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REVISION 1

NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 255 - VOLUME 2

FEEDWATER SYSTEM AND APPARATUS - DEAERATING FEED TANKS

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FEEDWATER SYSTEM AND APPARATUS DEAERATING FEED TANKS

SECTION 4.

GENERAL INFORMATION

255-4.1 INTRODUCTION

255-4.1.1 INTENT. The purpose of volume 2 is to provide to the fleet general information about the operation, maintenance, and repair of the deaerating feed tank (DFT). The user should augment this general information by referring to the following publications for additional and specific information on the DFT:

a. Ship Information Book, Volumes 1 and 2

b. NAVPERS 10788, Principles of Naval Engineering

c. Ship General Specifications, General Specifications for Overhaul (GSO), and MIL-H-15787, Heaters (Tanks), Fluid, Deaerating, Boiler Feed Water, Naval Shipboard Use .

d. Manufacturers' Technical Manuals and Instruction Books.

255-4.1.2 SCOPE. This volume covers only the deaerating feed heaters used in the feedwater systems of naval shipboard steam generators. The DFT's relation to the rest of the propulsion system is discussed only to the extent required to explain its function. The feed and condensate system of which it is a component, is covered in NSTM Chapter 255, Volume 1, Feed and Condensate Systems .

255-4.1.3 REFERENCES. The following NSTM chapters are referred to in this volume:

a. Chapter 050 - Readiness and Care of Inactive Ships

b. Chapter 220 - Boiler Water/Feedwater - Test and Treatment, Volume 2

c. Chapter 221 - Boilers

d. Chapter 254 - Condensers, Heat Exchangers, and Air Ejectors

e. Chapter 503 - Pumps

f. Chapter 504 - Pressure, Temperature, and Other Mechanical and Electromechanical Measuring Instruments

g. Chapter 505 - Piping Systems

255-4.2 BACKGROUND

255-4.2.1 DESCRIPTION. The heart of a steam powered ship's propulsion system is the steam generator, or boiler, which supplies steam power to the turbines. Efficiency and other considerations dictate that the watersides of the steam generators be kept perfectly clean. Consequently, its wetted heat exchange surfaces are extremely vulnerable to any oxygen dissolved in the feedwater. The temperature of boiler water far exceeds that required to drive every bit of dissolved oxygen out of solution. Any such oxygen would immediately attack the inner surfaces of the steam generator.

255-4.2.1.1 This corrosive attack is so aggressive that a steam generator designed to last 20 to 30 years would be rusted through and begin to leak in a matter of months, or even weeks, if the oxygen were not removed from the feedwater.

255-4.2.1.2 The primary function of the DFT is to remove the oxygen from the feedwater before the feedwater enters the boiler. DFT's are designed to perform other tasks in addition to oxygen removal. These are described in paragraph 255-5.1.

255-4.2.2 DEFINITIONS

a. Antivortex Baffle. A plate or plates arranged parallel to the flow of water and placed over a bottom drain. Its function is to keep the water from forming a whirlpool or vortex that could carry bubbles of vapor into the water being pumped out of a DFT and damage the pump. One type of antivortex baffle might resemble the vertical partitions of an egg crate or ice cube tray.

b. Atomizing Valve. A device used in some DFT's that regulates the opening through which steam enters the DFT according to steam mass flow rate. Its purpose is to maintain a uniformly high entering steam velocity over a wide range of flow rates. It does not regulate DFT shell pressure.

c. Augmenting Valve. A pressure-reducing valve that introduces steam from the boilers into the auxiliary exhaust system to maintain auxiliary exhaust pressure.

d. Auxiliary Exhaust. Spent steam leaving the small turbines that power pumps, blowers, etc. aboard ship. The steam contains enough heat to be used in evaporators for making freshwater and in the DFT.

e. Condensate. Condensed steam being returned to a boiler for the regeneration of steam (the water in a DFT before the gases are removed).

f. Deaeration. The complete removal of dissolved gases from water.

g. Feedwater. Water that, by the removal of dissolved scale-forming minerals and corrosive gases, has been made suitable for the generation of steam in a boiler or steam generator (the water in a DFT after the gases have been removed).

h. Monel. The metal from which DFT's and most of their internal parts are made. The alloy is 70 percent nickel and 30 percent copper, and is highly resistant to corrosion.

i. Nozzle. See spray nozzle.

j. Spray Nozzle. A device used in the first stage of deaeration. It resembles a valve in an automobile engine and is held closed by a spring in the same fashion. Water enters the spray nozzle from the stemside of the valve. The water pressure forces the valve off its seat. The narrow gap between the valve and its seat gives the nozzle effect, delivering water downstream of the spray nozzle in a cone-shaped, curtainlike spray. There may be as many as 50 spray nozzles in the largest DFT's.

k. Stripping. The action of separating gases from water by agitation after the solubility of the gases in the water has been rendered unstable by raising the temperature of the water (similar in principle to shaking a bottle of soda pop).

l. Swash Plate. A vertical baffle or metal plate installed inside the water storage section of a DFT. Swash plates limit the sloshing of water in the DFT with the rolling of the ship.

m. Vortex. A whirlpool (see antivortex baffle).

SECTION 5.
DESCRIPTION

255-5.1 GENERAL FUNCTION AND DESCRIPTION

255-5.1.1 FUNCTIONS. Deaerating feed tanks (DFT) accomplish three functions:

a. Remove oxygen and other dissolved gases in the feed water (generally referred to as deaeration) to prevent corrosion of wetted parts of the steam generator or boiler.

b. Preheat feedwater with auxiliary exhaust steam. This recovers both the pure water and the heat of exhaust steam, thus improving the efficiency of the steam propulsion cycle.

c. Provide storage or surge capacity for heated and deaerated feedwater when steam generator demands are changing.

255-5.1.2 DFT COMPONENTS. The DFT is essentially a cylindrical tank composed of three sections:

a. The upper section contains a direct-contact vent condenser and preheater, the condensate inlet chamber, spray nozzles, and various plates and baffles to provide support and collect water for discharge into the middle section.

b. The middle section contains a steam-atomizing assembly to mix steam and water in the DFT.

c. The lower section provides a storage space for the heated and deaerated feedwater. The storage space of the DFT has swash plates to prevent the water from damaging internal parts or creating undue pressure on the shell. These plates may also act as stiffeners for the shell.

255-5.1.2.1 The tank has openings for steam and water connections, access, vents, safety, and control devices.

255-5.1.3 ACCESSORIES. A typical DFT has the following accessories:

a. Vacuum Breaker. A vacuum release device set to open if tank vacuum rises above a predetermined value

b. Relief Valve. A valve set to open if DFT internal pressure exceeds the maximum allowable working pressure

c. Thermometers. One to indicate storage water temperature, another to indicate steam space temperature

d. Level Indicator. A device to indicate storage water level

e. Strainer and Antivortex Baffle. Stationary parts fitted to the outlet of the DFT, from which the booster pumps take suction. The strainer protects the feed system from material large enough to damage the pumps. The antivortex baffle prevents vapors from entering the pump suction with the feedwater.

255-5.1.3.1 A typical condensate and feedwater system with a DFT is shown in Figure 255-5-1. Variations in design are discussed in paragraph 255-5.3.

