THERMAFLO ENGINEERING COMPANY Since 1986
Manufacturers Of Steam Fired Specialty Equipment

• JS JET SPRAY SERIES
• TSB JET SPRAY TRAY SERIES

DEAERATORS
TSB-24 through TSB-120
JS Series 10 through 110

INSTALLATION
OPERATION
&
MAINTENANCE

5/201

PREFACE

These instructions describe the principles of deaeration of water and the physical equipment utilized to accomplish deaeration. An understanding of these principles will assist in achieving satisfactory and effective operation of the deaerating equipment. The equipment is flexible and will accomplish the required deaeration when operated properly. The instructions are intentionally made general to cover possible variations of operating conditions or applications of equipment. Refer to the submittal data and the equipment drawing for specific data on your equipment. The user of this equipment should contact Thermaflo Engineering, Inc. when questions arise regarding aspects of operation not addressed in this manual. Thermaflo Engineering, Inc. reserves the right to change drawings and procedures without notice. It is important to review this manual completely and understand its contents before installation and operation.

This is a general manual that provides information about all of our deaerators and has recommended practices. You should always have a specific drawing of your deaerator in order to be sure that the practices are applicable to your specific applications. Always consult your local engineer and contractor for specific needs for piping and hookup details.

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SAFETY PRECAUTIONS

ALL SAFETY BEGINS AND ENDS WITH A PRUDENT, RESPONSIBLE PERSON WHOSE WELFARE IS THE PRIMARY CONCERN. THERE IS NO GREATER SAFETY PRACTICE THAN THE CARE AND COMMON SENSE EXERCISED BY YOU.

BOILER PLANT SYSTEM

The deaerator is only part of a large boiler feed water system. Persons who come in contact with the system must know all safety rules of the deaerator and connecting and related equipment.

DEAERATOR

The following are potential dangers associated with a deaerator. DO NOT attempt to disassemble, repair, perform maintenance, or otherwise work on a deaerator until all of the potential dangers have been considered and their respective safety precautions followed.

HIGH PRESSURE

The deaerator is pressurized during operation and the pressure may remain high after the equipment is shut off. Removal of manway covers, inspection ports, or any bolted connections while pressure exists in the vessel can cause the covers, etc. to break loose or discharge hot, high pressure fluids which could cause injury. Therefore, disassembly or work on the deaerator should not begin until the following precautions have been taken:

1. Isolate the vessel from the boiler system to insure that there can be no operation, residual, or otherwise of the deaerator. Plant system safety procedures must be consulted to insure proper isolation.

2. Check to see that pressure gauges are properly functioning and that the pressure gauges or other pressure indicators show zero pressure.

3. Carefully open vent valves provided on vessel. Open valves very slowly. Listen for hissing sounds and observe any escaping steam or fluids. If hissing or escaping fluids are present, do not continue to open until all sounds or fluid discharge stops.

HIGH TEMPERATURE

The deaerator operates at high temperatures that could cause severe burns. When the vessel is shut off, it can take hours or days to cool to safe temperatures. Any temperature in excess of 212º F could also indicate the presence of internal pressure. Therefore, disassembly or contact with metal parts should not begin until the following precautions have been taken:

1. Isolate the vessel from the boiler system to insure that there can be no operation, residual, or otherwise of the deaerator. Plant system safety procedures must be consulted to insure proper isolation.
2. Check thermometers or other temperature indicators for proper functioning and make certain

that temperature is less than 100° F.

3. Use a temperature sensor or comparable devise to determine whether the deaerator has sufficiently cooled.

INTERNAL DANGER

Extreme caution should be exercised before entering the deaerator.

First, deaerators may contain oxygenless gases (e.g. nitrogen) that can cause severe illness or death if inhaled. Deaerators are frequently shipped with nitrogen. Many owners and users of deaerators also pressurize the deaerator with nitrogen during short or long inactivity. Nitrogen is colorless and odorless and cannot be easily detected. Because of the absence of oxygen in gases such as nitrogen, inhalation of sufficient amounts can cause severe illness or death. Therefore, do not enter the deaerator until the precautions listed below have been taken.

Second, the inside of the deaerator may be very tight and confining. It may also contain sharp corners and protrusions which could cause injury. Any person entering a deaerator should be knowledgeable of the proposed Occupational Safety and Health Act requirements on confined space entry and should follow the precautions listed below:

1. Isolate the vessel from the boiler system to insure that there can be no operation, residual, or otherwise of the deaerator. Plant system safety procedures must be consulted to insure proper isolation.

2. The work crew should consist of two or more people at all times.

3. Determine that the deaerator contains sufficient oxygen and does not contain any other dangerous gas.

4. Open all vents, manways, or access openings to permit all oxygenless gas to escape and properly ventilate the deaerator. It may be necessary to utilize exhaust fans, ventilators, and blowers to speed the ventilation process. Maintain adequate circulation of oxygen throughout work on the deaerator.

5. Provide adequate scaffolding, platforms, or ladders.

6. Provide adequate lighting.

7. Understand the construction of the equipment and all relevant safety requirements.

8. Use appropriate safety equipment including, but not limited to, hard hats, safety glasses or goggles, gloves, and heavy duty work clothing.

GENERAL MAINTENANCE

The maintenance section of this manual and the instructions in the accessory section provide normal maintenance procedures for the deaerator. Additionally, the following maintenance inspections should be performed to assure continued safe operation.

1. Inspect for cracks, breakage of internal parts, and internal erosion or corrosion in or near welds or pressure parts (e.g. shells and heads).

2. Inspect pumps for loose bolts or coupling parts. If the pumps are disassembled, examine all bearings, shafts, impellers, and seals for wear and damage.

3. Safety and relief valves should be activated periodically to assure proper performance. These valves should also be inspected to assure that no external devices such as "gags" or extraneous parts can impede proper operation.

4. Make certain that all safety tags are replaced when maintenance and inspections are complete.

Safety Valves, Relief Valves, and other Blow-Off Type Equipment (also Vacuum Breaking Equip.)

All deaerators are protected against damage by one or more safety devices. These devices are designed to discharge in the event that some operating condition causes the deaerator to exceed the standard operating level. This equipment partially relieves the pressure in the vessel and prevents damage.

The discharge from this equipment is extremely hot and can cause severe injury. Therefore, the following safety precautions should be observed in order to prevent personal injury:

1. If customer is installing these devices, locate them in areas where personnel cannot come in contact during operation.

2. Each device should have a suitable exhaust duct, pipe, or deflector to insure the discharge cannot cause personal injury.

3. Since these safety devices are not necessarily provided by Applied Heat Recovery, it is necessary to consult the maintenance, operation instructions, and safety manual of the specific supplier.

Pumps READ YOUR SPECIFIC PUMP MANUAL

Various pumps are used with every boiler feed water system. Injury can occur if proper operation and maintenance procedures are not followed. Therefore, persons performing maintenance on pumps should obtain all instructions, procedures and safety requirements. Additionally, the following general safety practices should be followed:

1. Avoid working on the pump while it is operating.

2. If running adjustments are necessary, avoid wearing loose clothing that could become tangled with rotating parts.

3. Always make certain that proper electrical disconnections and positive valve lock-outs are used.

4. If the pump must be dismantled, beware of hot fluids and high pressure.

SAFETY PRECAUTIONS CHECK LIST

1. Do not touch hot surfaces.

2. Do not open valves to atmosphere (except air vent outlet valves) while vessel is under pressure. Release internal pressure and allow stored water to cool to ambient temperature before entering the deaerator. Before entering the storage vessel, drain tank completely.

3. Do not remove instruments or instrument wells when vessel is under pressure.

4. Avoid hot vent vapors (vent valve, overflow valve, relief valve areas).

5. Always follow OSHA rules and use OSHA-approved equipment.

6. Power must be disconnected to all accessory electrical equipment and instruments, prior to working on the unit.

7. During shutdown, the following safety precautions shall be followed before manned entry into the vessel:

    a. All inlet lines connecting to the vessel shall be closed and safety-tagged.

    b. Release all internal pressure and allow the unit sufficient time to cool.

    c. Carefully open the manway covers and establish air circulation before entering the vessel. (Note: all water must be drained from the storage vessel before removing the manhole cover.)

    d. Verify with suitable monitoring equipment that the oxygen level in the vessel is adequate to support life.

    e. Always have a safety observer stationed immediately outside the vessel when the vessel is being inspected internally.

    f. Use low voltage (safety) lights inside the vessel.

