FEED WATER SYSTEM GUIDELINES

BACKGROUND

Boiler feedwater systems are required to replace the water evaporated as steam, but also prevent thermal shock, corrosion, and inevitable internal damage to the boiler. Re-using condensate is one of the most important goals for an efficient and effective steam system. Whenever condensate is not available, “new” water or make-up water is used to replenish the system. Almost every steam system has some amount of condensate and/or steam losses which require make-up water to be added. Along with softening systems and filtration, this make-up water must be conditioned through chemical and/or mechanical means to remove the harmful dissolved gases. Fortunately, by raising the temperature of the make-up water, the dissolved Oxygen (O_2) and Carbon Dioxide (CO_2) are released. The temperature and methods of deaeration will effect the overall dissolved gas concentration.

FEEDWATER TANKS

A feedwater tank is an unpressurized, non-code storage vessel with pump(s) designed to receive condensate and make-up water and supply feedwater to the boiler as required. The basic tank design includes connections for:

- Condensate returns
- Vent to atmosphere
- Overflow to drain
- Drain, with a manual ball valve
- Sight glass
- Thermometer
- Make-up water supply, with a mechanical float type control valve
- Feedwater pump suction

Additional connections may be necessary, such as feedwater pump recirculation orifice(s), to accommodate specific boiler and/or tank functionality.

The make-up water supply is generally controlled by a mechanical float valve which allows make-up to enter the tank as the float falls due to a lowering water level in the tank.

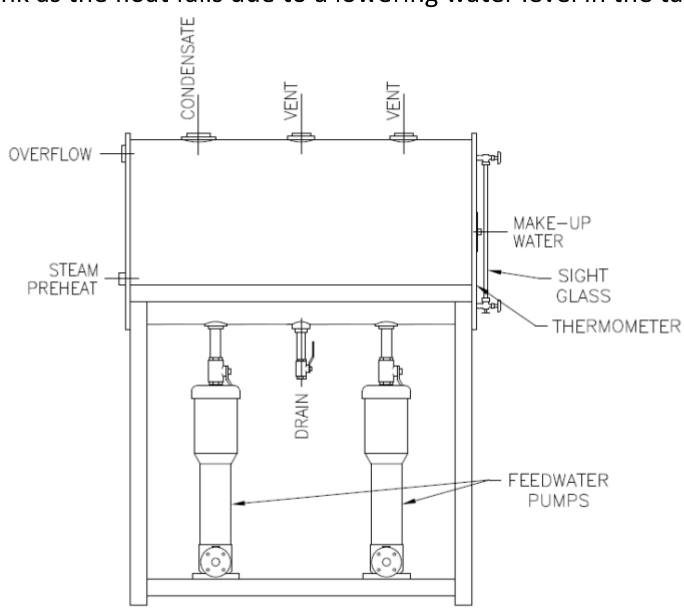

Figure 1: Feedwater Tank (Standard Layout)

The reasons for selecting a feedwater tank include:

- Low back pressure to accept low pressure or gravity/trapped condensate returns.
- High percent of condensate returns, (≥ 75% condensate returned).
- Capital costs are lower than a pressurized deaerator.

The consequences associated with a feedwater tank include:

- Increased chemical treatment and maintenance costs.
- Higher potential for boiler damage from corrosion and/or thermal shock due to chemical feed failure, low water temperatures, excessive condensate losses, etc.
- Increased boiler blowdown frequency resulting in heat and water losses.

Optional equipment includes a feedwater preheat assembly which maintains an elevated water temperature in the tank determined by the set point of the temperature sensing device. Preheating is recommended if condensate returns are unable to maintain the blended feedwater above 155°F. The assembly consists of a steam pressure reducing valve (PRV), temperature control valve with temperature sensor, strainer, and steam sparge tube. Steam is supplied to the assembly and initially passes through the strainer before entering the PRV. The PRV is set to an outlet pressure between 3-15 psig. The low pressure steam exits the PRV and is metered into the tank via the temperature control valve. The temperature sensing device mechanically opens and closes the control valve to maintain the desired water temperature set point inside the tank. The incoming steam is distributed into the tank by the sparge tube which is submerged below the water level. The sparge tube is a perforated tube designed to increase the surface area of the exiting steam to increase heat transfer, distribution, and absorption into the water.