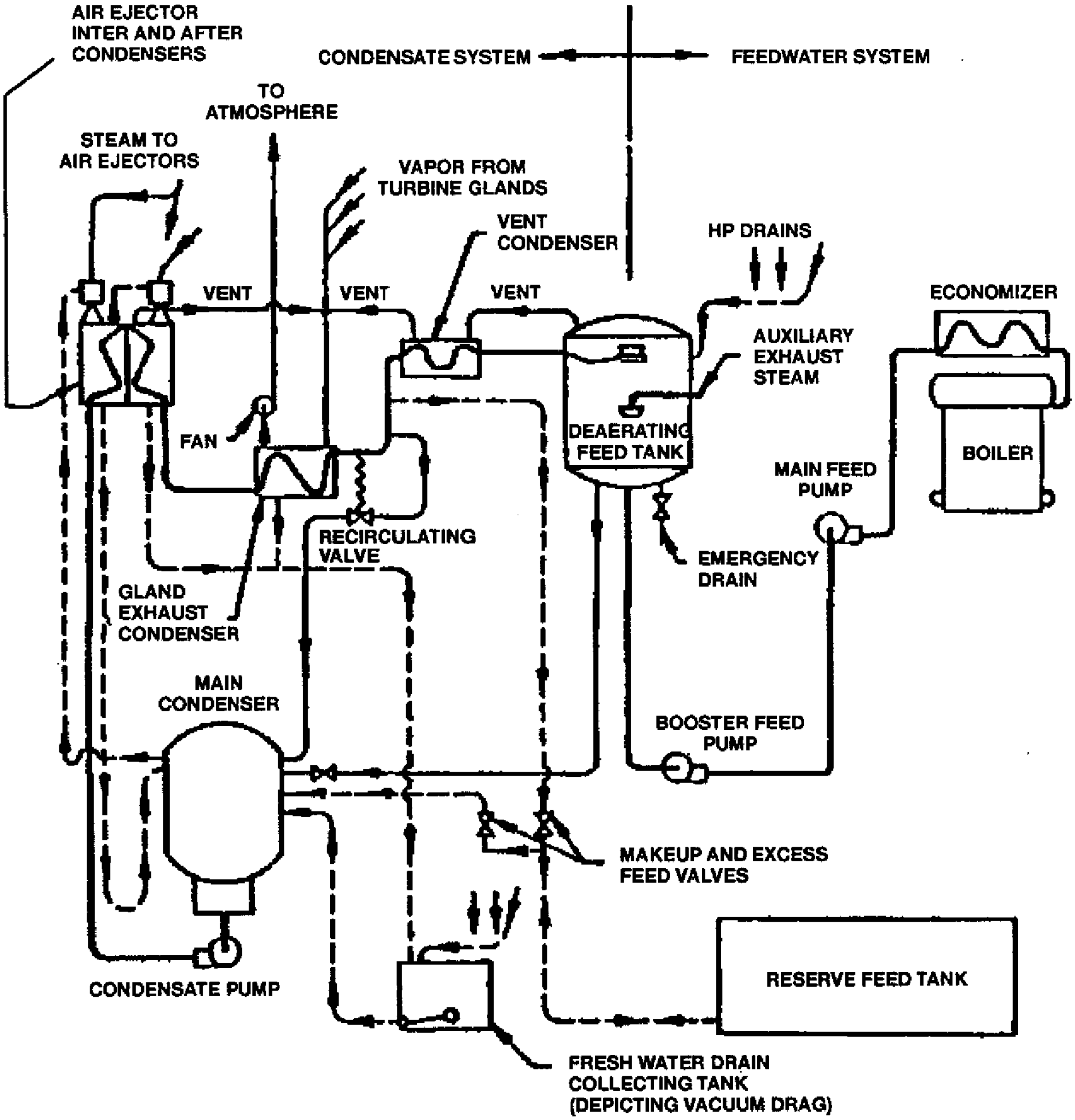


Figure 255-5-1. DFT Functional Relationship

255-5.2 DFT OPERATION

255-5.2.1 PRINCIPLES OF DEAERATION. Condensate formed as a result of extracting and using the energy in the steam from the boilers may be contaminated by exposure to air when it is at a temperature low enough to permit oxygen absorption. This condensate must be passed through the DFT before being readmitted to the boiler or steam generator. Naval shipboard DFT's remove the oxygen and other dissolved gases by the following means:

a. Condensate drawn from the main condenser is pumped into the DFT through spray nozzles in the upper section of the DFT. The spray nozzles break the incoming condensate into fine sheets of spray to maximize the water surface area in contact with the steam supplied to the DFT. The steam heats the condensate by mixing with and condensing into it. The sprayed, heated condensate runs and drips off the internal parts of the upper section into the funnel-shaped partition, which discharges into the middle section.

b. Steam enters the middle section of the DFT in such a way that it blasts through the heated condensate running out of the upper section. While some of this steam condenses into the water coming out of the upper section and provides the last increment of heating to bring the water to its end point temperature, the primary purpose of this middle section is agitation. Heating alone will not remove all the oxygen. The solubility of oxygen in water at various pressures and temperatures is shown in Figure 255-5-2. The combined effect of the mechanical agitation of the steam blasting through the water and the increase in surface area of the droplets of water picked up by the incoming steam completely separates the gases from the condensate. The gases and steam pass into the spray patterns of the upper section's incoming condensate. Gases released from the water are vented from the DFT. The completely deaerated feedwater produced in the middle section runs down into the lower, or storage, section of the DFT.

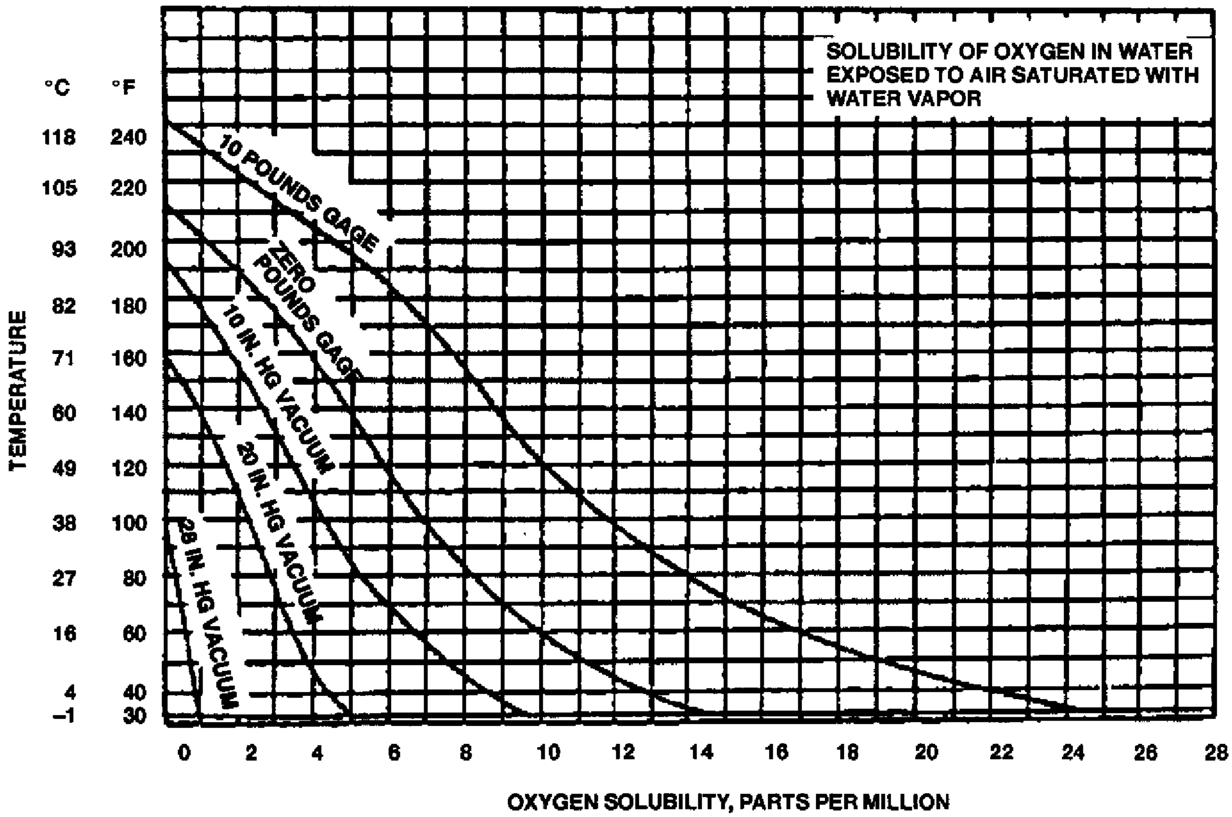


Figure 255-5-2. Oxygen-Dissolving Capabilities of Water

255-5.2.2 DFT STORAGE FUNCTIONS. The storage section is designed to eliminate the need for precise control of DFT water level. Steam pressure in the DFT is controlled by auxiliary exhaust steam pressure. Water is pumped out of the DFT to maintain a constant water level in the boiler(s).

255-5.2.2.1 On some ships water may be dumped from the DFT storage area to a reserve feed tank if a danger exists that the upper or middle sections might become flooded. Ships equipped with automatic control systems dump main condensate before reaching the DFT. If DFT levels drop low enough to risk uncovering the feed pump suction, a valve between the reserve feed tank and the main condenser is opened so condenser vacuum will draw water into the feedwater system. This will increase water levels in the DFT. The larger the storage area, or lower section of a DFT, the more flexible the feed and condensate system is with regard to absorbing surges in power level requirements.

255-5.3 DFT MANUFACTURERS

255-5.3.1 OVERVIEW. There are six manufacturers of DFT's used by the fleet. The basic differences in description and operation are discussed separately. The manufacturers are as follows:

a. Cochrane Crane

b. Elliott Marine

c. Worthington

d. Riley-Beaird

e. Permutit

f. Aqua-Chem.

255-5.3.2 COCHRANE. The Cochrane DFT consists of three sections (Figure 255-5-3). The upper section, contains a direct-contact vent condenser and preheater, condensate inlet chamber, condensate spray nozzles, and various plates and baffles to direct steam and condensate. The middle section contains a heating steam-atomizing valve. The lower section provides storage space for the heated and deaerated feedwater. The tank has openings for steam and water connections, access, vents, a vacuum breaker, a pressure relief valve, two thermometers, and water level indicators.

255-5.3.2.1 Condensate enters the DFT through a side inlet. The condensate is then directed to the condensate inlet chamber to a number of spring-loaded spray nozzles. Condensate is discharged through the nozzles into the upper section as a finely divided spray against the top of the DFT shell. The condensate then falls into the collecting cone, which directs the water to the steam-atomizing valve. The condensate collects in a pan around the atomizing valve disc opening and is blown outward into the middle section by the incoming steam. It then falls into the water storage space below. The main feed booster pump takes its supply through the connection at the bottom of the shell.

