Installation, Operation, and Maintenance

For

Stickle Series AIV Spray-Tray Type Deaerating Feedwater Heaters

Introduction

The Stickle Spray-tray type Deaerator, as the name implies, utilizes both the spray method and the tray method for heating and deaerating boiler feedwater. The combining of the two types ensures the most efficient Deaerator possible for all load levels from 1% through 100% of the Deaerator's capacity. The Stickle Series AIV Deaerator operates at a minimum of 5 psig. and 227 °F. Deaeration occurs in two stages.

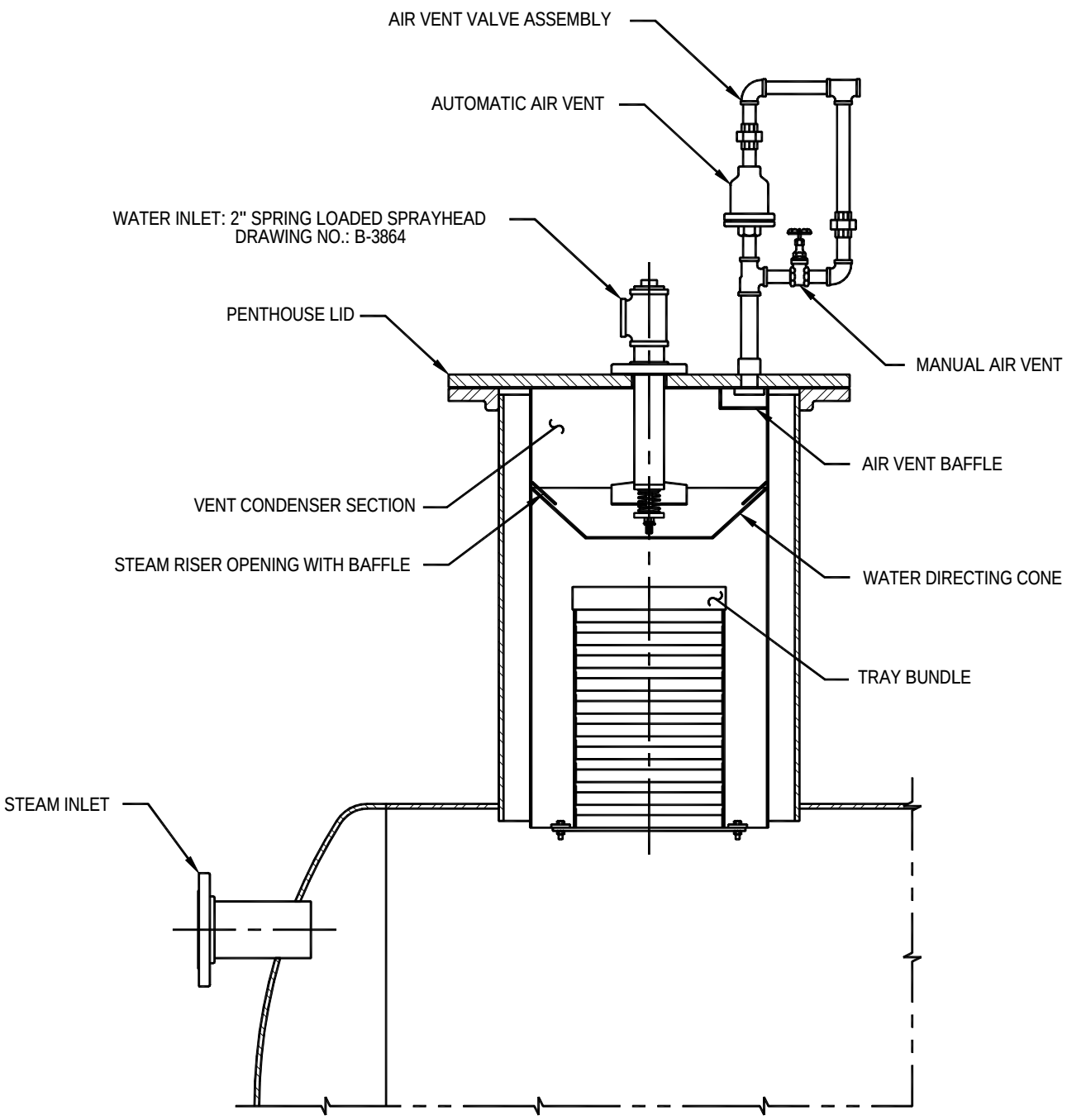
Operation

Stage 1:

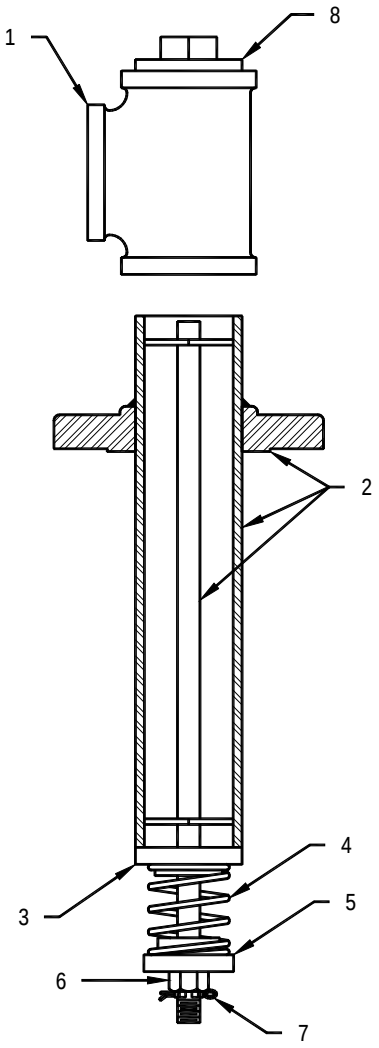
Referring to drawing A124C041: Water to be deaerated is introduced into the Deaerator via a pressure compensated, spring loaded spray valve(s) (See Drawing B-3864); each with a deflector which fans the water out into a thin flat sheet. As the water spreads, it changes into small droplets, yielding the greatest amount of surface area exposed to live heating steam. At this point, the latent heat of the surrounding steam heats the water to the saturation point temperature relative to the steam pressure being maintained on the Deaerator. As this takes place, the steam condenses and falls onto a large cone that carries the water to the tray section. The water falls through an opening at the bottom of the cone (Model 240 AIV). The Model 250 AIV Deaerator collects the falling water on a large flat pan with a cylindrical spill edge that directs the water into the tray section.

Stage 2:

After the water is heated, it is ready for agitation and scrubbing by live steam. In the tray section, the water cascades over a series of trays that are properly sized and arranged. The trays are arranged in rows, one above the other and lying on the same axis. Each row, relative to the adjacent row above or below it, is staggered to permit the water to cascade from the sides of the tray above to the center of the tray below. As the water travels downward through the tray section, the scrubbing action of the steam liberates the non-condensible gases. The steam travels upward through the tray section carrying the non-condensible gases into the vent condenser section. In the vent condenser section, the steam is condensed back into water and the non-condensible gases are vented from the Deaerator through a fixed orifice air vent valve.



Steam Specialties Co., Inc. 2215 Valley Ave., Indianapolis, IN 46218 Telephone (317) 636-6563 Fax (317) 637-3249	240 AIV. DEAERATION UNIT ASSEMBLY	DATE: 1/6/1995 DRAWING NO.: A124C041



PART NUMBER	DESCRIPTION	ITEM NUMBER	QTY. REQUIRED
B120-057	WATER HEAD BODY	1	1
A120C360	BARREL & STEM	2	1
A120C363	SPRAY DEFLECTOR	3	1
A120C365	SPRING	4	1
A120C362	SPRING BLOCK	5	1
A120-064	ADJUSTING NUT	6	1
A120-065	COTTER PIN	7	1
A120-053	2" NPT SST PLUG	8	1