DEAERATOR TANKS

A deaerator tank (DA) is a pressurized ASME Sect. VIII code vessel designed to receive and heat condensate and make-up water and supply feedwater through its pump(s) to the boiler as required. The DA has a design pressure of 50 psig and an operating pressure of 5-7 psig. The general sizing parameter for a DA is a water storage volume of about 10 minutes at full capacity. The basic DA design includes connections for:

- High temperature condensate returns
- Steam supply
- Medium temperature condensate returns & pumped condensate returns
- Continuous vent to atmosphere for non-condensable gases
- Overflow trap
- Drain, with a manual ball valve
- Sight glass/level control devices
- Chemical feed
- Make-up water supply
- Thermometer
- Feedwater pump suction
- Pressure Safety Valve (PSV)
- (2) Inspection openings

Additional connections may be necessary, such as feedwater pump recirculation orifice(s), to accommodate specific boiler and/or tank functionality.

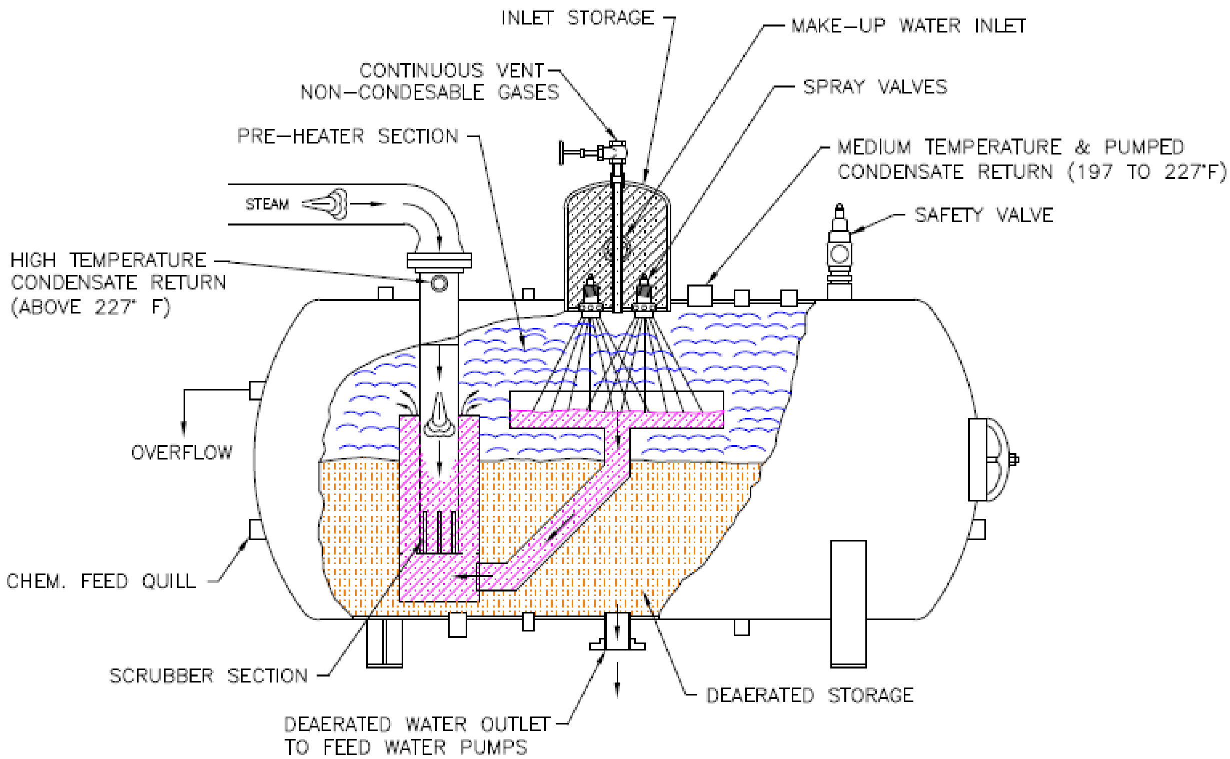

Figure 2: DA Cut Away View

The deaerator works by collecting high pressure/temperature condensate returns (> 227°F) through the steam supply pipe and medium pressure/temperature and pumped condensate returns (197-227°F) through the scrubber section. The steam supply assembly adds low pressure steam as required to maintain approximately a 5 psig steam blanket inside of the pressurized tank.