255-5.3.2.2 Heating steam enters through the side inlet and passes through a check valve to the steam-atomizing valve. The steam is discharged from the valve at high velocity, atomizing the water collected in the pan around the valve disc. The excess released steam and noncondensable gases are directed upward, between the water-collecting cone and the tank shell, to the upper section. The steam enters into direct contact with, and is condensed by, the incoming condensate coming out of the spray nozzles. The noncondensable gases and a small portion of the steam pass through the nozzle spray and are vented from the upper section through the air outlet connection.

255-5.3.3 AQUA-CHEM AND RILEY-BEAIRD. The Aqua-Chem (Figure 255-5-4) and Riley-Beaird (Figure 255-5-5) DFT's are almost identical to the Cochrane. Differences are:

a. The internal condensate chamber on the Cochrane is ring shaped and is placed horizontally in the bottom of the upper section. The Aqua-Chem and Riley-Beaird internal condensate chambers are pan shaped and are centrally located in the top of the upper section.

b. The spray nozzles spray upward in the Cochrane and spray downward in the Aqua-Chem and Riley-Beaird.

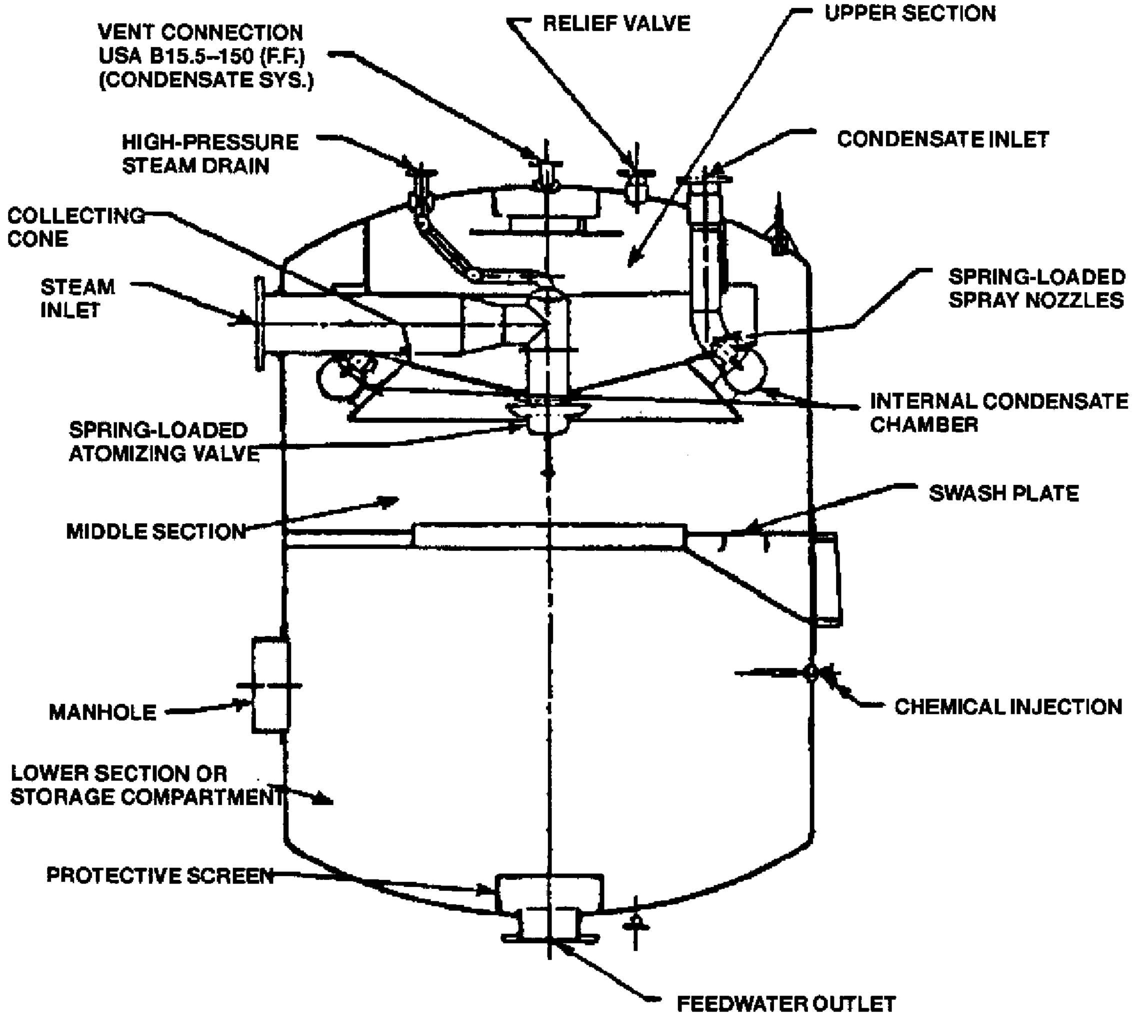


Figure 255-5-3. Cochrane DFT

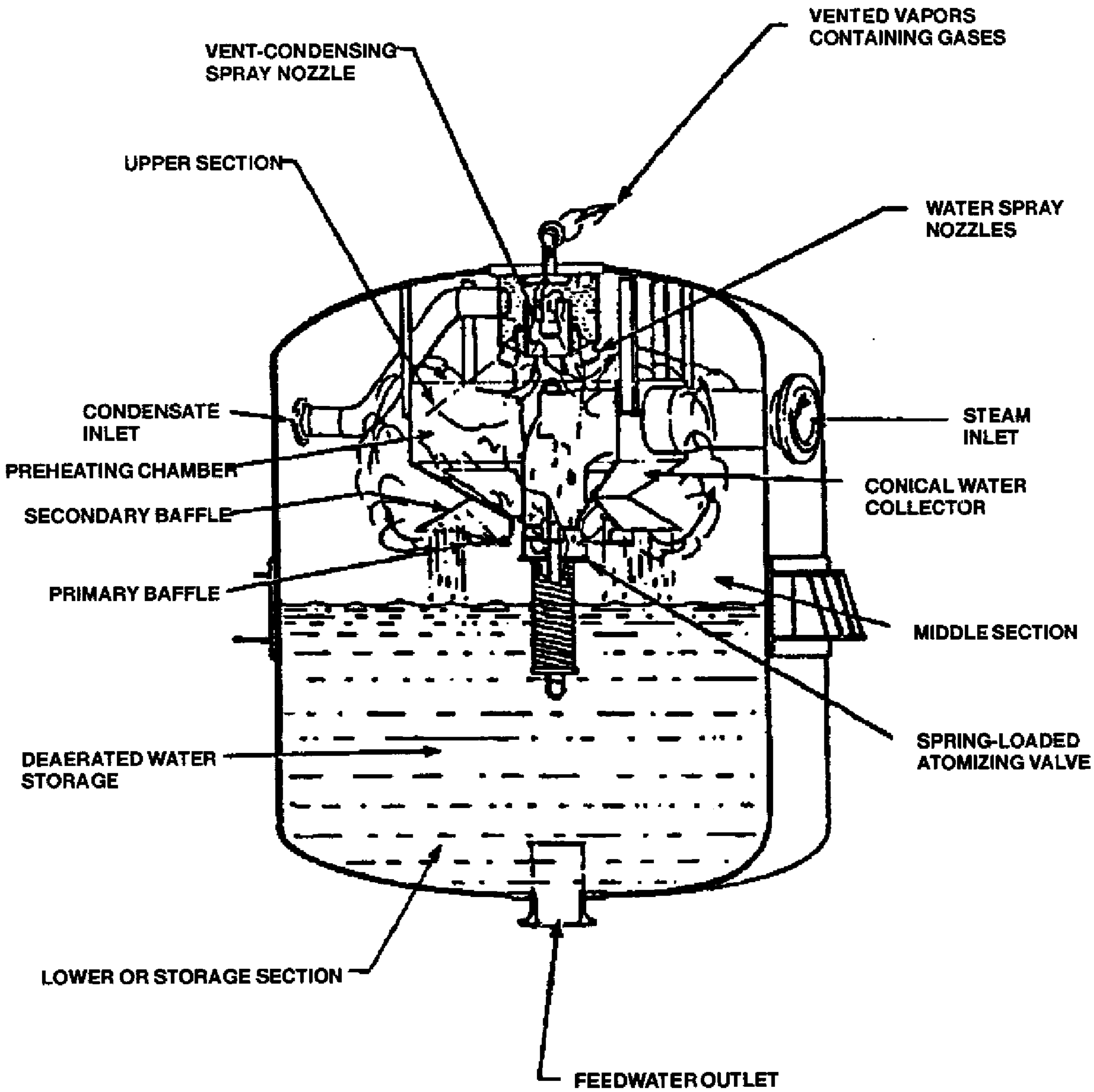


Figure 255-5-4. Aqua-Chem DFT

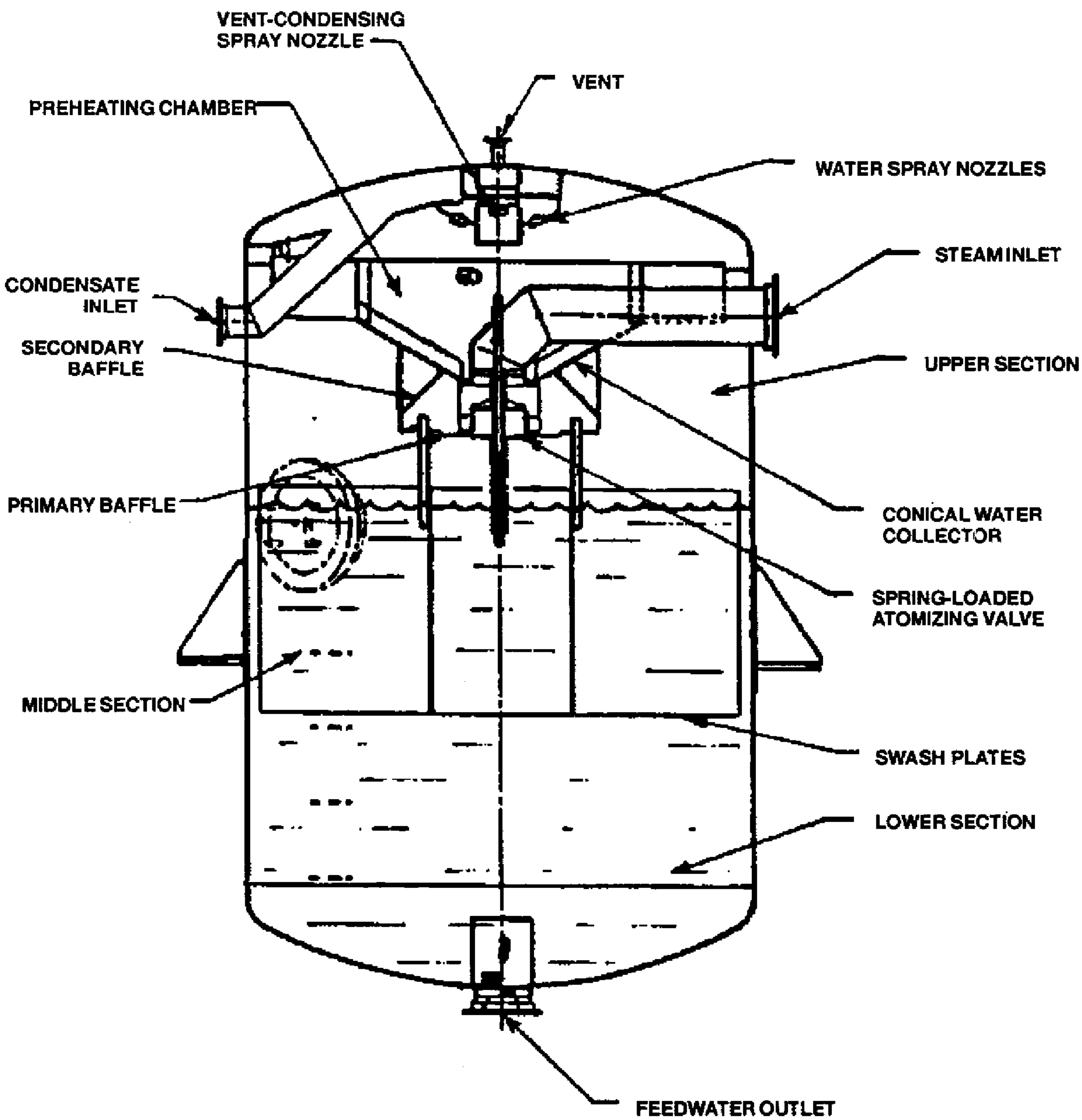


Figure 255-5-5. Riley-Beaird DFT

255-5.3.3.1 The steam-atomizing valves in the three units are functionally similar. There are slight differences in the way hot condensate running out of the upper section is picked up by steam coming from the atomizing valves. This accounts for slightly different baffle configurations in the middle section of the DFT's.

255-5.3.4 WORTHINGTON AND PERMUTIT. The internal condensate chamber and spray nozzle arrangement in the upper section of the Worthington (Figure 255-5-6) and Permutit (Figure 255-5-7) units are virtually the same as on the Aqua-Chem and Riley-Beaird units. The steam-atomizing mechanism, however, is entirely different in that it does not have a spring-loaded steam-atomizing valve.