NOTE: SUPERSEDES DRAWING B-3864, DATED: 1-6-95

Steam Specialties Co., Inc.
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Telephone (317) 636-6563 Fax (317) 637-3249

2" SPRAYHEAD ASSEMBLY

DATE: 1/6/2005

DRAWING NO.: B-3864

Tray Section

The tray section of the Stickle Model 250 AIV Deaerator is typically made up of tiers of several individual tray bundles. The top row of tray bundles is nested into the bottom row(s). The top tray bundles only are bolted to one another on the sides to insure a rigid and stable assembly. A rigid steel frame firmly secures and properly aligns the tray section. A hinged access door to the Deaerator section is provided for installation and removal of the individual tray bundles.

The tray section of the Stickle Model 240 AIV Deaerator is typically made up of a single tray bundle. Stickle Model 240-3.0 & 240-4.0 Deaerators have two tray bundles. The tray bundle(s) are held in place by bolts fastened to the bottom of the vent condenser. The Deaerator penthouse lid and vent condenser must be removed to gain access to the tray bundle(s).

How the Water is Heated and Deaerated

As mentioned, the sprayheads present the water in a conical vertexed spray pattern, which is the most revealing means of direct introduction of water to steam, for direct contact, agitation, heating and deaeration. As the water is heated, the entrainment of gases in the water becomes unstable. The agitation of the water causes the gases to escape. Of the soluble gases entrained in the cold water make-up, 25% is said to be normally oxygen. So stage I, the sprayed introduction of incoming water, initiates the deaerating and heating process.

A surge tank may be used whereby water of varying temperatures is collected and then pumped into the Deaerator via transfer pumps. The condensate returns, mixed with cold water make-up enters the Deaerator through the sprayheads. All cold water make-up must be deaerated, and must enter the Deaerator via the sprayheads. The water follows the course outlined previously; it is sprayed, directed by a collection cone or spill edge, and then cascades down through the tray section into the water storage compartment.

The entire inner portion of the Deaerator is filled with free-flowing live steam that is in direct contact with the exposed water for scrubbing, agitation and heat exchange activities.

Heating and agitation releases the non-condensible gases. Once the air has been liberated from the heated water, it must be removed from the Deaerator. To prevent having to exhaust large quantities of steam from the unit to move the air out, two principles of Physics are employed. Air is non-condensible, but steam is condensable. The spray-tray Deaerator employs an internal vent condenser located at the highest point in the Deaerator and also houses the sprayheads. The cool incoming water cools the upper portion of the vent condenser section and lures the air, which also includes oxygen and carbon dioxide, intermixed with some steam vapors, into the top of the vent condenser. The cool water condenses the steam vapor and leaves the air alone, now free to be vented from the unit. One or more manual vent valves with a fixed orifice are provided.

Steam Supply:

The steam utilized by the Stickle spray-tray type Deaerator is allowed to disperse throughout the unoccupied internals of the Deaerator compartment, permitting it direct access to all of the water.

The steam consumption for a Deaerator is contingent on some important variables; the total mass of water to be heated and the necessary heat input per unit mass. This involves the percentage of cold water make-up to be used versus the percentage of condensate returns. A conventional heat balance calculation considers the heat input necessary to maintain the required pressure on the unit, (Normally 5 psig. 227° F.).

High Pressure Condensate Returns:

Commonly called trapped returns, indicating that they are returned by their own velocity from steam traps. Categorically, high pressure returns have a quality of temperature and pressure greater than the maintained pressure and temperature of the Deaerator. They do not require deaeration and are valuable for their re-flashing ability. The temperature of these returns immediately drops to the relative temperature of the steam pressure maintained on the Deaerator. In so doing, flash steam is formed which is utilized in the heating and deaerating process. Normally, when sizing Deaerator steam pressure regulators, steam yield from high pressure returns is not considered. Designated connections on the Deaerator should be provided for these returns.