The water level controls and make-up water control valve meter in any required make-up water to keep the DA at the normal operating level. The make-up water enters through the dome and passes through spray valves into a steam-filled heating and venting section. The water temperature is raised rapidly and most of the undissolved gases are released. As the water passes through the assembly, it flows to a scrubber section where final deaeration is accomplished by scrubbing the water with steam. This steam is introduced through an internal pipe assembly which causes the high velocity steam to break the water down to a fine mist through a violent scrubbing action. The deaerated water spills over to the tanks storage compartment for use by the boiler, and the gases are vented to the atmosphere via the continuous vent valve.

Deaerators are considered essential for:

- All boiler plants operating at 75 psig or more.
- All boiler plants with little or no standby capacity.
- All boilers plants where production depends on continuous operation.
- All boiler plants operating with makeup water of 25% or more.

Some benefits of a DA over a feedwater tank are:

- Lower maintenance and chemical treatment costs.
- The higher water temperature drives off as much oxygen as possible before water enters the boiler, resulting in minimal boiler blowdown losses.

- Higher water temperature reduce the risk of thermal shock in instances when cooler make-up water is added to the system.
- Decreases flash steam losses to atmosphere.

The consequences associated with a DA include:

- Higher capital costs, when compared to a feedwater tank.
- Low pressure/temperature condensate returns may have to be pumped into the tank.

The controls associated with a DA can be as simple as a water-level control device, make-up water control valve, and steam PRV. They can also be upgraded to a complete PLC system with an HMI, pressure, level and temperature transmitters, modulating steam and make-up water control valves, feedwater pumps VFDs, etc.

SURGE TANKS

A surge tank is a vented, unpressurized, non-code storage vessel with pump(s) designed to receive overflow from the DA and low pressure/temperature condensate and transfer it to the DA as required. The basic tank design includes connections for:

- Low temperature condensate returns (< 197°F)
- Vent to atmosphere
- Overflow to drain
- Drain, with a manual ball valve
- Steam preheat assembly
- Transfer pump suction and low-water shutoff

Additional connections may be necessary, such as transfer pump recirculation orifice(s), to accommodate specific DA and/or tank functionality.

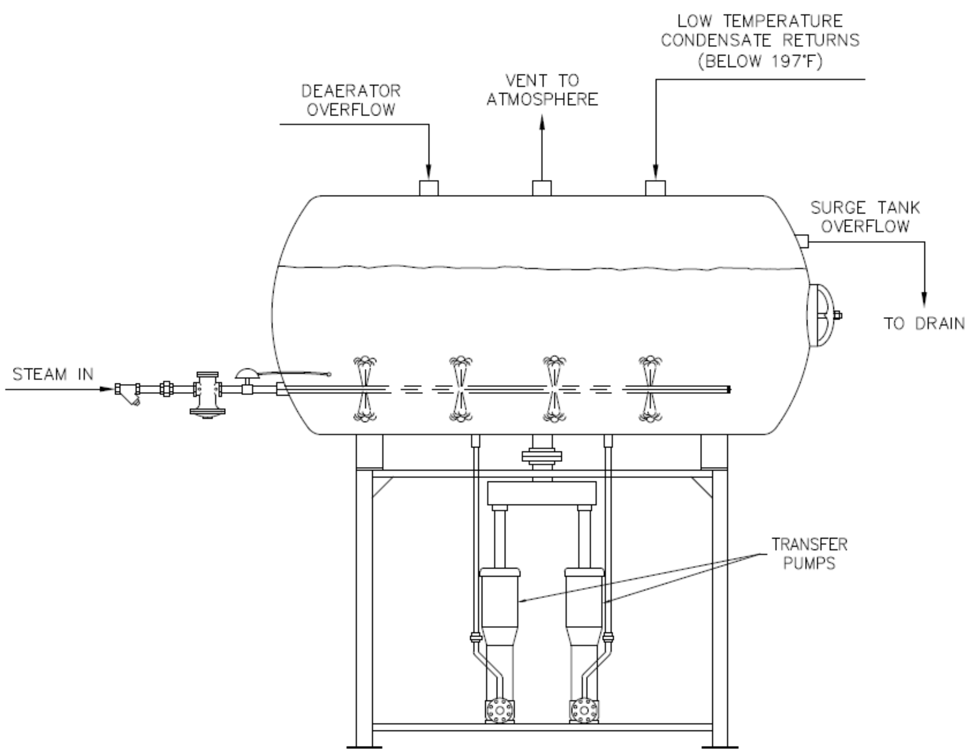

Figure 3: Surge Tank (Standard Layout)