255-5.3.4.1 In the Worthington DFT, the condensate spray is directed into the water-collecting cone (W) where the water is mixed and agitated (WS) then heated further by the temperature difference between the steam in the chamber (S) and the water in the water-collecting cone. The water in the collecting cone drains by gravity through a downtake pipe (U) to compartment (X). Water is drawn into the scrubbing and mixing passage (WS) by the eductor action of the steam leaving the passage (T). The high-velocity steam-water mixture is jetted from passage (WS) through the opening (Y), thus eliminating the need for a steam-atomizing valve assembly. It then strikes the conical impingement baffle (Z), which deflects the flow of water (P) downward into the storage section of the DFT. Air and other noncondensable gases rise to the top of the DFT and are vented out (Q).

255-5.3.4.2 A very small amount of the total steam required for heating the feedwater is condensed in passage (WS) because the water entering the passage is already very close to steam temperature. This allows the entering steam to transmit almost all of its energy to the water, increasing the water velocity. The water is blasted into minute particles, stripping the last traces of dissolved oxygen and gases from the condensate.

255-5.3.5 ELLIOTT. In the Elliott design, condensate leaving the tubeside of the vent condenser is sprayed through nozzles across the upper section of the DFT against an inner head (Figure 255-5-8). The partially deaerated condensate dripping off this inner head is caught by the funnel-shaped bottom in the upper section where vanes direct it toward the steam-atomizing valve in the middle section of the DFT. Steam entering the DFT through this valve picks up the water running out of the upper section and blasts it up along spiral vanes (A to O) that are fixed between two inverted cones (B and C) concentric about the steam-atomizing valve. This action completes the separation of noncondensable gases from the condensate, which now drips and runs off the top and sides of the middle section into the feedwater stored in the bottom of the DFT shell. The gases stripped from the condensate and the steam admitted through the steam-atomizing valve pass upward through the condensate spray patterns in the upper section. Most of this steam is condensed in giving up its heat to the droplets of condensate in the nozzle spray patterns. The remaining steam and all the noncondensable gases pass between the inner and outer DFT heads and enter the shellside of the vent condenser where the last of the steam is condensed and from which the gases are vented.