8. Personnel handling the stainless steel trays should wear gloves to protect their hands from sharp edges of the trays.

9. Safety relief valves, overflow valves, vent valves, vacuum breakers, sample valves, drain valves, etc. emit high temperature and high pressure fluid discharges that will result in serious injury.

10. All devices which discharge to atmosphere such as those listed in Item No. 9 should be piped to a location that prevents injury to personnel.

INSTALLATION

RECEIVING SHIPMENT

The deaerator top and storage tank have been hydrostatically tested before shipment. Unload the deaerator carefully, ensuring that it is level in both planes. See paragraph on leveling. Slings, blocks, and handling rigging must be placed carefully. The valves and accessory parts are shipped separately, boxed or crated as necessary. Check packing slip and verify receipt of all items listed. Notify Thermaflo Engineering, Inc. immediately of any discrepancies.

Note: When installing the deaerator top to the storage vessel with a flanged downcomer, it may be necessary to install the studs for this connection before lowering the deaerator top.

LOCATION

The deaerator should be supported at an elevation above the boiler feed pump to provide the necessary suction head on the pump as specified by the pump manufacturer. When determining the elevation of the deaerator with respect to the pump, it is necessary to include a safe allowance for pipe friction as well as the hydrostatic suction head required for the pump. The static head to be provided must be computed accounting for the elevated temperature (reduced specific gravity and density) of the water in the storage section.

In locating the deaerator and storage tank, consideration should be given to providing sufficient space around the unit to permit tray removal and to providing suitable access to the accessory equipment for maintenance or inspection work.

LEVELING

The shell of the deaerator must be leveled accurately in two directions to insure uniform water distribution. Because the steam inlet flange of the deaerator was used as a shop reference for leveling, the deaerator should be level when it is bolted to the foundation. It is important that this procedure be followed.

PIPING

All piping is to be supplied by others.

The deaerator must be piped to connections as shown on the assembly drawing. Check valves must be installed in the steam line when the deaerator is fed by exhaust headers. Care must be exercised so that no stresses are imposed on the deaerator shell. The deaerator and storage tank nozzles are not designed to take excessive external piping loadings. The customer shall design connecting piping such that the piping is supported independently of these vessels.

Thermaflo Engineering, Inc. offers the following recommendations for mixing hot condensate with cold makeup water:

1. Provide check valves in lines prior to blending point.
2. Hot condensate must be non-flashing under all operating conditions.
3. It is recommended that a stainless steel bull head tee and nipples be used at the point where hot condensate and cold makeup come together to avoid oxygen pitting.
4. Allow 10 pipe diameters upstream of the deaerator inlet to insure a proper blend.

VENT PIPING

Vent piping should be installed with care to avoid any traps, pockets or horizontal runs. A vertical line, as short as possible, is best. A gate valve should be installed as close as possible to the end of the vent pipe.

An alternate to this would be a gate valve (for isolation) with an orifice device mounted at the end of the vent pipe. The vent orifice can be an orifice plate within an orifice union, an orifice plate between two flanges, or as simple as a pipe cap with a drilled hole sized for the vent flow rate. Vent orifices are the most feasible for a system that would have a fairly uniform or constant flow of non-condensable gases venting from it. Care must be taken to avoid closing the gate valve at any time except for maintenance or change of the orifice.

Note: Horizontal vent pipe lines will accumulate condensed steam which will result in water exiting the vent. Also, non-condensable gases are highly corrosive; therefore all piping should be either stainless steel or brass/bronze.

TRAYS JS Series Spray Deaerators Do Not Contain Trays

If trays are not installed by the fabricator, refer to the tray installation instructions below.

<u>Tray Installation Instructions</u>

Review all safety precautions before entering the vessel. It is imperative that all pertinent safety precautions be followed when entering and working in the vessel. In particular, Thermaflo Engineering, Inc. recommends that personnel handling the stainless steel trays wear gloves to protect their hands from sharp edges on the trays.

Refer to the illustration on page 28 of this manual and the following instructions for proper installation of the trays:

1. After ensuring that required safety precautions have been taken, remove the vessel manway cover and enter the vessel.

2. After entering the vessel, slide up the closure plate.

3. Install the trays in side by side stacks with their long dimension perpendicular to the tray support beams.

4. Install the lowest tray of each stack such that the tray support legs clear the outside of the support beams. This ensures that the bottom face of the tray rests squarely on the support beam.

   NOTE: If these trays replace existing trays of another style or are installed on top of grating,

it may be necessary to cut off or flatten the support legs of the bottom tray of each stack in order for the trays to rest properly. Also, on existing deaerators where less than a full complement of replacement trays is being furnished, these trays must be installed in full height vertical stacks independent of any older style trays. Do not attempt to intermix the new trays with another style tray in the same vertical stack.

5. With the bottom tray in place, as described above, install the next tray by aligning the upper tray's support legs with the two slots located at either end of the lower tray. If the support legs and slots do not line up properly, rotate the upper tray 180 degrees.

   NOTE: Proper installation requires that the tray support legs point down and are inserted into the slots of the next lower tray. The trays are constructed such that when the end slots and support legs are aligned properly, the slotted spilling edges are staggered. This staggering of the slots is essential for proper operation of the deaerator. Any other alignment of the trays is unacceptable.

6. Continue stacking the trays as described above until all trays have been installed. Refer to the table on page 27 for the correct stack height and quantity of trays for your size deaerator.

7. After all trays have been installed, firmly secure the closure plate on the inner compartment so that water and steam leakage are minimized.

8. If your deaerator is equipped with a tray hold down device, please refer to pages 29-30.

SYSTEMS

Thermaflo Engineering, Inc. recommends that any steam system that returns over 20% condensate have a surge or condensate holding system for the deaerator. If a surge system is not employed in the system, condensate flooding through the over flow will occur. Consult engineering or Thermaflo for a recommendation in these applications.

GENERAL

NOMENCLATURE

The letter "TSB" stands for an Thermaflo Engineering, Inc. Jet Tray Deaerator type, while the number represents the deaerator tank diameter. When the suffix "S" appears, this represents special options that may have been purchased, such as heavy gauge trays and/or a tray hold down system for severe services. For the actual options purchased, refer to your contract with Thermaflo Engineering, Inc.

Example: TSB-84 = Jet Tray Deaerator 7' 0" outside diameter

TSB-84S = Jet Tray Deaerator 7' 0" outside diameter with special options.

FUNCTION

The Thermaflo Engineering, Inc. ATSB Deaerator's primary function is deaeration of the feedwater. However, the unit also performs the following additional functions:

1. Feedwater Heating
2. Feedwater Storage
3. Feedwater Surge

In water, the presence of dissolved gases, particularly oxygen and carbon dioxide, causes accelerated corrosion. The corrosion process is especially rapid at elevated temperatures such as are encountered in boilers and heat exchange equipment. The primary function of the deaerator is to prevent this corrosion by removing the dissolved gases from all sources of water entering the boiler.

PRINCIPLES OF HEATING AND DEAERATION

Complete heating of boiler feed water is accomplished by direct contact of the water and the steam. As in all heat transfer phenomena, contact surface and duration of contact are critical for proper operation. In these units, contact surface is maximized by the use of spray nozzle(s) and duration of contact is optimized in the heating trays.

To remove non-condensible gases from the water (deaeration) the water temperature must be raised to the boiling point. The solubility of a gas is dependent upon the temperature of the water and the partial pressure of the gas in contact with the water. When the temperature of the water is at the

boiling point for the operating pressure, the solubility of the gases is zero.

Rendering gases insoluble by heating to the boiling point does not in itself eliminate the gas from the mass of water. In order to escape from the mass of water, the gas must diffuse through the surface film surrounding the particle of water. Repeated agitation and breaking up of the water by passing it through sprays and over trays and through a steam atmosphere, which is maintained by venting, causes rapid diffusion and elimination of the gases.