NOTE: There is a possibility, in some instances, that the flash steam generated from high pressure returns is greater than the steam required to heat and deaerated the incoming water. This will be covered under “Trouble Shooting”.

Typical Deaerator Accessories:

Standard accessories (Figure 1) for a Packaged Deaerator include but are not limited to the following:

A. Cold Water Make-Up Valve.
B. Liquid Level Controller (Cold Water Make-Up).
C. Automatic Air Vent Valve.
D. Manual Air Vent Valve with Orifice.
E. Safety Relief Valve. (Sentinel or Full Capacity depending on design requirements).
F. 5” Dial Thermometer.
G. Water Level Alarm Switches.
H. Water Level Indicators.
J. Vacuum Breaker.
K. Steam Pressure Regulator (P.R.V.)
L. Overflow Trap and Drainer.
M. Boiler Feed Pumps.
N. Pressure Indicators (Deaerator & Pump Discharge).
P. Control Panel.

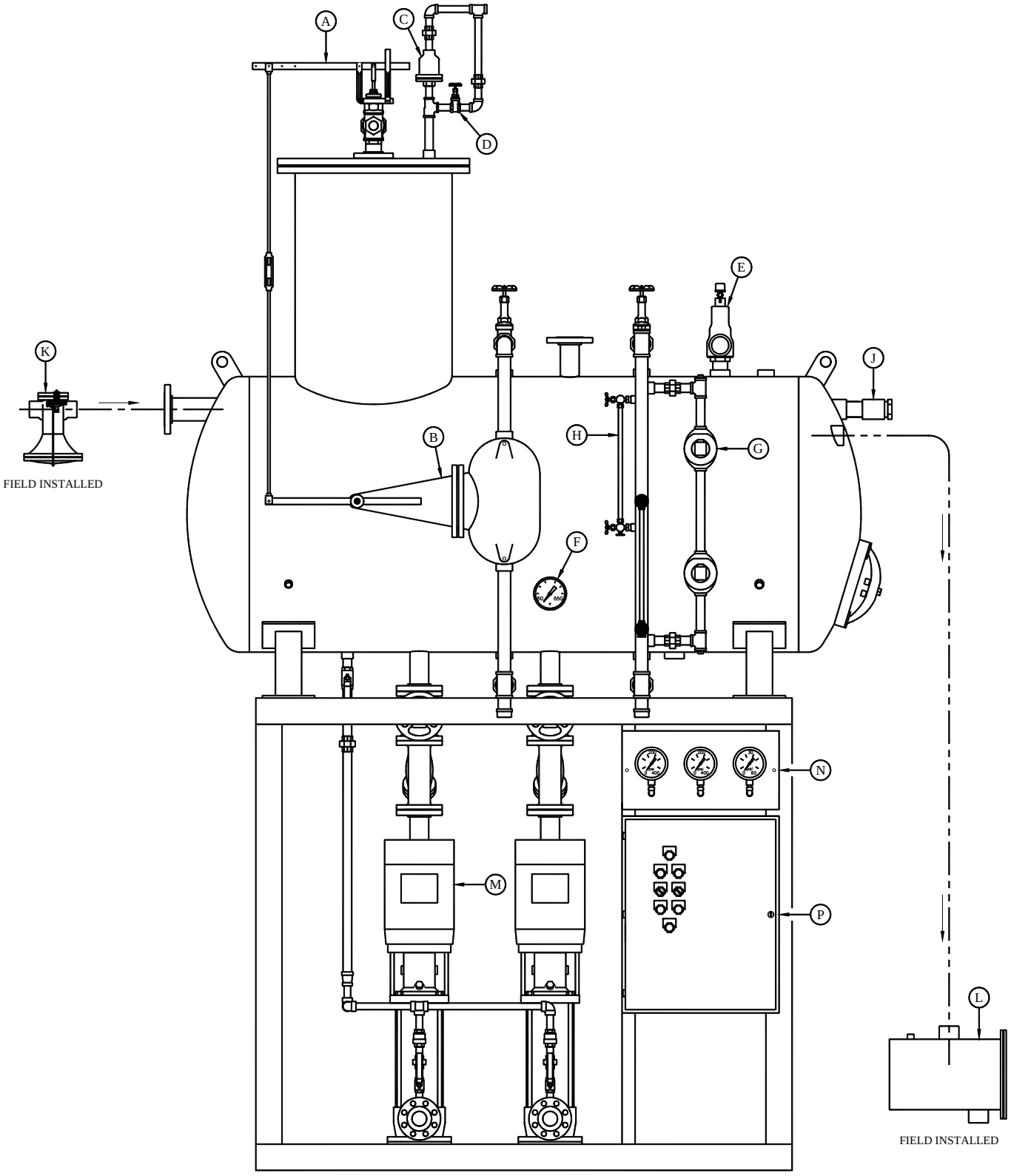

Figure 1: Deaerator Accessories
(Deaerator Illustrated with Mechanical Trim)

Other accessory items may have been furnished, as there are several different configurations for accessory equipment possible. Manuals and insertions of the actual accessory equipment furnished are provided at the end of this manual.
Please review each accessory manual prior to start up.

Pre-Start Up Procedures:
(Deaerator with Pneumatic Level Controls and Electro-Pneumatic Steam Pressure Controls):

1.) Deaerator system should be installed, leveled, and anchored, with all piping attached to appropriate connections as indicated by the general arrangement drawing and piping schematics.

2.) Make sure that all piping, fittings, and components are properly rated for the service that they were designed for and are properly installed.

3.) Make sure that all flanged and bolted connections are properly tightened and properly gasketed.

4.) Make sure that all unioned connections are properly tightened.

5.) Boiler Feed Pumps: **Note: Please read and thoroughly understand the pump operation manual.**