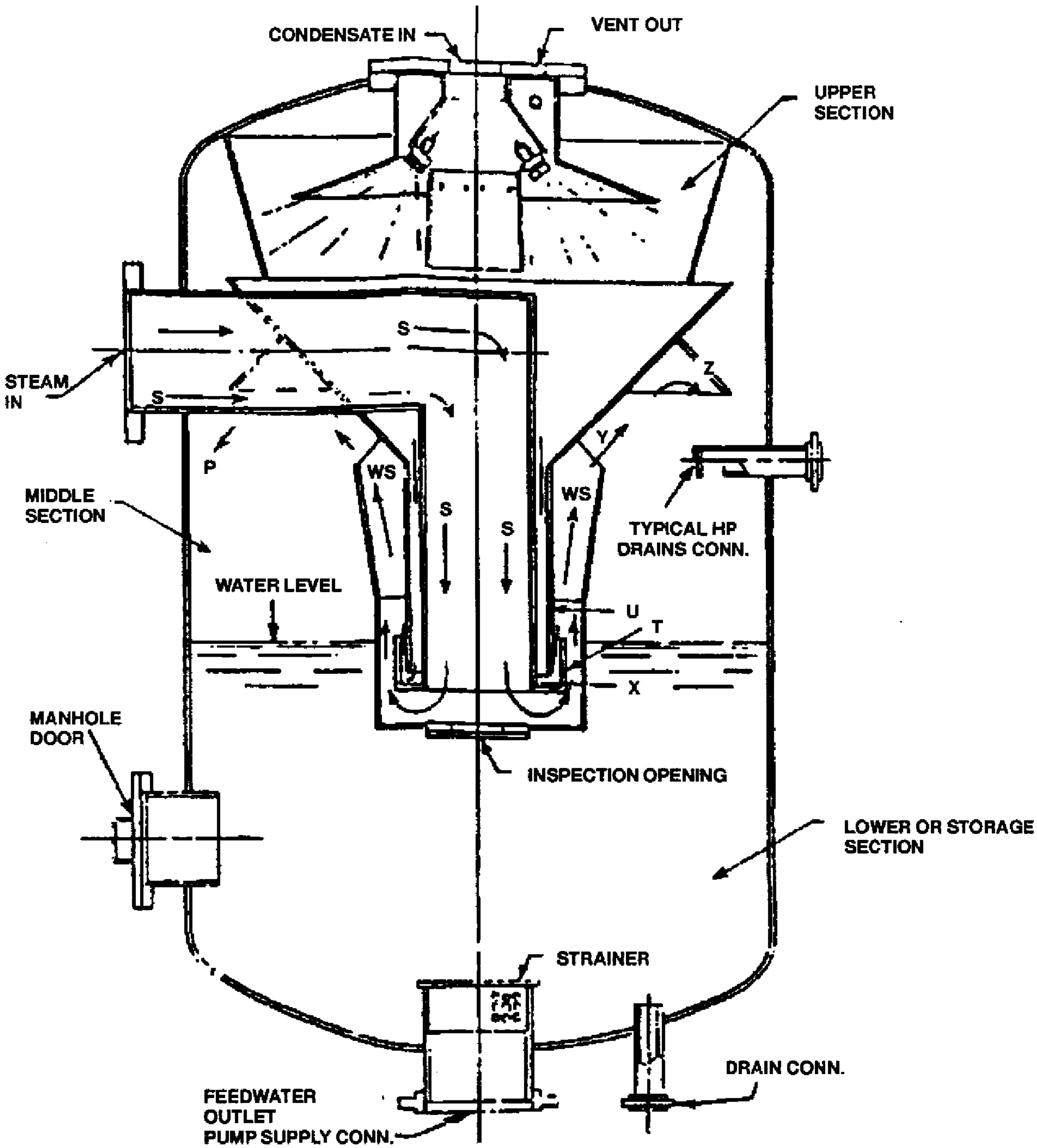


Figure 255-5-6. Worthington DFT

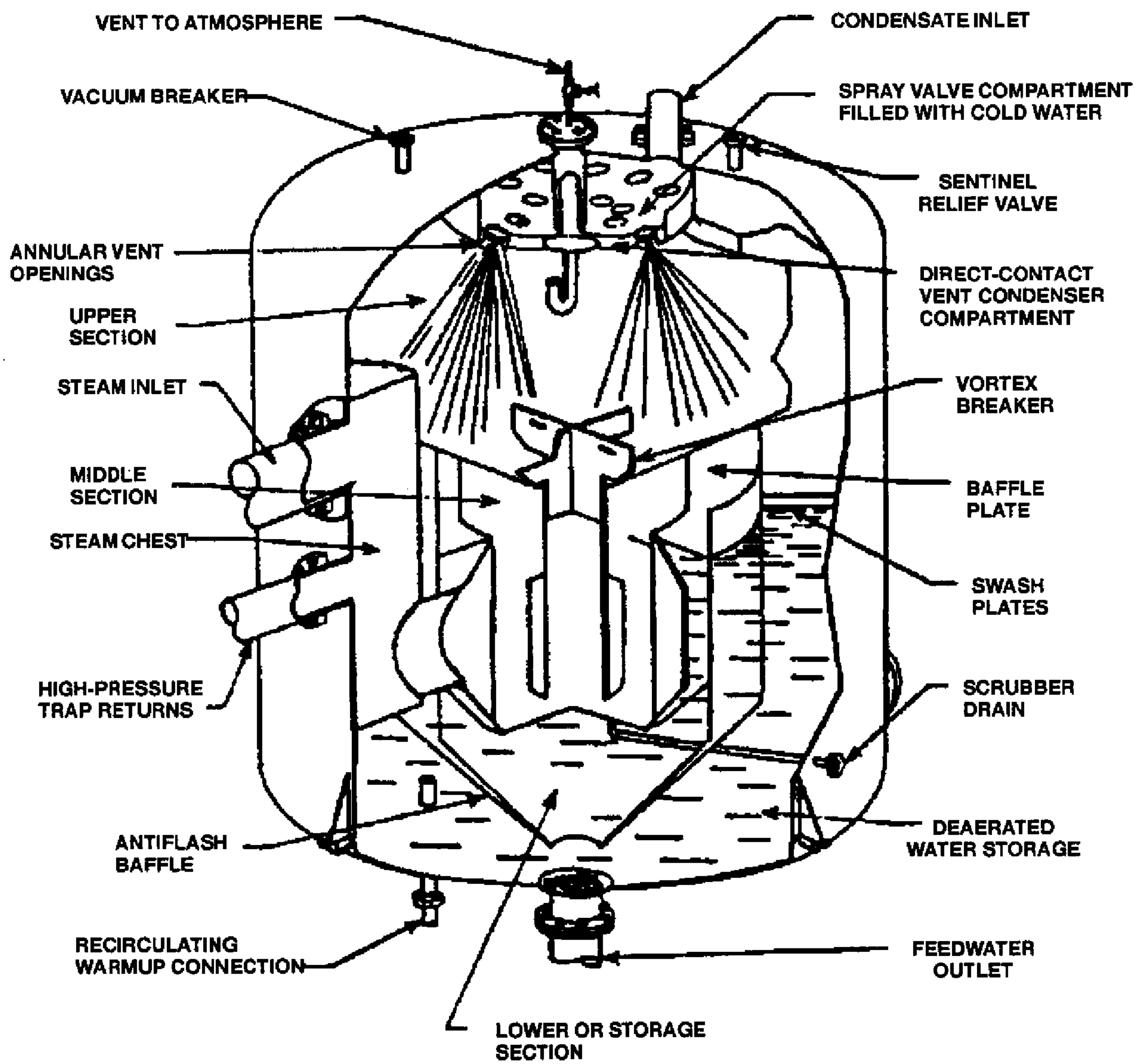


Figure 255-5-7. Permutit DFT

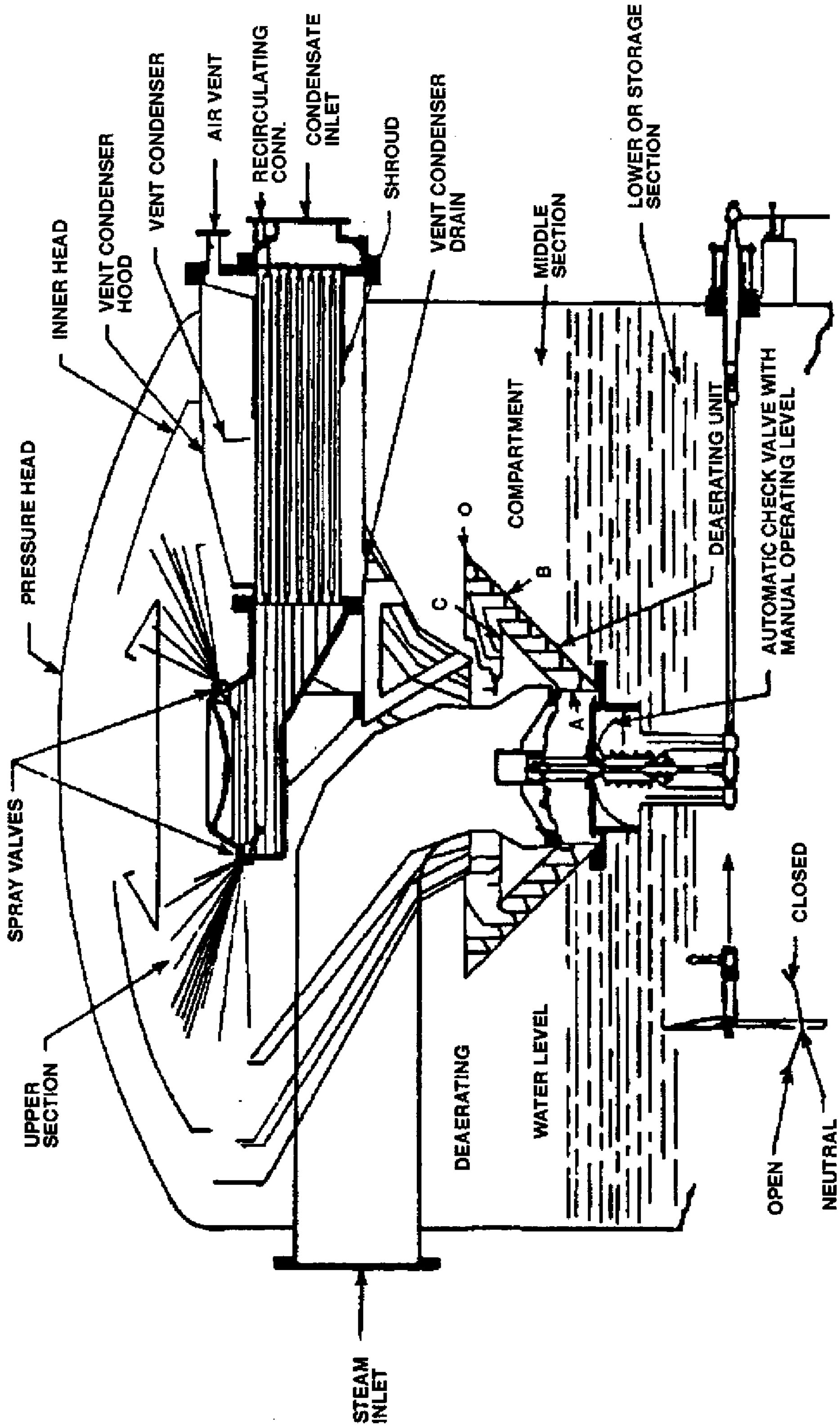


Figure 255-5-8. Elliot DFT - Upper Portion

SECTION 6.

OPERATION

255-6.1 COLD STARTING

255-6.1.1 GENERAL. Refer to the technical manual for the particular deaerating feed tank (DFT) on board for specific operating instructions.