PRINCIPLES OF OPERATION

The Thermaflo Engineering, Inc. TSB Series deaerator consists of the following essential parts:

1. Deaerator Shell
2. Water Chamber and Spray Nozzles
3. Downcomer and Water Seal
4. Trays
5. Storage Compartment
6. Water Inlet Flow and Overflow Controls

Water enters the pre-heating compartment through stainless steel, spring-loaded spray nozzle(s). The water is sprayed downward in a finely divided state into an atmosphere of steam where the water is heated to practically steam temperature. This spraying and heating results in a major portion of the dissolved gases being separated from the water. The sprayed and heated water falls to the bottom of the pre-heating compartment from which it flows through the downcomers to the water seal in the tray compartment.

The heated and partially deaerated water passes from the water seal to the trays where the final deaeration is accomplished. The water seal blocks the steam from bypassing the tray compartment into the pre-heating compartment and prevents non-condensible gases from entering the tray compartment from the pre-heating compartment. The water cascades downward in small streams through the tray stack. The water is continuously subjected to the scrubbing action of the concurrently flowing steam. The arrangement of trays is such that a complete redistribution of water is accomplished at each layer of trays. The heated and deaerated water flows from the bottom of the tray section to the storage section where it is blanketed by steam and maintained at or near the temperature of saturated steam under the operating pressure.

Steam is introduced to the deaerator through a connection in the shell and discharged into the space above the trays in the tray section. The steam flows downward through the tray stack. Because the water entering the tray compartment is heated and the bulk of non-condensible gases was removed in the pre-heating compartment, practically no condensation of steam occurs in the tray compartment. Therefore, the entire volume of steam is employed in the scrubbing action which removes the final traces of oxygen and other non-condensible gases. The steam exits through the bottom of the tray stack and flows outside the tray compartment to the preheating compartment where the major portion of the steam is condensed in heating the water. A very slight amount of steam and non-condensible gases is discharged to atmosphere through a vent located in the top of the unit.

Make-up water is controlled by means of the water level in the storage compartment operating through a level control and a regulating valve which can be either mechanical or pneumatic.

Condensate and returns which are at least 20° F below the temperature corresponding to the minimum operating steam pressure are introduced downstream of the regulating valve and enter through the same spray nozzles as the make-up water. Any returns which would flash into steam when introduced into the deaerator are piped to the high pressure trap return connection. The flashed steam follows the same path as the steam described above and assists in the scrubbing of pre-heated water.

The customer should provide a check valve in the condensate inlet line close to its junction with the cold makeup water inlet line. This check valve should open toward the deaerator. Its purpose is to prevent the entrance of cold make-up water into the condensate line when no condensate is flowing or when condensate pressure is less than deaerator pressure.

The customer should also provide a pressure reducing valve to supply live steam during conditions when the normal exhaust steam supply is not sufficient to maintain a continuous positive steam pressure in the deaerator. The steam reducing valve should be controlled from the steam space of the deaerator. A 3/4" connection on the deaerator is provided for this purpose. Do not control this valve from a connection in the piping downstream of the reducing valve because this will result in a lower pressure in the deaerator than is required, particularly when the valve is located a great distance from the deaerator. The reducing valve should be sized to supply the entire steam requirement i.e., a capacity in pounds per hour equal to one sixth of the rated capacity of the deaerator. The reducing valve should be set to open at least 4 psig below the normal deaerator pressure, and to close at 2 psig below the normal deaerator pressure. In no case should the reducing valve be set to open at less than 2 psig above atmospheric pressure. If a shut off valve is provided in the exhaust steam line ahead of the deaerator, Thermaflo Engineering, Inc. recommends introducing the live steam upstream of this valve so that the deaerator can be cut off from both steam sources when it is necessary to inspect the unit. Thermaflo Engineering, Inc. also recommends installing a shut off valve in the live steam line upstream of the pressure reducing valve. This is necessary because the pressure reducing valve is equalized to the steam space of the deaerator and when the shut off valve in the exhaust steam line is closed and the deaerator pressure decreases, the pressure reducing valve will open and supply live steam to the exhaust line. This steam will then be released to atmosphere through the main relief valve which is protecting the exhaust system. To prevent this waste of steam, the shuAT-off valve in the live steam line is closed for inspection of the deaerator.

JS Series Deaerators

JS Series Deaerators are spray only and do not contain trays. All makeup and incoming condensate flow through the main makeup nozzle to the modulating spray valve. The spray valve produces a thin film hollow cone feed into the top deaerator steam space. The steam instantly heats this water to saturation, generally within a degree or two of 227F or 5 psig steam. Most of the oxygen is then removed at this point through the vent tube. Heater feedwater falls into the condenser pan and flows down into the scrubber section. Inlet steam from the PRV senses a pressure drop in the top of the deaerator and sends saturated steam into the diffuser/scrubber. In this section steam flows at high velocity through orifices boiling the feedwater violently and removing all remaining oxygen.

OPERATION

PRELIMINARY

Before placing the unit into service for the first time, carefully check the following:

1. Check the installation of the trays and spray nozzles to insure proper installation.

2. All dirt and foreign material have been removed from the inside of the deaerator and storage tank shells and from the piping and accessories.

3. All piping should be tight, properly supported, and assembled in accordance with Thermaflo Engineering, Inc.'s drawings.

Before placing the unit in service or when it has been out of service for an extended period of time, be sure that:

1. All piping or any access openings repaired or taken down have been closed or secured in place.

2. Relief valves and vacuum breakers are in proper working condition. The relief valve should be lifted by hand while starting up to check proper working conditions.

3. The following valves should be closed: steam isolation, water isolation and pump supply isolation.

4. Be sure that all manual valves for controls, indicating devices, warning devices and protective devices are open, and that all other valves are closed.

PLACING EQUIPMENT IN SERVICE

Procedure for placing the equipment in service is outlined as follows:

1. Open the vent valve to atmosphere wide. If the unit has a vent orifice plate, completely open the vent bypass valve.

2. Open the water inlet valve and allow the storage section of the deaerator to fill slowly.

3. Note the water level in the gauge glasses and set level controls and alarms as the level reaches that particular control point.

4. Close the water inlet valve being used to fill the storage space.

5. Drain the storage space. When the storage tank is empty, shut the drain valve.

6. **SLOWLY** open the PRV valve in the steam inlet line to a position little more than "cracked". Leave the valve in this position until the unit has been fully heated to the operating temperature and steam is flowing freely out of the vent valve. Set at 7 psig

7. Open the steam inlet valve wide.

8. When the unit is fully heated, again tighten bolts on all flanges and manhole covers.

9. If there are any condensate return lines or trap discharge lines connected to the deaerator, slowly open the valves in these lines and allow the unit to fill to the working level. If no condensate returns are available, use the make-up inlet control valve by-pass line to fill the storage tank to the working level. Open this valve slowly to avoid pressure loss in the deaerator. Close the valve(s) once the operating level has been reached.

10. Slowly open the valve in the makeup water line and let the makeup regulating valve take control. Re-check the operating level in the storage tank for proper operation of the make-up regulating valve.

11. Slowly open the isolation valve in the pump supply line. Open the valve in the pump supply line.

12. If practical, the initial effluent water from the deaerator should go to waste or to a source utilizing water that does not need to be completely deaerated until the effluent water has reached a temperature approximately the temperature of saturated steam at the operating pressure in the deaerator.

13. Close vent orifice by-pass valve if used and adjust vent valve as described under normal operations.

NORMAL OPERATION

During normal operation the vent valve should be throttled so that there is always a short plume of escaping steam apparent. The vent valve should be throttled to maintain the vent rate at the minimum consistent with efficient operation of the deaerator.

If the vent valve is throttled too much, air and non-condensible gases will accumulate in the deaerator. This condition will result in a decreased heating, and incomplete deaeration. This condition is known as air blanketing and results from an insufficient vent rate.