A. Check the pump rotation by jogging the motor starter or selector switch. Correct the rotation if necessary. **(Note: Some pumps require removal of the motor to pump shaft coupling prior to rotational check)**

B. Make sure that the coupling guard is securely in place.

C. Break open the pump recirculation union orifices to make sure that the orifice was installed.

6.) **For Deaerators with Pneumatic Instruments,** Adjust the Instrument air regulators on the Deaerator P.R.V, B.P.R.V. and Magnetrol level controller, to obtain 20 psig. on the supply gauges.

7.) **For Deaerators with Electro-Pneumatic Instruments.** With the air regulators properly adjusted to 20 psig and electrical power on to the pump control panel, place the Omron controllers in “Manual Mode”. Press and hold in the Omron A/M button until the “MANU” indicator light turns on.

A. Press the up arrow key on the Deaerator Pressure Controller to increase the output value to 100.0 All of the 10 green lights in the vertical column to the left of the display will light up. Check the Deaerator P.R.V. to see that the valve has gone from full closed to full open.

B. Press the up arrow key on the Deaerator Back Pressure Controller to increase the output value to 100.0 All of the 10 green lights in the vertical column to the left of the display will light up. Check the Deaerator B.P.R.V. to see that the valve has gone from full open to full closed.

C. Press and hold in the Omron A/M button until the “MANU” indicator light turns off.

8.) **Pneumatic Liquid Level Controller:** Check out the Magnetrol level controller. Make sure that the Magnetrol set screw is tight and that the head does not move at all. Make sure that the magnet travels its full stroke up and down without sticking to the E-tube. Adjust the magnet position if it is sticking to the E-tube. If it still sticks to the E-tube after adjustment, the E-tube is probably bent a little. Use a plastic hammer or mallet to straighten the E-tube and re-adjust the magnet. Set the Magnetrol proportional band on 3 and the level knob at 5. With the travel fixed at 50%, adjust the zero screw on the flapper assembly until you obtain 9 psig on the output gage.