CAUTION

This starting procedure is based on the DFT being cold. For a hot DFT, always cut in auxiliary exhaust steam before introducing cold feedwater or condensate. Supplying water to a hot DFT by way of the spray nozzles without the steam supply being cut in could cause a sudden vacuum in the tank, which could result in its collapse. Vacuum breakers may not act fast enough under such circumstances to prevent low tank pressure.

255-6.1.2 FILLING THE DFT. The following procedure is recommended for filling the DFT:

1. Open the vent valve to atmosphere.
2. Lift the vacuum breaker by hand to ensure its freedom of movement.
3. Line up the suction sides of the reserve feed transfer and the emergency feed pump from a reserve feed tank.
4. Ensure that the recirculation valves at the pump and DFT are open and that the pump casings are vented.
5. Open the valve in the fill line to the DFT.
6. Start the pump, open the pump discharge valve, and fill the DFT to the prescribed level.
7. Close the pump discharge valve, secure the pump, and close the reserve feed tank suction valve.

255-6.1.3 WARMING UP THE DFT. The following procedure is recommended for warming up the DFT:

1. Close the condensate cross-connection line valves.
2. Line up the emergency feed and feed transfer pump to warm up the DFT.
3. Open the valve between the DFT and the reserve feed transfer pump suction.
4. Start the reserve feed transfer pump to recirculate the water in the tank.
5. Open the valve in the fill and warm up line at the DFT condensate inlet connection.
6. After ensuring that pressure is sufficient in the auxiliary exhaust line and that the augmenting valve from the 150-psi system has been cut in, slowly open the auxiliary exhaust valve to the DFT so that no sudden temperature changes occur.
7. When the recirculating and warming process has proceeded to the point where steam is emerging from the vent, shift from the full vent to atmosphere mode to the vent by way of orifice or throttling valve to auxiliary gland exhaust steam mode.

8. Recirculate for about 10 minutes after the water in the tank has reached a temperature of approximately 246° F or the dissolved oxygen content in the deaerated water has dropped below component technical manual maximum operating limit, whichever occurs first.
9. If the water approaches the maximum level in the DFT, it may be lowered by bleeding a portion of the discharge from the reserve feed transfer pump to a reserve feedwater tank through the reserve feed manifold.

255-6.1.4 BRINGING THE DFT ON LINE. The following procedure is recommended for bringing the DFT on line:

1. Start the main feed booster pump, and secure the emergency feed and feed transfer pumps and the recirculation line.
2. When vacuum has been raised on the main and auxiliary condensers, open the condensate line valve from the air ejector to the DFT. If installed, place the DFT makeup and excess feed control valves in automatic control.

255-6.2 UNDERWAY OPERATION

255-6.2.1 CROSS-CONNECTED ENGINE ROOMS. For those systems provided with a main feed discharge header cross-connection, securing of one or more DFT's when underway at low and medium speeds is desirable because more effective deaeration is obtained in the operating tanks, control of makeup and excess feed is simplified, and some improvement in overall operating economy is obtained. When operating cross-connected, one or more DFT's are normally secured and condensate from the propelling unit associated with the secured DFT is transferred to another engine room by way of the condensate discharge cross-connection.

NOTE

When running cross-connected in this manner, do not operate the boiler feed pumps associated with the secured DFT.

255-6.2.1.1 When the reserve feed transfer and emergency feed pumps are not being used for other operations, place them on standby to supply feedwater from the emergency feed tank should the feed booster pump fail.

255-6.2.2 MANEUVERING. When maneuvering, the DFT level will not remain constant but will surge up and down. These surges are not actual changes in the amount of water in the system, but are merely apparent changes. A change in the rate of evaporation in the boilers may cause a greater or lesser percentage of the feedwater in the system to be in the DFT. Increasing the ship's speed will decrease the amount of water carried in the DFT, and decreasing speed will increase that amount of water. This is due to the increased or decreased volume of steam produced by the boiler. Such a condition is only temporary, and when speed is returned to normal, the level in the DFT will return to normal. As long as the water level stays within prescribed limits, operating the manual makeup and excess feedwater valves is usually unnecessary.

CAUTION

Do not throttle the DFT steam supply valves during operation to control pressure in the tank. This would cause improper deaeration of the incoming

Caution - *precedes*

water. Using noncondensing, turbine-driven auxiliaries, when provided, rather than motor-driven auxiliaries helps maintain auxiliary exhaust pressure.

255-6.2.3 MAINTAINING DFT PRESSURE. Steam valves (augmenting valves), from the 150-psi steam system, automatically bleed live steam into the auxiliary exhaust main through a pressure-reducing valve should the pressure fall to the minimum necessary for proper DFT operation, usually over 10 pounds per square inch gage. To ensure proper deaeration, keep the DFT steam supply valves wide open when the DFT is operating.

255-6.3 PRECAUTIONS

255-6.3.1 DFT OPERATING PRECAUTIONS. Observe the following precautions when operating the DFT. Refer also to paragraph 255-2.5 in volume 1 of this NSTM chapter.

a. Do not throttle the steam inlet valves to the DFT's.

b. After switching from the atmospheric vent used during warmup to the vent system used for operation, do not close or throttle valves in a vent equipped with an orifice. On older systems having a throttling valve to the auxiliary gland exhaust system instead of an orifice, adjust throttling valve to thoroughly vent noncondensable gases and to conserve steam as much as practical.

c. Open the feed pump recirculating lines whenever pumps are operating.

d. In warming up a cold DFT, open the steam supply valve slowly to avoid sudden temperature changes in the tank.

e. Never supply makeup feedwater or condensate to a hot DFT without first verifying an adequate heating steam supply to the DFT.

255-6.3.2 DFT REPAIR PRECAUTIONS. Before starting any repairs on the DFT, observe the following precautions:

a. Wire all isolating valves closed, and tag.

b. Drain the tank completely, and leave the drain valve open when removing the manhole.

c. Do not allow an open flame or any source of sparks near a newly opened tank.

d. Never enter the DFT until the ship's gas-free engineer has certified that it is safe to enter. Provide forced ventilation while personnel are in the tank.

e. Whenever personnel are in the tank, station someone immediately outside with the sole assignment of rendering assistance to those in the tank.

f. Before closing the tank, make certain that all personnel and foreign material (tools, lights, rags, dirt, etc.) have been removed.

255-6.3.3 ELLIOTT DFT PRECAUTION. A dirty vent condenser will give low heat transfer rates and affect performance. Periodically examine the vent condenser to ensure that it is clean. If cleaning is necessary, refer to the manufacturer's technical manual for proper procedure.

255-6.4 SECURING THE DFT

CAUTION

For a warm DFT that is cross-connected, do not secure the DFT until the last boiler bottom blow has been completed.

255-6.4.1 PRECAUTION. When the boilers are secured and cease to require feedwater, secure the main feed pump and feed booster pump as outlined in NSTM Chapter 503, Pumps.

255-6.4.2 SECURING PROCEDURE.

CAUTION

With heating steam and the condensate valve secured, watch for heat buildup and overpressurization in the DFT. This may occur through the hot drains or, where fitted, a supplementary heating steam line to the tank that enters on the tankside of the large heating steam cutout valve. Once the securing procedure for the DFT is initiated, it must be carried through to completion.

1. Secure the DFT by closing the main condensate inlet valve.
2. Close the auxiliary steam exhaust line valve and the drain lines to the DFT.
3. Secure the automatic makeup and excess feed valves, if installed.

SECTION 7.
TEST AND INSPECTION

255-7.1 GENERAL

WARNING

If the shell ruptures from DFT collapse, steam and hot water will be released into the machinery room.

CAUTION

When taking the DFT out of service, always secure the flow of condensate to the DFT first and then secure the heating steam. When returning a hot DFT

Caution - *precedes*

to operation, open the steam first and then the condensate. Always follow this sequence to prevent DFT collapse due to low internal pressure.

NOTE

Lifting the vacuum breaker valve is required on all DFT's regardless of manufacturer as a step in preparing the tank for cold startup. Perform this operation quarterly. (The requirement may be omitted in any quarter when the tank is in service continuously.)

255-7.1.1 This section covers component tests (other than scheduled shipboard preventive maintenance) conducted in accordance with Maintenance and Material Management (3M) cards. The following precautionary checks should be made periodically and apply to all deaerating feed tanks (DFT) regardless of manufacturer:

a. Ensure that the relief valve and vacuum breaker are free to operate.
b. Check the oxygen removal performance. Take water samples under pressure, and chemically analyze them as soon as possible.
c. Ensure that the pressure gages and thermometers are working, and calibrate if necessary to establish accuracy.

255-7.2 COMPONENT TESTING AND INSPECTION

255-7.2.1 TEST FOR THE DFT SPRAY VALVES.

255-7.2.1.1 Spray Valve Test Rig. A rig for testing spray valves is shown in Figure 255-7-1. All shore and afloat repair activities servicing ships equipped with DFT's should construct this rig for testing spray valves. A water supply with a minimum pressure of 10 psi furnished from either shipboard or dockside should be connected by a globe valve to the 1/2-inch nominal pipe size (NPS) nipple. Connect a pressure gage with a 3-psi operating midrange to the 1/4-inch NPS side outlet pressure tap. Attach a 1/4-inch valve to the 1/4-inch NPS drain connection on the bottom, if required.