If a steam system has the ability to accumulate and then overwhelm the DA with condensate, a surge tank can be utilized to increase the storage capacity of boiler feed system. A surge tank acts as a buffer to ensure the proper operation of the DA and protect it from surge loads. Also, a surge tank collects and reutilizes condensate/feed water that would otherwise be lost down a drain, greatly reducing energy usage and dependence on replacing boiler system losses with cold, untreated, raw water. Some circumstances that necessitate the requisite for a surge tank include:

- Certain process conditions, such as excessive or intermittent startup and/or process loads.
- Steam systems with gravity returns that may not have enough static pressure to overcome the DA operating pressure and spray valves.
- Installations that potentially have a high rate of condensate return which can intermittently overload the DA with water if multiple condensate pumps start simultaneously.

The constant run transfer pumps, between the surge tank and deaerator, with a modulating control valve driven by the DA level, gives the DA a steady flow of water, with a slowly changing temperature, to heat before sending it to the boiler.

The surge tank should be piped in so that the overflow from the DA goes into the surge tank along with any low temperature/pressure returns that cannot naturally enter the DA. Then the surge tank pumps need to be arranged to send this water go back into the DA as soon as possible, so that all of this is used up before the DA takes on new replacement water. The surge tank needs to have a small steam feed controlled by temperature to prevent air from being drawn into the stored condensate.

CONCLUSION

It is paramount to select the correct feedwater system in order to optimize the operation of each steam system. It is important to understand the dynamics of the installation and the implications of the equipment proposed to the customer. It is our duty to provide guidance when the pertinent information is available and advise of recommended options when necessary. Having better knowledge of the equipment and its operating principles can help this be achieved.