The temperature of the deaerated water should always be within one to three degrees of the steam temperature in the operating space of the deaerator. A wide variation in these temperatures may be due to air blanketing resulting from an insufficient vent rate. The vent rate may be increased by opening the manually operated air vent valve.

TROUBLE SHOOTING

A. Symptom

Insufficient heating (Difference of 3° F or more between saturation temperature, corresponding to steam pressure in unit and outlet water temperature). Excessive oxygen content in the deaerator effluent.

Cause & Remedy

1. Insufficient venting. Before making any adjustments, check thermometers for accuracy. A lower temperature in one thermometer may be caused by internal air blanketing. Increase vent rate by opening the manually operated air vent valve and recheck thermometer.

2. Insufficient steam pressure reducing valve improper operation or hookup. Check valve for free operation and make certain that control line is connected to the fitting provided on the deaerator for this purpose and not to the piping downstream of the valve. Ensure that adequate steam is available.

3. Improper spray from nozzle. Check nozzle for sediment, deposit on seat, a broken spring or other damage.

4. Excessive free air due to leaking stuffing boxes on pumps upstream of deaerator which have negative suction head. Repair stuffing box or seal with water or install free air vent trap in water inlet line to deaerator.

B. Symptom

High Water Level/Low Water Level

Cause & Remedy

Improper operation of level controls or inlet control valve. Adjust as necessary.

C. Symptom

Unable to maintain deaerator pressure.

Cause & Remedy

1. Check for faulty operation of steam pressure reducing valve.

2. Check relief valves on the deaerator and in the main steam supply system for proper operation.

3. Check for adequate steam supply to deaerator.

D. Symptom

Excessive steam pressure losses through deaerator. Check pressure gauge on steam supply and compare with pressure gauge on deaerator shell. The difference in pressure should not exceed 1-2 psi.

Cause & Remedy

Sediment and deposits. Check trays. Remove and clean if necessary.

Chemical Treatment

Chemical treatment companies all have different viewpoints about boiler water treatment. Thermaflo Engineering, Inc. is not responsible for chemical treatment and its effects to our equipment. If we suspect in any way that a chemical company has incorrectly applied chemical, the warranty is void. It is the full 100% responsibility of

SHUTTING DOWN

To remove the deaerator from service, proceed as follows:

1. Close all water, condensate and trap return inlet valves.

2. Close the steam inlet valve and steam pressure reducing valve, if any.

3. Open vent valve wide.

4. Close the pump supply valve.

5. If the unit is to be out of service for an appreciable period, drain the storage tank through the drain valve.

CAUTION NOTE

WATER HAMMER

Severe water hammer can damage equipment. The following precautions should be taken to minimize:

1. Avoid abrupt changes in operating conditions.

2. Provide adequate proportional band for flow and pressure control.

3. Design water piping to minimize any pockets or traps where steam may form or accumulate during periods of zero, or low flow.

4. Make certain that check valves and other devices to prevent drainage of piping are properly installed and operative.

5. Continued water hammer without attention voids the warranty.

OPERATING CONDITIONS CONTRIBUTING TO WATER HAMMER

A pressurized system containing water at a temperature equal to the corresponding steam pressure must have its flow and pressure conditions changed slowly to avoid water hammer. "Slowly" is a function of time (from seconds up through minutes) which will vary with each plant and with the various pieces of control equipment in the system.

Water hammer damages equipment and results from changes in velocity components, such as those occurring when steam is collapsed or large volumes of hot water are permitted to flash to steam, causing a mixture of water and steam in vessels and piping, which disrupts their normal flow paths in the system. Steps should be taken to avoid operating conditions described below which may cause water hammer:

1. DECREASING STEAM PRESSURE

   A decrease in the operating pressure of a deaerator can be caused by:

   A. Insufficient steam flow to heat incoming water.
   B. Planned decrease in operating pressure.

   EFFECT

a. Pressure drops below the flash point of the water stored in the deaerator, causing false level indication and/or measurement in the storage tank.
b. Flashing can occur downstream of the unit to the boiler feed pump if the pressure is decreased too rapidly, causing the pump to receive a mixture of water and steam bubbles.
c. If the incoming water is at a temperature above the boiling point corresponding to the reduced pressure, flashing will occur in the water inlet piping upstream of the deaerator.
d. Level control equipment will hunt wildly, aggravating the problem.

e. Oxygen will not be removed under all operating conditions.

REMEDY

Change operating conditions slowly to allow control equipment to respond, avoiding loss of pressure flashing of large quantities of water. This time will be a function of the flow rate through the system and the response time of the control equipment.

2. LONG IDLE PERIODS

A period of no water flow into the deaerator can cause the following:

A. Water can drain from distributors and inlet piping and be replaced by steam.
B. The water will be boiled out of the distributor, leaving steam.
C. Leaky check valves can permit flow back, draining inlet piping.

EFFECT

Rumbling, water hammer and possible damage on startup.

REMEDY

When re-establishing flow, do so at a slow rate. Make certain valving (especially, check valves) are seated properly and tight. Long idle periods cannot be avoided, but the problems associated with them can be minimized by having all water inlet piping come from below the unit and not above the water inlet connections.

3. RAPID INCREASE IN WATER FLOW RATE

A rapid increase of flow can be caused by:

A. Level control equipment not adjusted to a wide enough proportional band to smooth out surges by using some of the water in storage.
B. Uncontrolled dumping of water to the deaerator.
C. An oversized inlet regulating valve.
D. Excessive water pressure at the inlet side of the “inlet regulating valve”.

EFFECT

a. See No 1, rapid decline in steam pressure, Cause "A".
b. Flooding of unit if flow rate exceeds overflow capacity or if pressure is decreasing and level control equipment is hunting due to flashing and turbulence in the storage section.
c. If unit has been idle, flashing and rumbling in water inlet line and distributors.

REMEDY

a. Adjust water inlet control to start flow into unit at a slow enough rate to avoid rumbling or flashing in the water inlet system.
b. Adjust steam control equipment to respond to the highest surge rate expected.

c. Adjust level control proportional band to admit water slow enough to avoid collapsing large volumes of steam which may be in the inlet water lines and distributors, and to allow sufficient time for the steam control equipment to respond.
d. Overflow equipment capable of handling maximum dumping rate of water.

MAINTENANCE

GENERAL

When the unit has been shut down, drained, and cooled sufficiently in accordance with all safety precautions, remove the manhole cover plate, loosen bolts on upper tray retaining bar and slide bar upward so that the trays can be removed. Inspect and, if necessary, clean the trays and storage space. Inspect, clean, and repair or replace any parts such as spray nozzles, trays, etc. which are broken or show excessive wear.

TRAY CLEANING

Remove the trays from the tray compartment and inspect for deposits or damage. If appreciable deposits are present, remove them by dipping the trays in a 10% solution of inhibited muriatic acid (35% HCL diluted to 10% strength). Muriatic acid which is already provided with an inhibitor can be purchased from most chemical suppliers. In purchasing the muriatic acid, specify "to be inhibited to prevent attack of steel while dissolving calcium carbonate scale". Muriatic acid as purchased will contain approximately 35% HCL. After cleaning, the trays should be washed in plain water or dipped in a 10% solution of soda ash to remove the acid solution. **ALL SAFETY PRECAUTIONS TO MINIMIZE THE DANGER OF HANDLING ACID MUST BE OBSERVED IN THE PERFORMANCE OF THE CLEANING OPERATION.**

SPRAY NOZZLES

(TSB-24 through TSB-48 only):

The spring-loaded spray nozzle should be inspected to make sure that it is free of sediment and deposit. The valve seat must be kept free and clean to insure effective spraying of the water. The spray nozzle is removed by loosening the nuts on the water inlet head and removing the two 1/2" diameter lock nuts on the spray nozzle.

(TSB-54 through TSB-120 only):

To remove and inspect the spring-loaded nozzles, the trays and the access door cover in the preheater section floor must be removed. The cover is held in place by several nuts. After the nuts and cover are removed, access is gained to the preheater compartment. The spray nozzles are removed by loosening the two nuts on each spray nozzle.