255-7.2.1.2 Test and Calibration of Spray Valves. Test and calibrate each spray valve separately as follows:

1. Mount the test rig, with its connecting water supply and indicating gage, in an angular position similar to the spray valve position in the DFT.
2. Mount the spray valve to be tested or calibrated on the 3-inch coupling on the test rig. A rubber gasket or similar material can be used instead of a copper gasket for mounting the spray valve. If the 3-inch coupling has been threaded for a particular size of spray valve, adapters can be fabricated for fitting other sizes of valves.
3. Fill the test rig with water, lifting the valve plug either by hand or by water pressure to remove air pockets.
4. Apply water pressure, slowly operating the water supply valve, to determine the condition of the valve seats and the pressure required to lift the spray valve plug (usually 1-1/2 to 3 psig). Leakage during the buildup of pressure indicates scored or poor seats. Record the pressure when the spray valve opens. If the pressure does not agree with the opening pressure specified in the manufacturer's technical manual, adjust the valve spring

tension. If the opening pressure is not given in the technical manual, note any pressure drop under test that produces the desired spray pattern. If there are seat leaks, reseat the valves before making the final spring or lift adjustment.

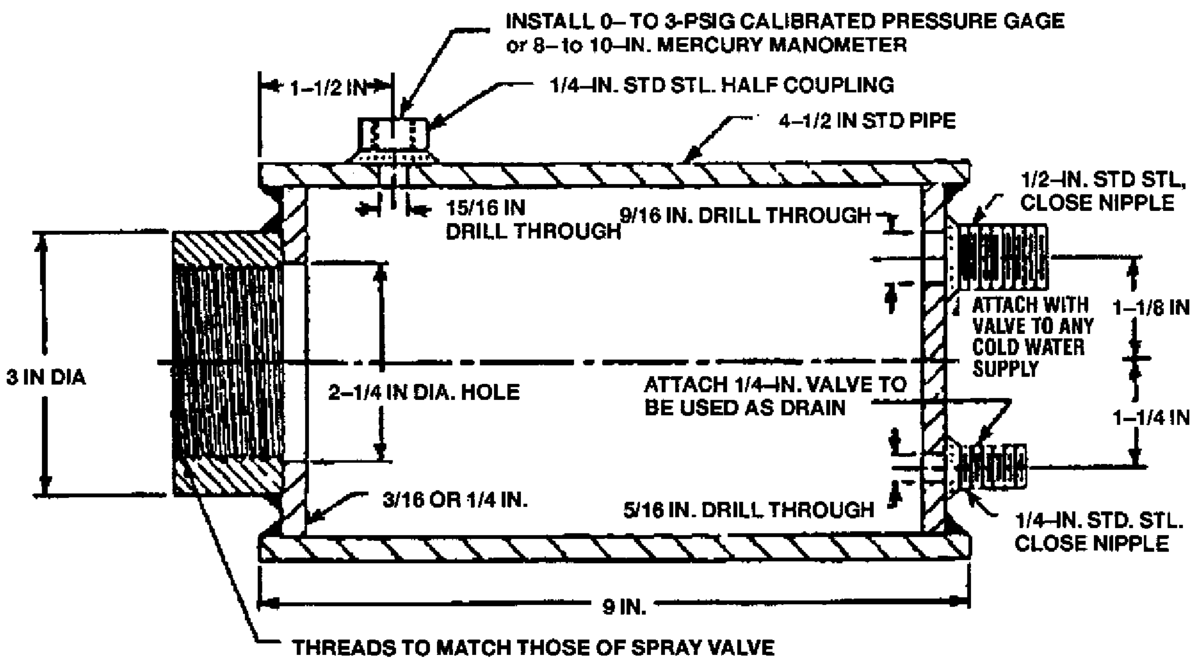


Figure 255-7-1. DFT Spray Valve Test Rig

255-7.2.1.3 Spray Valve Test Criteria. When testing spray valves, note the following items:

a. The valves should shut completely. Leakage in the closed position indicates faulty operation that critically affects deaeration. If such a condition exists, examine the valves for scored or damaged seats or improper spring tension.

b. When the valve opens, the discharge should be a completely conical bubblelike film of water. Any other form of discharge indicates faulty operation. An incomplete cone indicates cocking of the disk in respect to the seat. This may be caused by defective springs. Examine replacement valves carefully to verify that the springs are correctly formed. If the flow of water through the test rig is insufficient to produce the spray cone, check the spray valves in the tank by observing the flow pattern through the inspection plate.

c. All valves in a particular tank should open at the same pressure differential to avoid gaps in the total configuration. Adjust all associated valves for the same opening pressure.

d. Valves should operate freely in any position.

e. Valves and seats should be clean and free of deposits.

255-7.2.2 TEST FOR THE STEAM-ATOMIZING VALVE. Apply sufficient force on opposite sides of the disc to open the steam-atomizing valve. This movement should be slow because of the dashpot. On removal of the opening force, the valve disc should return to its seat. If the valve moves rapidly or becomes cocked, check dashpot and guides. If the valve fails to seat properly, check the pressure spring setting.

CAUTION

Never operate DFT with the vacuum breaker valve removed. Low internal pressure could result, causing DFT collapse. If removal becomes necessary, shut down the DFT and tag out for safety.

255-7.2.3 TEST FOR THE DFT VACUUM BREAKER. Tag out the DFT for safety, and deliver the vacuum breaker to the Intermediate Maintenance Activity (IMA) for testing according to Planned Maintenance System (PMS) requirements.

255-7.2.4 INSPECTION OF DFT INTERNAL COMPONENTS. Inspect the DFT internals for oil and foreign matter, and clean as necessary. Details on oil contamination can be found in NSTM Chapter 220, Volume 2, Boiler Water/Feedwater - Test and Treatment, and NSTM Chapter 221, Boilers .

255-7.2.5 TEST FOR THE DFT CHECK VALVE. Inspect and clean as necessary the check valve at the steam inlet to the DFT (Worthington, Aqua-Chem, Riley-Beaird, Permutit, and some Cochrane installations, for example FF 1052 class). For the internal check valves of the Elliott design, follow the procedures for the steam-atomizing valves. Test the DFT check valve for tightness by applying a hydraulic pressure of approximately 20 psi on the tank with the steam inlet piping removed.

255-7.2.6 TEST FOR THE DFT RELIEF VALVE. Test in accordance with PMS requirements.

SECTION 8.
TROUBLESHOOTING

255-8.1 FEEDWATER SYSTEM

255-8.1.1 Troubleshooting procedures for the feedwater system can be found in volume 1 of this NSTM chapter.

255-8.2 DEAERATING FEED TANK

255-8.2.1 GENERAL. Unsatisfactory deaerating feed tank (DFT) temperature and deaeration can usually be traced to one of the causes identified in the following paragraphs.

255-8.2.2 IMPROPER SAMPLING AND ANALYZING TECHNIQUES. Follow established procedures strictly (NSTM Chapter 220, Volume 2, Boiler Water/Feedwater - Test and Treatment). Before obtaining the feedwater sample for the dissolved oxygen test, ensure that the sampling line root valves are properly alined to obtain a representative sample. Check for leakage in the sampling lines and coolers.

255-8.2.3 PROBLEMS DURING OPERATION.

255-8.2.3.1 DFT Pressures and Water Level. Keep the DFT shell pressure and water level within limits. Excessive fluctuations in auxiliary exhaust pressure, condensate pump discharge pressure, and high-pressure (HP) drain pressure will make the DFT unstable. The auxiliary exhaust system augmenting steam valves and relief valves automatically control the auxiliary exhaust pressure under all plant conditions. Maintain their proper working condition. Manual control is unacceptable.

255-8.2.3.2 HP Drain Loads. In some installations excessive HP drain loads will close the internal check valve. This starves the DFT middle section of the steam it needs for vigorous scrubbing and final oxygen removal.

255-8.2.3.3 Clogged Vent Lines. Clogged DFT vent lines prevent air removal from the DFT. Take precautions to ensure that these lines, particularly the vent orifice, are clear at all times.

255-8.2.4 DFT COLLAPSE. Another type of DFT casualty is collapse. This type of failure can occur if the pressure in the tank drops too far below the ambient pressure on the outside. For a hazardous condition to arise, the internal pressure of the tank would have to drop well into the vacuum range. For protection against this condition, the DFT is fitted with a vacuum breaker. The vacuum breaker is simply a spring-loaded or weight-loaded check valve set to open and permit air to flow into the tank when the internal pressure drops to some preset value below atmospheric pressure. If the vacuum breaker malfunctions and pressure in the tank continues to fall, the tank shell will collapse and the tank will be permanently distorted. If shell rupture results from the severity of this collapse, steam and hot water will be released into the machinery space.

