relieving set pressure to be 50 psig. Relief valve manufacturer to be _____, Model_____.

5. Optional - High level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on rise and break on fall. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
6. Optional - Low level alarm switch. This shall be an externally mounted float type switch. The switch shall make contact on fall and break on rise. The float cage construction shall be cast iron. (Not required with electronic make up controller.)
7. Optional - _____" overflow drainer sized to relieve full capacity at the operating pressure of the deaerator. The overflow drainer shall be a float type trap. The construction is to be a steel housing with stainless steel float ball. The overflow drainer manufacturer shall be _____, Model _____.
8. Optional - Suction piping for pumps shall consist of a gate valve, cast iron Y-type strainer with replaceable stainless steel screen and flexible connector or hose. This piping assembly shall be 125 lb class construction. The vortex breaker shall be located in the tank nozzle. Manifold suction lines are not acceptable.

D. Boiler Feedwater Pump and Motor Set

1. Option (Intermittent) - Quantity _____, turbine type boiler feedwater pump and motor set. Centrifugal type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____" x _____".
2. Option (Continuous) - Quantity _____, centrifugal type boiler feedwater pump and motor set. Turbine type pumps are not acceptable in this application. Pump to be rated for _____ gpm at _____ feet TDH with _____ feet NPSH required. Pump to be _____ materials of construction as defined by the Hydraulic Institute and have _____ seals for a maximum water temperature of 250 °F. Pump impeller to be hydraulically balanced. The pump shall be mounted on a steel baseplate and flexibly coupled with an OSHA type coupling guard to a _____ hp, _____ phase, _____ Hz, _____ Volt, _____ rpm, _____ enclosure motor. Motor to be non-overloading at the rated condition without using any portion of the service factor. Pump and motor set to be factory aligned prior to shipment. Pump manufacturer to be _____, Model _____, size _____ " x _____ ". A stainless steel recirculation orifice is to be supplied with the pump and shipped loose for field installation to provide minimum bypass flow.
3. Optional - The stand shall elevate the deaerator tank to provide the net positive suction head required by the pump at the rated condition to prevent cavitation plus a 1-1/2 foot safety factor. The stand shall be constructed of heavy square steel tubing for the legs and 1/4" steel plate covering the floor.

E. Control Panel

1. Optional (Base) - Control panel shall be in a NEMA 1 enclosure and wired to the National Electric Code. The wire shall be black number coded. The assembly is to contain individual motor starters with 120 Volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. All switches and lights to have nameplate identification. The assembled panel shall be given a factory continuity test prior to shipment.

2. Optional (Electric Components) - Audible and visual high and low water alarm function shall be provided by a bell or horn with silence switch and individual red oil-tight lights.
   a. Control circuit transformer to supply 110-120 volts, single-phase power supply. The transformer shall be mounted, wired and fused.
   b. Auxiliary contacts shall be furnished for chemical feed pump initiation. Contacts shall be normally open.
3. Standard
   a. The deaerator shall have a gauge glass assembly that covers the entire tank diameter. The gauge glass shall be quartz 0.625 inch diameter by 24 inch maximum length. Each length of glass shall be furnished with a bronze gauge cock set and protector rods.
   b. The deaerator shall be supplied with a pressure gauge that has a 4-1/2 inch dial with a 0-60 psig range and a thermometer with a 50 to 300 °F range. Packaged units are required to have both gauges bracket-mounted at eye level.
   c. The deaerator is to be hand cleaned with a solvent to SSPC- SP-1 standards prior to painting. Prime coated to not less than 1 mil thick and finish coated with an enamel paint to not less than 1 mil thick prior to shipment.
   d. Unit is to be knocked down for shipment. Piping is to be matched marked. Three bound Operating and Maintenance manuals to be provided. Warranty period to be twelve months after start-up or eighteen months after shipment, whichever comes first.