Note: When re-installing spray nozzles, make sure new gasket is seated properly. Install nozzle using two new lock-nuts and do not over-tighten.

(All Models):

During operation gauge glasses, pressure gauges and thermometers should be kept clean. Thermometers and gauges should be checked periodically for accuracy. A quick check can be made by switching the thermometers and noting any change in the temperature or the difference in temperatures recorded when

the thermometers are reversed. Another quick check on thermometer accuracy can be made by immersing the thermometers in boiling water. The indicated temperature should be the boiling point of the water.

Protective devices, such as the relief valves, vacuum breakers, etc., should be hand-operated or tripped periodically to ensure proper operation. Follow all safety precautions as outlined on pages 1-4 before operating equipment.

RECOMMENDED PROCEDURE FOR STORAGE

INTERNAL MAINTENANCE

Vapor Absorption All openings are to be sealed and taped and a vapor absorbing chemical installed in the shell. Activated alumina or equivalent in quantities of three pounds for every 100 cubic foot of vessel is normally used.

A rust inhibiting chemical may be used in lieu of or in conjunction with the vapor absorbing chemicals. Application by spray or brush is recommended. The rust inhibitor should be water soluble and is usually removed during the initial flush out. This method is suited for storage periods of six to twelve months depending upon the environment. Longer periods would require that the vapor absorbing chemical be replaced. Some rusting will occur when using this treatment.

Nitrogen Blanketing

WARNING: See the safety section of this manual before entering a nitrogen blanketed vessel.

No internal preparation of the vessel shell is required. This method requires that all openings are tightly sealed, gasketed and/or welded shut.

Dry nitrogen (or other inert gas) is used to purge the vessel until the dewpoint is below that expected at the site. Then the vessel is pressurized to 1/4-1 psi and all air vented.

Blanketed vessels may be stored in any environment for indefinite periods, but a daily checking of the pressure must be made and the nitrogen cylinders replaced as required.

EXTERNAL PREPARATION

EXPOSURE	SUGGESTED PAINT SYSTEM			
	PRIMER COAT		SECOND COAT	
	FIRST COAT	SECOND COAT	FIRST COAT	SECOND COAT
1-Dry Interior Climate	Red Oxide Primer	Not Required	Not Required	Not Required
2-Rural or Light Industrial Areas	Red Oxide Primer	Not Required	Not Required	Not Required
3-Frequently Wet Climates	Red Oxide Primer	Red Oxide Primer	High Build Polyamide	Not Required
4-Continuously	Inorganic Zinc	Inorganic Zinc	High Build Polyamide Epoxy	Not Required
	Inorganic Zinc	Inorganic Zinc	High Build Polyamide Epoxy	High Build Polyamide Epoxy

Wet Climate

5-Corrosive Areas

NOTE: Check contract with Thermaflo Engineering, Inc. for actual paint system used. Thermaflo Engineering, Inc. typically furnishes only a primer coat because shipping may damage paint finish. Second coat applied at storage site by customer when required.

WARNING: Paints may contain poisonous fumes. Always make sure paint is applied in a well ventilated area.

In selecting the type of external preparation, consideration must be given to the environmental conditions and maintenance provisions available. Exposure environments are arranged in the table in order of increasing severity.

Paint systems for condition No. 1 usually consist of a single coat of red oxide primer. For the remaining conditions, paint systems would normally consist of one or two coats of rusting inhibiting primer and one or two finish coats, depending on the severity of the conditions. Before selecting painting systems and materials for conditions No. 3 through 5, consideration must be given to the specific climate condition at the storage site.

Where day-night temperature changes exceed 30° F, special attention should be given to the preparation of the metal surface and selection of the primer paint. Under these conditions, the metal surfaces should be blast cleaned to remove all mill scale which might otherwise flake off due to expansion and contracting of the vessel. The type of primer and finish system selected should be compatible with the particular expansion characteristics of the vessels and the final operating temperatures.

SUGGESTED PRIME AND FINISH COATS

Primer Coat:	Red Oxide Primer Inorganic Zinc	Sherwin Williams Company Carboline Corporations
Finish Coat:	Polyamide Epoxy No. 500 Series	Porter Company Zinc-Lock

Surface Preparation

Application and dry film thickness are to be in accordance with the manufacturer's recommendations for the paint selected.

MAINTENANCE REQUIREMENTS

Short-Term Storage (up to 12 months)

The absorption material should be removed after 3 months or replaced as required. Remove saturated absorption materials and replace with dry absorbent from unopened sealed container. The exterior portions of the shell are to be visually inspected periodically.

Long-Term Storage (over 12 months)

The inert gas cylinders and vessels must be checked weekly for any loss of pressure and replaced as required. The exterior portions of the shell are to be visually inspected periodically and the finish repaired as required using the finish paint specified.

EQUIPMENT

SHELL

The deaerator shell is a vertical cylindrical unit of steel construction and is mounted on a horizontal, cylindrical, welded steel storage tank.

SPRING-LOADED SPRAY NOZZLES (TSB-24, 30, 36, 42, 48) JS Series

The water preheater consists of a single inlet spray nozzle for projecting the inlet water into the steam atmosphere of the deaerator. The nozzle divides the water into a spray throughout the preheater section of the deaerator.

(TSB-54 thru 120)

The water preheater consists of an inlet connection and, an internal chamber with multiple spray nozzles. The inlet chamber delivers water to the spray nozzles. The nozzles spray the inlet water into the steam atmosphere of the deaerator.

The preheater should be inspected periodically to make sure that it is free of sediment and deposit. Spray nozzles should be inspected for any undue erosion, worn or broken parts. Spray nozzle seats must be kept clean to ensure even distribution of water in the preheater.

WATER SEAL

The water seal is a steel trough which receives the water from the pre-heating compartment through the downcomers and distributes it over the trays.

TRAYS

The tray compartment is provided with stainless steel trays. When handling stainless steel trays, Thermaflo Engineering, Inc. recommends that the installing personnel wear gloves to avoid cutting their hands on the sharp edges of the trays.

The trays should be installed in stacks which are side by side with their long dimensions at right angles to the tray supporting beams and the spilling edges of the water seal.

Refer to the tray installation instructions in this manual for installation instructions for the trays. Refer to the table on page 27 for the correct stack height and quantity of trays for your deaerator.

DIRECT CONTACT VENT CONDENSER AND PREHEATING COMPARTMENT

To ensure complete deaeration and to prevent air blanketing, it is essential that a continuous sweep of steam be maintained through the deaerating and the direct contact vent condensing preheater sections. During normal operation, a steady plume of vented vapors and steam should be discharged continuously from the vent valve on the deaerator top.

Insufficient venting will result in air blanketing. This condition is cumulative and will eventually lead to incomplete deaeration. Adjustment of the vent valve to increase the vent rate will remedy this condition.

REGULATING VALVES

Inlet water regulating valves are utilized to control the water flow to the deaerator. For those installations in which the pressure differential across the valve at shut-off is low, a double disc regulating valve is used. When higher pressure differentials are encountered across the valve at shut-off, a pilot actuated or air-operated diaphragm type regulating valve is used.

Double Disc Type

This valve must be installed in a horizontal line. With the valve closed, the upstream pressure is imposed on the underside of the upper disc and the top side of the lower disc, partially balancing the moving parts. Valves are of the rising stem type. The yoke carrying the link and the guide for the operating lever is held to the bonnet by a lock nut and can be set in any position.

Pilot-Actuated Type

These single seated, internal pilot type, lever valves are used wherever a tight closing mechanical valve is required. Installation must be in a horizontal line with the arrow marked on the body casting pointing in the proper direction. The valve linkage may be rotated 360° .

When a 1" or 1 -1/2" valve is closed, upstream pressure is applied on the top side of the main valve disc, holding the disc on its seat. When the operating lever is raised, the pilot valve is opened; thus, releasing the pressure above the piston. The upstream pressure is applied to the underside of a piston, which forms the upper section of the valve disc, and raises this disc from its seat.

In the 2" and larger valves, the upstream pressure is under the valve disc. The basic operation is the same as the smaller valves; however, this design utilizes the inlet pressure to open and close the valve. This method is used on the larger valves to prevent sudden closing when the valve disc approaches its seat.