255-8.2.4.1 The vacuum breaker, like the relief valve, must be in good operating condition to protect the tank adequately. The vacuum breaker will seldom need to be removed for maintenance. Should such removal become necessary, do not operate the DFT. It shall be tagged out for safety.

255-8.2.4.2 Heat transfer is so efficient between the thin curtains of water spraying from the nozzles and the steam in the DFT that the sprayed water could condense all the steam in the DFT almost instantaneously. If the flow of steam is cut off before the condensate is secured, DFT pressure could fall faster than air entering from the vacuum breaker can fill the void. Even though this condition would exist for only a short time, the tank could collapse and rupture if the pressure falls low enough. DFT collapse due to low internal pressure can also occur when feed is transferred from one DFT to another if the vent valve of the tank being emptied is not open during transfer.

255-8.2.4.3 Note the following principles regarding DFT vacuum hazards:

a. The internal pressure of the DFT should never fall into the vacuum range.

b. When in good working order, the vacuum breaker provides the primary protection from collapse.

c. The greatest risk of the DFT pressure dropping into the vacuum range exists when the tank is hot but without a supply of heating steam. This occurs when the auxiliary exhaust steam has been cut out as a step in securing; steam has been cut out as part of a casualty simulation; or steam supply has been lost because of a casualty affecting the auxiliary exhaust pressure.

d. Before adding water to a hot DFT by way of the spray nozzles, ensure that the supply of heating steam is adequate and that it is supplying the tank. Then, begin adding the water carefully, first cracking the valve slightly. Watch tank pressure, and increase flow to the spray nozzles only if pressure is sustained. If pressure falls to 10 psig, shut off the water and investigate why the heating steam is not sustaining pressure.

e. Never attempt to verify the setpoint of the vacuum breaker (the amount of vacuum at which the valve begins to open) by cooling a hot DFT.

255-8.2.5 DFT WATER LEVEL. The level of water in the storage section of the DFT is maintained by the excess and makeup feed valves. This is accomplished on older ships by manual control valves located adjacent to the tank gage glass and on newer ships by an automatic liquid-level control. When water in the DFT rises above the upper operating level on systems equipped with automatic control, a differential-pressure transmitter, high-level controller opens an air-operated control valve supplied from and connected to the condensate system. Since the pressure in the condensate system is higher than that in the reserve feedwater tank, the condensate will flow into the reserve feedwater tank. When the water level in the DFT drops sufficiently, the control valve closes and the condensate again flows into the DFT. Likewise, when the water level in the DFT falls below the lower operating level, a differential-pressure transmitter, low-level controller opens an air-operated control valve in the makeup feed line. Atmospheric pressure on the reserve feedwater tank then forces makeup feedwater through the line (vacuum drag) to the main condenser. Each control valve has an emergency handwheel in case of failure of the air supply to the automatic controls.

255-8.2.6 OVERPRESSURIZATION. The DFT is equipped with a sentinel relief valve. Always consider this valve a warning device; that is, any lifting of this valve is a signal for immediate corrective action. This valve is large enough to prevent high-pressure drains from overpressurizing a secured DFT. It cannot, however, relieve large fluid flows as might be generated through the condensate or heating steam inlets. The only safe operating concept, therefore, is to always regard this valve as a sentinel valve. All watchstanders shall be thoroughly aware that any such protective device must be in good operating condition to provide the intended protection. The sentinel relief valve will occasionally have to be removed from the tank for corrective maintenance. Whenever this is necessary, tank operation is prohibited and the tank shall be tagged out for safety. The following principles apply to overpressurization of the DFT:

a. Know the internal pressure of the DFT at all times, and know its safe pressure limit. A high temperature reading is a sign of high pressure. High temperature is a danger signal requiring immediate corrective action.

b. If high pressure readings on the pressure gage or high temperature readings on a DFT thermometer are unattended, pressure buildup will lift the sentinel relief valve and call attention to the pressure hazard. Consult ship's Engineering Operational Sequencing System (EOSS) procedure to relieve overpressure.

c. Boiling out the tank with chemical solution to decontaminate it can cause overpressurization. Review and understand the method of tank overpressure protection before proceeding.

255-8.2.7 IDLE DFT'S. Lay-up requirements for DFT's are described in paragraph 255-6.4.

255-8.2.7.1 Monel DFT's. Lay-up procedures for Monel DFT's are specified in NSTM Chapter 050, Readiness and Care of Inactive Ships .

255-8.2.7.2 Steel DFT's. Three types of lay-up procedures exist for steel DFT's:

a. Idle Periods up to 1 Month. For idle periods extending up to 1 month for steel DFT's, the tanks shall be drained and kept empty.

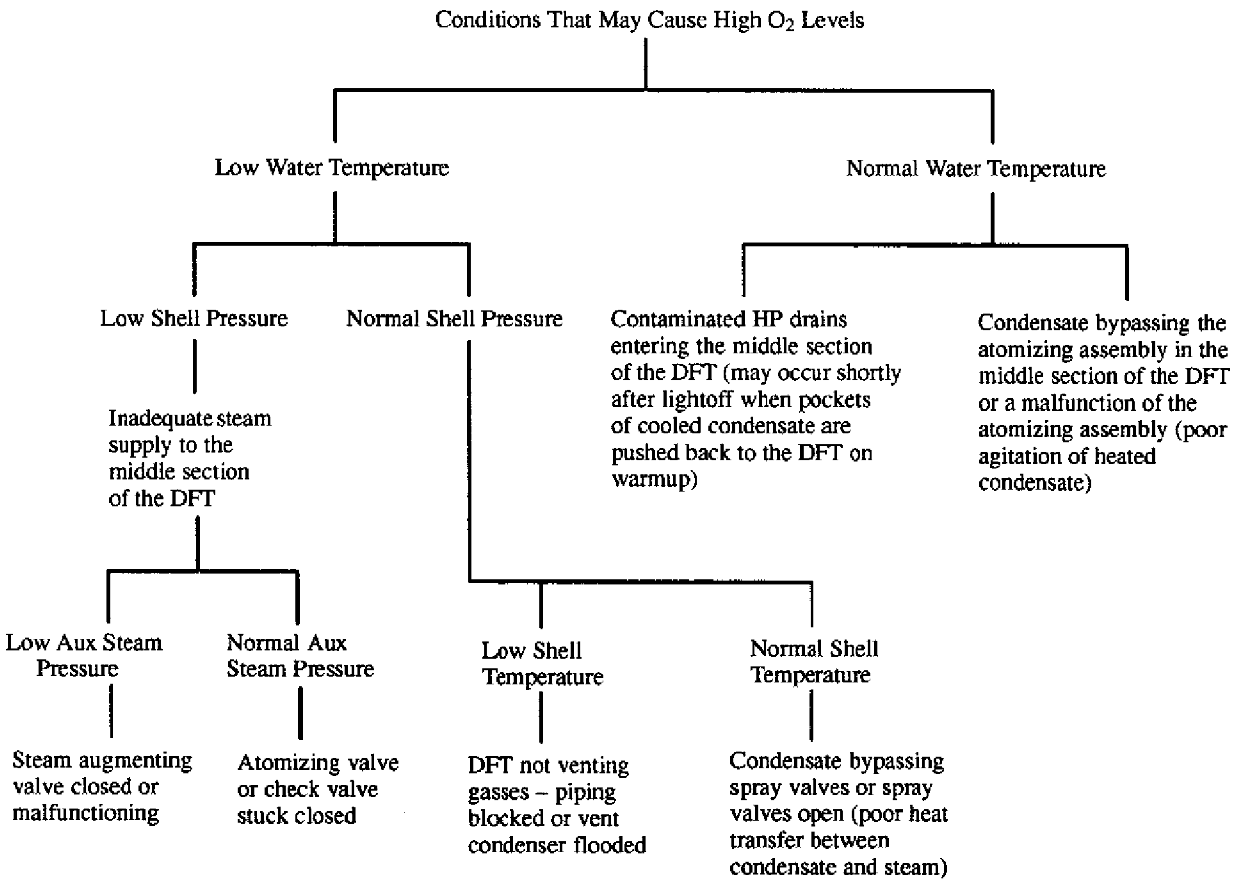
b. Extended Idle Condition in Excess of 1 Month. For idle periods of 1 month or more, drain and dry the tanks as soon as possible after the system has been secured. Dry the tanks with an electric warm-air blower. When the tank is dry, close the DFT openings. Check the DFT weekly, and dry again if moisture is found inside.

c. Inactive Service. For inactive service of steel DFT's, refer to NSTM Chapter 050 .

255-8.3 TROUBLESHOOTING GUIDE

255-8.3.1 A DFT troubleshooting guide is provided in Table 255-8-1.

Table 255-8-1 DFT TROUBLESHOOTING GUIDE



NOTES:

1. Difficulty in pumping water from the DFT may be due to the strainer being clogged or deterioration of the vortex baffle at the drain.
2. Piping, valves, controls, and other DFT accessories are covered separately in this NSTM chapter.

REAR SECTION

NOTE

TECHNICAL MANUAL DEFICIENCY/EVALUATION EVALUATION REPORT (TMDER) Forms can be found at the bottom of the CD list of books. Click on the TMDER form to display the form.