9.) Fill the Deaerator with water. Make sure that the pump control panel is turned on before filling, and make sure that the low water alarm is working properly. Overfill the Deaerator to test the high water level alarm.

10.) Check that all valves necessary for normal running are in the operating position; open or closed. (e.g., Isolation Valves: Pump Suction, Sight Glass, Pump Recirc., Condensate Inlet, Sensing Lines, Pressure Indicators, Etc.)

11.) **Please read and thoroughly understand the operation manual for each individual accessory that is provided.**

Trouble Shooting Deaerators:

From Experience, we would like to list some troubles that are not uncommon to everyone's Deaerators and antidotes which we have found to be successful.

1. **Deaerator is low on temperature; the temperature is not relative to the indicate pressure.**

Antidotes:

(a) Check the accuracy of both, temperature and pressure gauges.

(b) Open the manual air vent valve wide. As water rises in a Deaerator and heat begins to liberate air, air pressure on pressure gauge and steam regulator sensing line can cause the steam regulator to throttle down or even close, preventing necessary temperature build-up. If this proves beneficial, check the air vent valve for failure.

(c) "Load" on the Deaerator has been such that the cold water make-up flow rate is over 100% of its rated capacity. A Deaerator, as with any boiler room device, operates best under modulated conditions.

Considerations should be given to the water controls on boilers. A 100% modulating control is superior for the boiler itself and for all related equipment. Switch actuated solenoid valves or motorized valves, as well as intermittent pump control tends to demand water en masse. This sudden demand on the Deaerator causes the water to be replenished immediately. The liquid level controller opens the Deaerator inlet valve wide. In extreme cases, pressure drops across this inlet valve can cause the valve to pass more water than the Deaerator has the ability to heat and Deaerate. In effect, the Deaerator becomes "Flooded" or "Water Logged".

(d) The steam pressure reducing valve may be undersized if conditions are altered from when the valve was originally sized. The conditions, if changed, might present a problem with the valves ability to supply enough volume of steam to heat the make-up water.

Observations should be made that the pressure reducing valve used is responsive to small pressure fluctuations. Also, the pressure reducing valve should be checked in accordance with maintenance requirements periodically.

2. **Deaerator runs high on pressure, causes safety valve and / or back pressure relief valve to lift.**

(a) A Deaerator, of itself, cannot generate pressure under normal conditions. The Deaerator collects water at varying temperatures, and in so doing, must accommodate its heat. If a quantity of flash steam is generated from excessive high pressure returns, which proves to be more than ample to heat the water entering the unit at this time, a pressure build up results, and eventually the safety valve or back pressure relief valve will open to relieve

(b) Steam traps blowing through: There is a difference between flash steam and "Blow-through" steam.

Flash steam is generated when condensate is returned to a vessel which has a lower pressure, consequently a lower relative temperature than does the condensate. The condensate is releasing heat in the form of steam to make itself relative to the lower pressure.

Blow-through steam is steam that blows through the process along with condensate. This can usually be attributed to malfunctioning steam traps. Traps that are not intermitting properly or closing off tightly, permit steam to blow straight through even after the trap has voided itself of water. If an overabundance of steam suddenly occurs at the Deaerator, inspection of all steam traps is a good place to investigate.

(c) A defective steam pressure reducing valve which is not throttling down or possibly not shutting off. Check valve stem movement.

(d) Sometimes the condition is deceiving; relief valves open, or may appear to open due to over-pressure, whereas the problem may be a defective relief valve. The system may actually be operating at the required pressure.

(e) Check pressure controller for proper set point, air supply and air output readings.

3. Vacuum is Formed in the Deaerator

It is good practice to provide a vacuum breaker on a heating vessel such as a Deaerator. A swing check valve installed in a horizontal position will suffice as a vacuum breaker or a more sophisticated spring loaded breaker may be used. Normally 2" pipe size is recommended. The breaker is installed so that when there is pressure on the Deaerator it forces the valve shut. When a vacuum occurs, the valve is pulled open and the vacuum broken.