Air-Operated Type

This type valve is maintained open by a spring and is closed by the application of air pressure to the top of the diaphragm. The valve throttles as the valve movement is controlled by air pressure supplied by the pilot valve of the level controller. The controller can be either the float box or the displacement type and responds to water level variations in the deaerator. This valve opens on loss of air pressure, but it can be furnished so that it closes on loss of air pressure.

The controller is located at an elevation corresponding to the working water level in the deaerator. Instructions for adjusting the sensitivity of control and the liquid level range are

contained in the cabinet housing the control equipment. The sensitivity of control should be adjusted according to the operating and load conditions of the installation. If the sensitivity of the control is too great, i.e., snap acting, the regulating valve will tend to open and shut excessively at constant loads. Oscillation from full open to closed or full load to no-load operation of the deaerator will result from a low continuous demand from the storage section. This condition should be avoided because the load fluctuations imposed on the deaerator by the control rather than the load demand will result in unsatisfactory operation of the equipment and reduced deaeration. If the sensitivity of the control is not great enough, the regulating valve will lag behind load demands. In the change from a low load to a high load, much or all of the storagecapacity may be required if the control is not adequately sensitive. In the change from a heavy demand to practically no demand, the control may lag to the extent that the overflow level is exceeded. The sensitivity of control should be adjusted so that any momentary load surges will be dampened or averaged out by the lag in inlet regulation, but any permanent load change will be anticipated in sufficient time to prevent a dangerous drainage of available storage capacity or an overflow condition.

CONNECTING REGULATING VALVES TO FLOAT CONTROL

Bring the level in the storage tank up to the "closing line" and open the gate valves in both the water and steam equalizing lines and let the water level rise in the float control to the same level as in the storage tank.

Connect the float lever and the valve lever by means of the reach rod. Loosen the float lever from the float spindle by backing off the lock-nut on the float spindle. Then, while the weight of the float is not affecting the assembly, bring the system into balance by moving the counterweight.

With water in the tank and in the float control (if used) at the closing line, move the regulating valve to the shut position and secure the float lever to the float spindle.

The customer is required to make up the loose ends of the reach rod which is furnished with extra length to permit cutting and fitting to suit. Before cutting the reach rod, be certain that the float is in the down position with the lever arm up and that the regulating valve is in the open position that is with the counterweight in the down position and the lever arm in the up position. Then measure, cut, and fit the reach rod.

RELIEF VALVE (SEE PAGES 1-4 FOR SAFETY PRECAUTIONS)

A relief valve connection is furnished on the top head of the vessel. The relief valve whether furnished by Thermaflo Engineering, Inc. or by others is provided to give warning of excess pressure in the deaerator, particularly when the deaerator is out of service and high pressure returns (such as trap discharges) have not been shut off. **THIS RELIEF VALVE PERFORMS ONLY A WARNING FUNCTION AND IS NOT CAPABLE OF PROVIDING OVER PRESSURE RELIEF FOR THE VESSEL OR THE STEAM SYSTEM.** The deaerator and steam system as a whole must be protected from excess pressure by large capacity relief valves such as a Thermaflo Engineering, Inc. Multiport Relief Valve in the steam supply to the deaerator.

The relief valve should be operated by hand or ASME periodically and while starting up the deaerator. This will serve as a check to indicate free movement and proper operation of the

valve.

OVERFLOW PROTECTION (SEE PAGES 1-4 FOR SAFETY PRECAUTIONS)

The deaerator is provided overflow protection by means of a drainer, a double disc overflow trap, a loop seal overflow, or an air-operated valve.

It should be noted that whether or not the hot overflow goes to waste, no valve should be put in the discharge line. A closed valve in the overflow discharge line would permit the water level in the deaerator to build up and overflow into the steam inlet line with probable damage resulting to the auxiliaries supplying the steam.

When the overflow discharges to waste, a significant quantity flashed steam will be produced. Consideration should be given to carefully anchoring the overflow piping and to the possible damage to sewer piping. **IF THE DISCHARGE IS INTO AN OPEN FUNNEL CONNECTION TO THE SEWER, THERE IS ALSO THE POSSIBILITY OF FLASHED STEAM INJURING AN OPERATOR.** The discharge should never be admitted to a common drain line carrying low temperature drainage water because serious water hammer may result due to the condensation of the flashed steam. For these reasons the installation of a blowdown tank to receive the discharge should be considered.

Drainer

The Thermaflo Engineering, Inc. Multiport Drainer is a rotary valve, floaAT-actuated trap. Water in the overflow pipe enters the body of the drainer and raises the float which opens the rotary valve. The valve remains open until the water level in the drainer body is lowered and the skimmer or overflow standpipe is drained, dropping the float and closing the valve.

Care must be taken to keep the overflow lines free of debris before installing the drainer. The drainer is installed with the elevation of the top of the drainer below the overflow level. Periodically the drainer should be tripped by hand or the tank should be allowed to overflow to make sure that the valve operates freely.

When this type of overflow control is in its closed position, a small amount of steam vapor may be observed at the outlet. This is normal.

Overflow Trap

The valve construction of the double disc overflow trap is similar to the corresponding type of regulating valve. This type of overflow trap is for deaerators operating under 15 psig. Care must be taken to keep the overflow lines free of scale and debris before installing the overflow trap. The double disc overflow trap is installed with the elevation of the top of the float chamber below the overflow level. The top of the float chamber is to be equalized to the steam space of the chamber from which overflow is taken. Periodically the tank should be allowed to overflow to make sure that the valve operates freely. When this type of overflow control is in its closed position, a small amount of steam vapor may be observed at the outlet. This is normal.

Air-Operated Overflow

The air-operated diaphragm type overflow valve is maintained open by a spring and is closed by the application of air pressure to the top of the diaphragm. At normal operating levels in the deaerator storage section, the valve is held closed by air pressure on the diaphragm.

An increase in water volume to the overflow level actuates the normally energized mercoid switch. This increase of level in the switch float chamber, raises the float which in turn de-energizes the solenoid valve, and allows the air from the diaphragm to bleed off and open the overflow valve.

INSTRUMENTS (supplied only when ordered)

Thermometers

Thermometers are the local indicating type. They are supplied to indicate the steam temperature in the deaerating space and the temperature of the deaerated water in the storage section. The scale and range of these thermometers are dependent upon the operating characteristics of the installation. Thermometers are of the separable socket type and are attached to the separable sockets by union connections.

The thermometers serve as a check on deaeration. The water thermometer should register a temperature which is within one or two degrees of the steam thermometer temperature. If the thermometers are accurate and the difference in their readings is greater than one or two degrees, increase the opening of the air vent valve so that non-condensable gases are released to the atmosphere.

If the thermometers are not supplied, plugged connections for the thermometers are provided on the deaerator.

Pressure Gauges

The pressure gauges are the Bourdon tube type commonly used to indicate steam pressure. A pressure gauge is desirable to indicate the operating pressure in the steam space of the deaerator.

If a pressure gauge is not supplied, a plugged connection for the pressure gauge is provided on the deaerator.

Special Devices

Low level and high level alarm switches can be provided. These alarm switches, used in conjunction with a warning device, alert the operator of an abnormal level condition.

REPAIR AND REPLACEMENT ORDERS

The handling of repair and replacement orders will be facilitated if the following instructions are carefully followed:

1. Indicate the shop order (S.O.) number as it appears on the nameplate of the deaerator.

2. Designate the parts required by the item number and name which appear on the parts illustrations or reference prints.

3. When ordering parts for accessory equipment such as valves for controls, describe briefly and provide the serial number of the accessory.

4. Specify the quantity of each part required.

5. Give complete shipping instructions.

Thermaflo Engineering, Inc. has representatives nationwide who will be glad to assist you, and to whom orders for parts should be given to ensure prompt and efficient handling.

In returning parts to the Thermaflo Engineering, Inc. Plant, be sure that all parts are accompanied with a "return material tag" (RMT). Contact Thermaflo Engineering, Inc. service department for issuance of RMT.