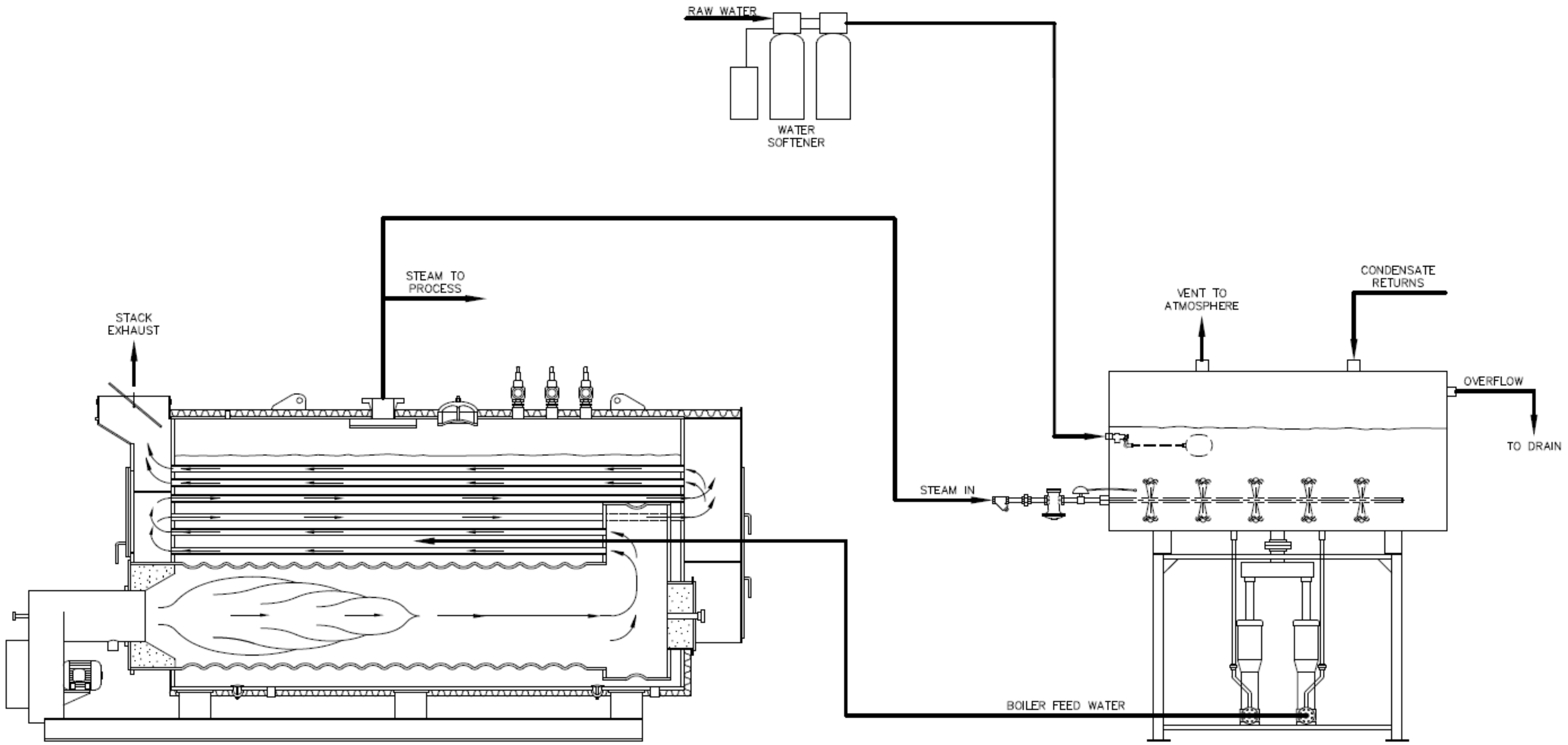

Figure 4: Feed Water Tank Installation Diagram

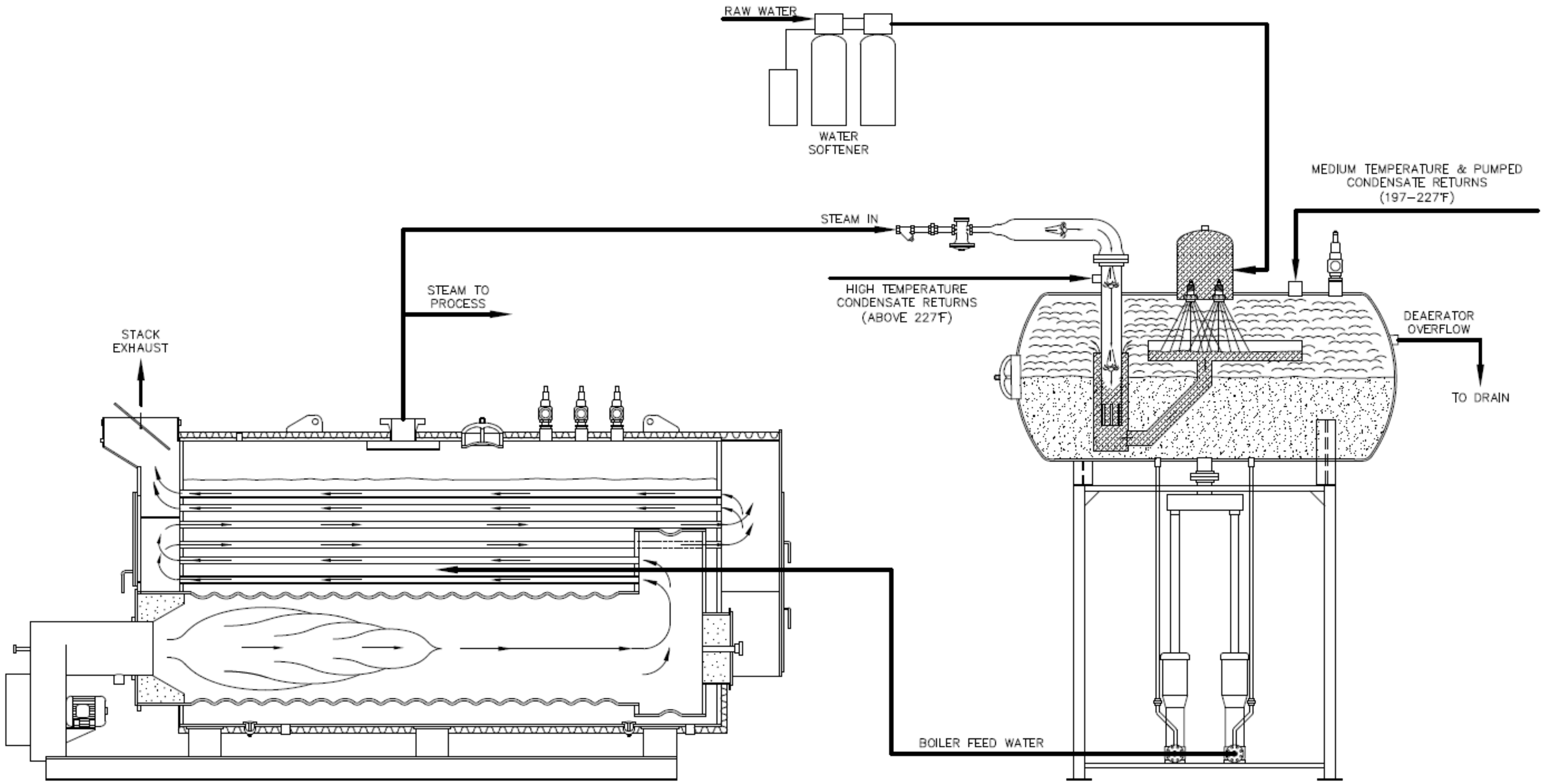