Vacuum is formed when pressure and temperature is suddenly removed for the vessel. This can be known as a condensing vacuum. When this occurs, flashing (or reboiling) of the water can occur, causing cavitation at the boiler feed pumps. The result is partial or complete loss of feedwater flow to the boiler and possible pump damage.

4. Noise:

A unit having water and steam fed into it with significant velocity will not be completely void of noise. However, the noise level should be completely bearable. Noise similar to "rumbling" or "water hammer" should be investigated immediately. The cause of "thud" type noises, normally called "water hammer", is usually due to the inability of a combination of water and steam to pass through a line simultaneously. This condition can be damaging, especially to the internals of a Deaerator. Internal flooding of the Deaerator can cause this condition. However, the possibility of flooding is remote since the liquid level controller, controlling the water level, should maintain a level well below the deaerating section. Consequently, the overflow controller should handle any water allowed to rise to the vessel overflow level. There exists the possibility that while the water inlet controller is maintaining its proper level, a large surge of water returns to the Deaerator. In this event, the overflow valve must handle the water that exceeds the overflow level. If the overflow is not handling the water, it should be investigated for malfunction.

If "hammering" is caused by flooding, the steam supply to the Deaerator should be shut off immediately and remain off until the problem has been corrected.

Under extreme circumstances, as discussed before, there is the possibility that pressure fluctuations on the Deaerator are of such magnitude that the remaining water in the Deaerator is above the vapor point. In giving up heat to drop to the vapor point, a reverse boiling effect can occur. The water, in effect, is "boiling down" to the point of evaporation.

This would have the same physical sound as water being brought up to the boiling point, and would persist until all of the water reaches a temperature relative to the lowered pressure on the unit. Due to the volume of water involved and the size of some vessels, a "rumbling" will occur. The rumbling can be quickly stopped through raising the pressure by introducing steam into the unit. This may be accomplished by raising the set point on the pressure controller, or by manually opening a by-pass line around the pressure reducing valve. **WARNING: WHEN OPENING A BYPASS LINE AROUND THE PRESSURE REDUCING VALVE, THE OPERATOR ASSUMES CONTROL OF PRESSURE ON THE DEAERATOR. AUTOMATIC CONTROL IS USURPED. STEPS SHOULD BE TAKEN BEFOREHAND TO PREVENT OVERPRESSURE OF THE DEAERATOR DURING THIS EVENT.** Be sure that the by-pass line is tightly shut once the condition subsides, returning the unit to automatic pressure control.

If the noise condition outlined persists, it is indicative of the fact that because the pressure reducing valve is not maintaining sufficient pressure , possibly the Deaerator is being forced to operate at over 100% of its rated capacity. If it is found upon investigation that the flow rate is such that it would overload the Deaerator excessively, steps should be taken to restrict the flow through the Deaerator inlet valve. Lowering the water pressure on the "upstream" side automatically lowers the flow capacity of a valve.

Superficial noises, such as small rattles, can occur due to the existence of “flutter” in the spring loaded spray valves. They should be intermittent and of short duration. If they become continuous and their noise level increases, they should be checked to ascertain the problem.

MAINTENANCE:

A deaerating feedwater heater is a simple device and normally requires a minimum of maintenance. The sprayheads are removable from the unit by entering through the access door, removing the appropriate tray bundles for access, and unscrewing the sprayheads. The sprayheads can be completely disassembled without difficulty. They can be cleaned, machined, or “ground in” if necessary. Note the setting of the spring adjusting nuts before disassembly, or measure the compressed spring length and duplicate for reassembly.

AIR VENT VALVE: This valve mat be replaced in the vent of malfunction.

TRAY BUNDLES: The tray bundles are designed so that they can be cleaned by a commercial cleaner by dunking and soaking them in an open top 55 gal. drum.

ACCESSORIES: Follow the instructions provided in the individual manuals for each accessory items