BOILER SYSTEMS

1.0 PURPOSE

Two utility boilers are designed to supply 125,000 lbs/hr each of superheated steam to maintain the Super High Pressure Steam Header at 1500 psig. They are to be primarily used during startup when insufficient steam is being produced to provide additional steam makeup to the 1500 psig steam header for steam requirements for the Compressors, and to supply additional steam any time there is an imbalance in the steam header and when more steam is needed in the system.

2.0 SAFETY AND ENVIRONMENTAL CONSIDERATIONS

The greatest hazard in the boiler feed water and boiler areas is the potential for "fuel related" explosions. To minimize this potential a complete burner management system controls the purge and light off of the boilers but it is still essential that the operator verifies before light off that all fuel valves are closed to the boiler and that the FD fan is operating giving sufficient purge to the boiler. Even with an automated purge system in place, always wait an extra few minutes before requesting a purge after a shutdown as the single biggest cause of explosions is flammable material in the firebox during light off.

Since the unit consists of several pieces of rotating equipment be sure to maintain a safe distance from mechanical linkages and rotating parts while equipment is in operation.

Personnel should always guard against burns in the boiler areas from the many hot items of equipment and piping even though personnel protective insulation is provided in most areas. Even with insulation, some of the boiler walls may be above 150^{o}F and during operation some of the insulation may have been removed for maintenance.

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3.0. GENERAL PROCESS OVERVIEW

3.1 BOILER FEEDWATER PROCESS FLOWS

The Boiler Feed Water System area consists of the Deaerator, Boiler Feed Water pumps and the Chemical Injection Systems. Demineralized Water flows from the Demineralized Water Storage Tank to the Deaerator Stripper Section of the Deaerator Tank.

Treated Low Pressure Condensate enters the stripper section from Condensate Activated Carbon Filter and Condensate Mixed Bed Polisher System. Here the water is steam stripped with low pressure steam to remove oxygen, and chemicals added to treat the water before use in the plant. Non-condensibles accumulated in the Deaerator are vented through an atmospheric vent pipe located on the top of the stripper section . Boiler Feed Water Pump is provided to pump the Boiler Feed Water to various users via high (1500 psig) and medium(950 psig) pressured headers.

The Deaerator removes dissolved gases from the BFW to supply BFW to the two utility boilers, furnace steam drums, desuperheaters and process users. Demineralized Water from Demineralized Water Storage Tank is pumped by the BFW Makeup Pump and preheated by the Boiler Blow Down Cooler, before being fed to the stripper section of the Deaerator. Low pressure steam from the distribution header is introduced to the stripper section under pressure control to steam strip out the oxygen and dissolved gases in the BFW.

A low low level activated by will shut down the Boiler Feed Water Pump on line to conserve the level in the Deaerator tank to prevent pump cavitation. Amine from pump is injected into the BFW Pump suction piping to control corrosion in the condensate systems.

An O_2 scavenger chemical from a pump is injected into the Deaerator to remove any free oxygen remaining after steam stripping of the BFW. Analyzers have been provided to indicate the level of conductivity and pH of the BFW. The treated BFW is then pumped by the BFW pumps to the high and medium pressure BFW headers. Boiler Feed Water Pump, is driven by a steam turbine. The steam turbine uses high pressure steam(1500 psig) and exhausts low pressure steam(50 psig) to the low pressure steam header.

Each BFW pump has an Automatic Recirculation Control Valve. This valve is designed to function as a check valve and a minimum flow valve. The main flow passing through the guided check valve, overcomes the spring force by lifting the complete Disc-Piston assembly which in turn reduces the recirculation flow back to the Deaerator. A reduction in the main flow, lowers the Disc-Piston assembly, increasing the recirculation flow, thus maintaining the minimum specified flow through the pump. Each BFW pump is provided with a pump case warm up line to maintain the selected spare pump in a standby condition.

The electric motor driven pumps are provided with local hand, off, automatic (HOA) function switch. Both of the electric motor driven pumps and the turbine driven pump are designed to shut down on low low level in the Deaerator and startup on indication of low low header pressure. This function is only applicable if the HOA switch on the pump is in the automatic mode. The BFW pump is a two stage pump; the first stage supplies 950 psig discharge and the second stage supplies BFW at 1500 psig.

Chemical Injection Package, has been provided to supply Amine, an O_2 scavenger, and Phosphate chemicals to treat the BFW and is made up of the following equipment:

- Amine Mixing Tank & pump
- Hydrazine Mixing Tank & pump
- Phosphate Mixing Tank, Phosphate Tank Mixer,and Phosphate Dosing Pump

Amine is pumped from the tank using the Amine Dosing Pumps, to the suction piping of the BFW Pumps, to control the pH of the BFW. The Amine Mixing Tank is inventoried with Amine and Demineralized Water to achieve the desired concentration (determined by the vendor) before the Amine is introduced into the BFW.