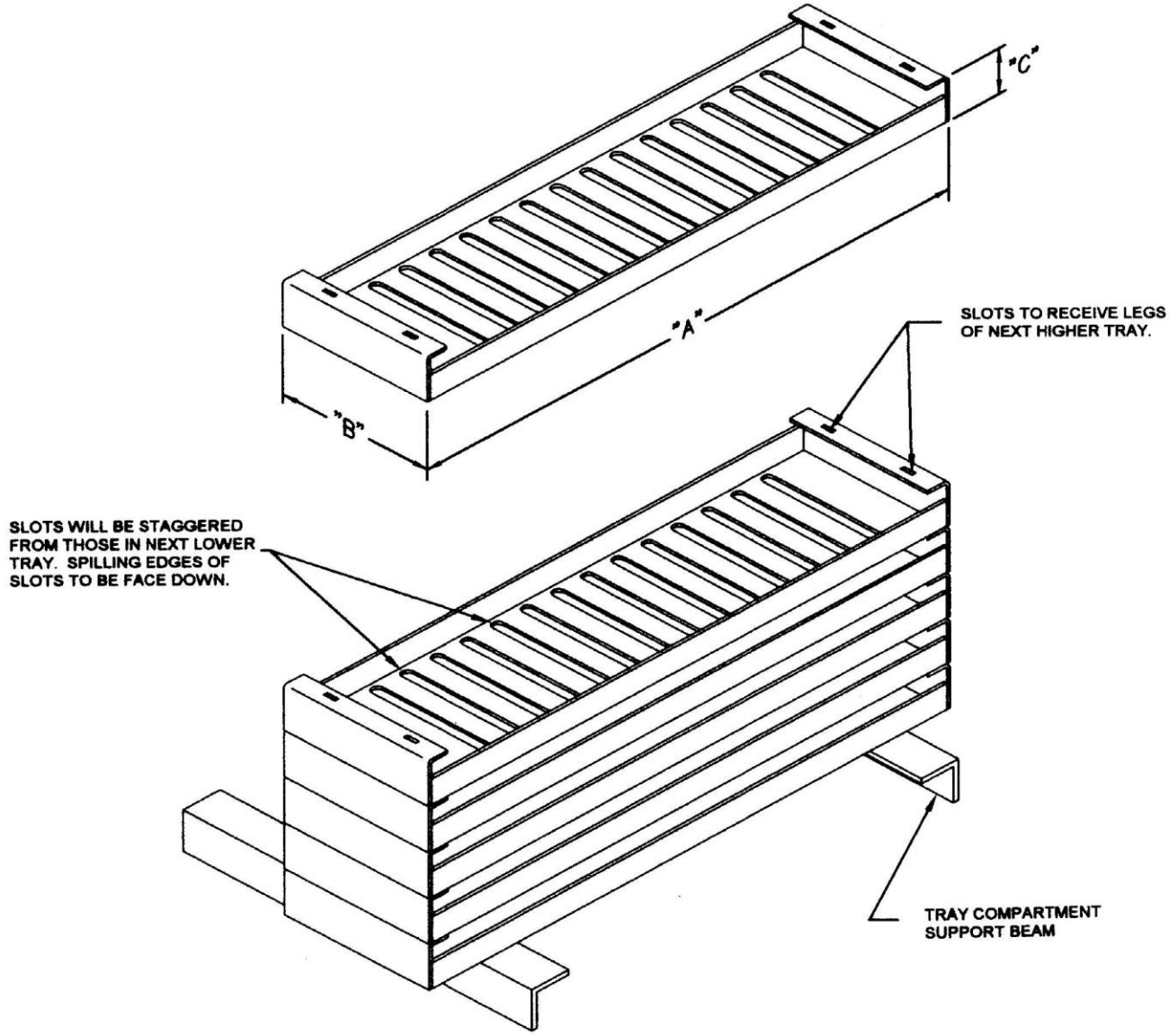
Deaerating Tray Data			
Deaerator Size TSB-Series	Tray Size (inches)	Number of Trays High	Total Number of Trays
TSB-24	6 x 18	24	48
TSB-30	6 x 18	24	72
TSB-36	6 x 24	24	96
TSB-42	6 x 30	24	96
TSB-48	6 x 30	24	120
TSB-54	6 x 36	24	144
TSB-60	6 x 36	24	168
TSB-66	6 x 36	24	192
TSB-72	6 x 24	24	384
TSB-78	6 x 24	24	432
TSB-84	6 x 30	24	432
TSB-90	6 x 30	24	480
TSB-96	6 x 36	24	480
TSB-102	6 x 36	24	528
TSB-108	6 x 36	24	624
TSB-114	6 x 36	24	672
TSB-120	6 x 36	24	720

Note: *Tray sizes and stacking arrangements may vary with custom deaerators.*

Deaerator Tray Outline

SIZE OF TRAY	NOMINAL DIMENSIONS		
	A	B	C
6" X 36"	36"	6"	1"
6" X 30"	30"	6"	1"
6" X 24"	24"	6"	1"
6" X 18"	18"	6"	1"

MATERIAL: STAINLESS STEEL



TRAY HOLD-DOWN DEVICE INSTALLATION

GENERAL NOTE: AS YOU READ THROUGH THE FOLLOWING STEPS, REFER TO DETAIL “A” or “B” FOR PROPER CROSSSECTIONAL VIEW OF YOUR UNIT.

1. REMOVE TRAY DOOR OR MANHOLE COVER. (CHECK GASKET. REPLACE IF NECESSARY.)

2. LOOKING THROUGH THE OPENING YOU SHOULD SEE A SLIDE ENCLOSURE PLATE OR AN INTERNAL ACCESS DOOR. REMOVE THIS DOOR AND PLACE IT INSIDE OF TANK.

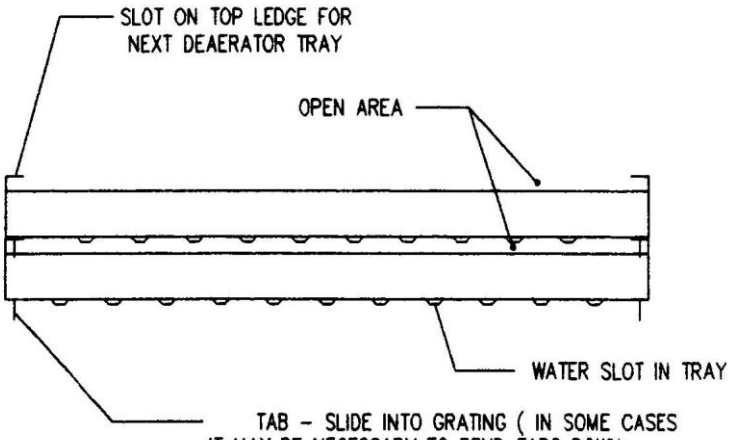
3. LOOKING DOWNWARD, THERE SHOULD BE SOME LOOSE PIECES OF GRATING. REMOVE ALL LOOSE PIECES UNTIL ONLY ONE SOLID PIECE OF GRATING REMAINS. IN MOST CASES, THIS SECTION OF GRATING IS TACK WELDED TO STRUCTURAL STEEL SUPPORT ANGLES. THE LOOSE PIECES OF GRATING, WHICH ARE REMOVED (OR SHIPPED SEPARATELY), ARE YOUR TOP SECTIONS OF GRATING.

4. WITH ALL TOP SECTIONS OF GRATING REMOVED, YOU ARE NOW READY TO INSTALL THE DEAERATOR TRAYS. BEFORE INSTALLING, REVIEW CAREFULLY DETAIL "C". IN GENERAL, DEAERATOR TRAYS ARE 6" WIDE X 1” HIGH X EITHER 18”, 24”, 30”, OR 36” LONG AND SHOULD ALWAYS BE STACKED 24” HIGH. IN SMALLER DEAERATOR UNITS (SEE DETAIL "A") THERE IS ONLY ONE BANK OF DEAERATOR TRAYS. IN LARGER DEAERATOR UNITS (SEE DETAIL “B”), THERE ARE TWO (2) BANKS OF TRAYS NEARSIDE AND FARSIDE. FOR MORE DETAILED INFORMATION SEE “TRAY INSTALLATION INSTRUCTIONS” WHICH IS SHIPPED WTH DEAERATATOR TRAYS.