Figure 5: Deaerator Tank Installation Diagram

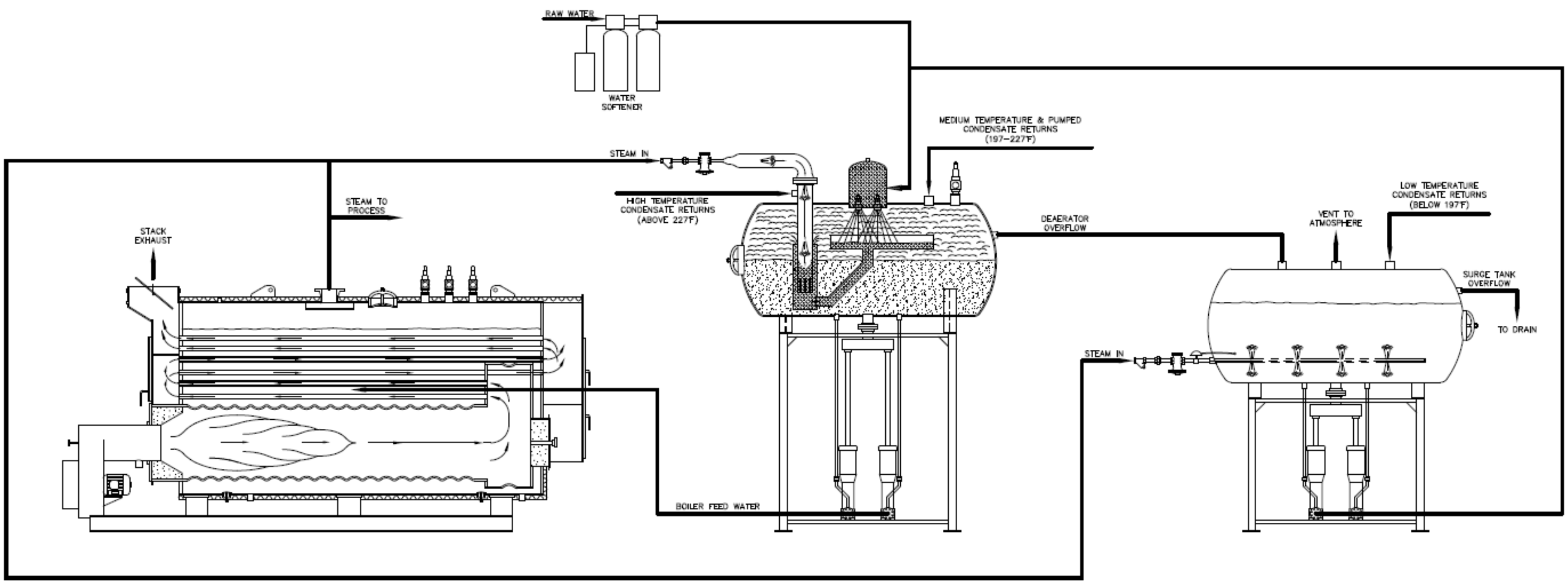

Figure 6: Deaerator Tank & Surge Tank Installation Diagram