5. NOTE FOR TSB-30 THROUGH AT-60 DEAERATORS (DETAIL “A”)
AFTER ALL TRAYS HAVE BEEN INSTALLED, SLIDE TOP SECTION OF GRATING ACROSS TRAYS AND UNDER SLIDING ANGLE ON FARSIDE- LOWER SLIDE ANGLE TO MEET GRATING AND TIGHTEN ½” BOLTS. REPLACE SLIDE ENCLOSURE. LOWER IT UNTIL IT RESTS ON GRATING AND TIGHTEN ½” NUTS. THIS SLIDE ANGLE AND SLIDE ENCLOSURE PLATE WILL HOLD THE TRAYS BETWEEN THE TWO SECTIONS OF GRATING CAUSING A SANDWICH EFFECT. REPLACE MANHOLECOVER. THIS COMPLETES THE TRAY HOLD-DOWN DEVICE INSTALLATION.

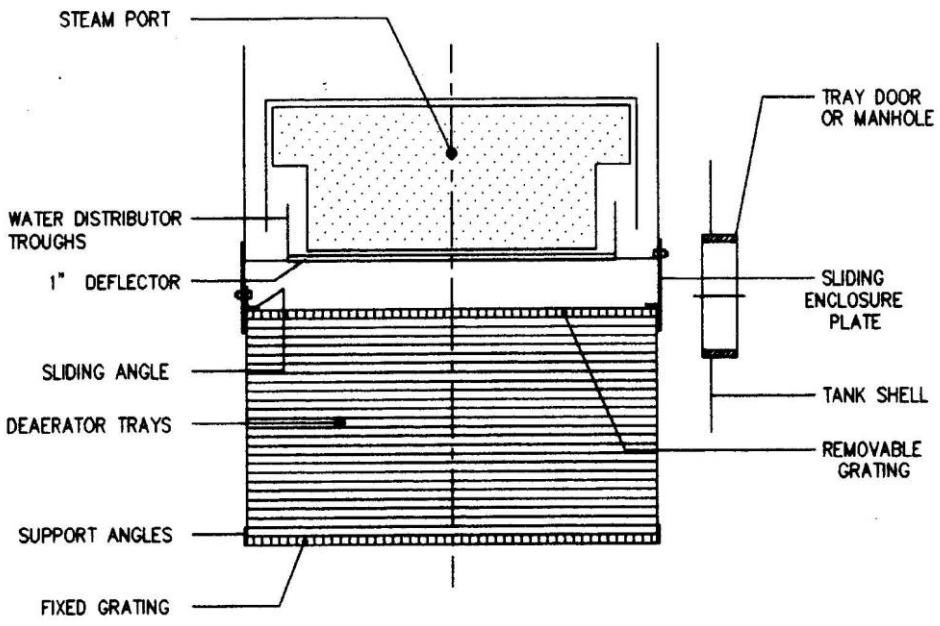
6. NOTE FOR TSB-72 AND LARGER DEAERATORS (DETAIL “B”)
AFTER ALL TRAYS HAVE BEEN INSTALLED ON FARSIDE OF TRAY BOX, SLIDE TOP SECTIONS OF GRATING (WITHOUT WELDED LIP ON THEM) ACROSS TOP OF TRAYS AND UNDER SLIDE ANGLE ON FARSIDE. LOWER ANGLE TO MEET GRATING AND TIGHTEN ½” BOLTS. INSTALL ALL TRAYS ON NEARSIDE OF TRAY COMPARTMENT AND SLIDE TOP SECTIONS OF GRATING (WITH LIP) SO LIP OVERLAPS FARSIDE GRATING, (REFER TO DETAIL “B” FOR A PICTORIAL VIEW). SLIDE FLAT PLATE WITH CUPS UNDER THREADED RODS AND LOWER RODS INTO CUPS LOCATED ON FLAT BAR BY TURNING ADJUSTMENT NUT TO A SNUG FIT. REPLACE SLIDE ENCLOSURE PLATE AND LOWER UNTIL IT RESTS ON GRATING AND TIGHTEN ½” NUTS. THE SLIDE ANGLE THREADED RODS AND SLIDE ENCLOSURE PLATE WILL HOLD THE TRAYS BETWEEN THE TWO SECTIONS OF GRATING CAUSING A SANDWICH EFFECT. REPLACE MANHOLE COVER. THIS COMPLETES THE TRAY HOLD-DOWN INSTALLATION.

HOLD DOWNS MAY VARY WITH CUSTOM UNITS CONSULT FACTORY



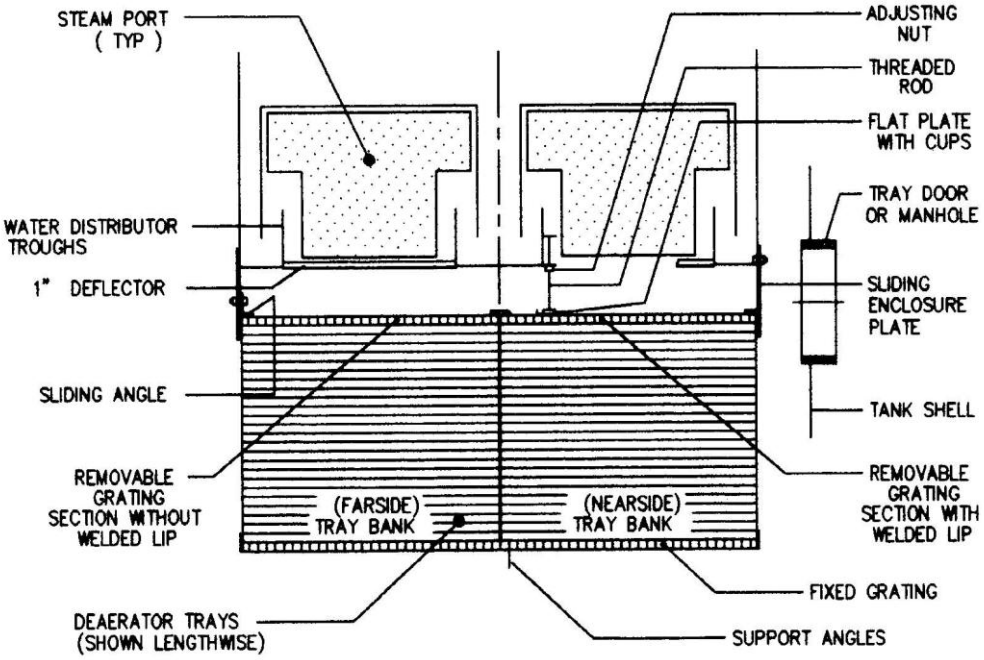
TO INSURE PROPER INSTALLATION OF DEAERATOR TRAYS,
THE DEAERATOR TRAY TABS ALWAYS POINT DOWN AND
THE TABS SLIDE INTO THE UNDERLYING TRAY.

DETAIL "C"
TRAY INSTALLATION



DETAIL "A"

FOR DEAERATORS 60" DIA OR LESS
(T-30 THRU T-60)
(SINGLE TRAY BANK)



DETAIL "B"

FOR DEAERATORS 72" DIA OR GREATER
(T-72 AND LARGER)
(DOUBLE TRAY BANK)

Spring-Loaded Spray Nozzle

1	2	3	4	5	6	7	8	9	10	ITEM NO.
BODY	SPREADER	LOWER BODY	SPRING	STEM	BUSHING	JAM NUT	GASKET	SPRING RETAINER	ELASTIC HEX NUT	NAME
1	1	1	1	1	1	2	1	1	2	QTY.

SUPPLIED WITH EACH VALVE

- TWO HEX NUT – ½"X 20NF
  MAT'L: SILVER PLATED
  304 ST'N ST'L ELASTIC
  STOP NUT
- ONE SOLID TEFLON GASKET
  UNLESS OTHERWISE SPECIFIED