An O_2 scavenger is pumped from the tank, using the Dosing Pump, to the outlet line of Deaerator Stripper, to scavenge O_2 in the BFW. The Mixing Tank is inventoried with an O_2 scavenger and Demineralized Water to achieve the desired concentration (determined by the vendor) before the O_2 scavenger is introduced into the Deaerator Stripper.

Phosphate is pumped from to the Boiler using the Phosphate Dosing Pumps. Phosphate is used to increase the suspension of solids to later be removed through blow down. The Phosphate Mixing Tank is inventoried with Phosphate and Demineralized Water and mixed a Mixer, before the Phosphate is introduced into the boilers. Phosphate is injected into the BFW header but not into the desuperheater BFW line. Phosphate works well in the water side of the steam drums but should never be allowed to get into any steam lines because the phosphate does not vaporize and will cause damage to the super heater sections and any carryover in the steam headers can damage steam turbines.

Design Data

NORMAL OPERATING CONDITIONS

Deaerator

Pressure (design)	10 PSIG
Temperature (design)	250 degrees F

Deaerator Stripper

Pressure (design)	10 PSIG
Temperature (design)	250 degrees F

Boiler Feed Water Pump

Rated Capacity	700 GPM
High Header P(psig)	1500
Medium Header P(psig)	950

Amine Dosing Pumps

Discharge Pressure	70 PSIG
Rated Capacity	2.0 GPH

O_2 scavenger (Hydrazine) Dosing Pump

Discharge Pressure	70 PSIG
Rated Capacity	1.0 GPH

Phosphate Dosing Pump

Discharge Pressure	2000 PSIG

Rated Capacity	1.0 GPH

3.2 BOILER SYSTEM PROCESS FLOWS

1500 PSIG steam is generated by two Boilers. Each boiler is rated at 125,000 Lbs/hr. giving a total capacity of 250,000 lbs/Hr. The boilers are fired using Fuel Gas from the plant fuel gas header. There are two separate high and low pressure blow down vessels provided for the boiler, continuous and intermittent blow downs. The blow down from the continuous drum is flashed to recover steam with the condensate from this drum supplying condensate to the caustic tower's water wash section.

The Utility boilers are provided to makeup any shortage in super high pressure steam required by the compressor turbine to maintain the process pressure requirements of the compressor, and temperature requirements for other process needs.

The steam drum maintains a constant level with makeup of Boiler Feedwater at 230^{o}F from the Boiler Feed water Pumps. Before entering the steam drum, the boiler feedwater is heated as it passes through the economizer to recover heat from the flue gas.

The 1500 psig saturated steam at 600^{o}F exiting the steam drum is then "superheated" in the superheater section. To maintain an exiting steam temperature of 950^{o}F, additional boiler feedwater is added on temperature control to desuperheat the steam to the required superheated steam temperature.

Heat is supplied to the boiler from the combustion of fuel gas. This fuel gas is obtained from the plant fuel gas header which is made up of hydrogen, methane, etc. Fuel gas flow to the boiler is controlled by the BTU value of the fuel gas to each boiler to maintain desired steam production and also to maintain an oxygen level in the stack to prevent excessive fuel consumption.

A Forced Draft Fan supplies combustion air to each boiler. The fan has both turbine and motor driven. If the turbine fails for any reason and is not able to maintain a level of rpm's, the motor takes over to maintain the fan speed. The suction to the fan consists of fresh air and also recirculated flue gas from the flue gas duct. The flue gas recirculation stream is on flow control and is utilized to reduce the Nox emissions in the stack. Flow of air to the Fan is controlled by an inlet vane actuator which opens or closes as needed to add or reduce air, respectively.

The conductivity analyzer signal on the continuous blow down stream from the steam drum is sent to the DCS for monitoring. High conductivity in this stream indicates that the blow down needs to be manually increased as the system is "cycling up" usually because of increased steam production.

There are two flame scanners on each boiler to verify flame in the firebox. It takes the loss of both to shut the boiler down. The burner management system utilizes the scanners to ensure that there is fire in the firebox. If there is no fire in the firebox after an allotted time, the system will shut down and require a repurge.

In the event of a sudden increase in the 1500 psig steam header pressure if the SHP steam header can not respond quickly enough to reduce the boiler load pressure, there is a pressure controller that will open up to vent any excess 1500 psig steam pressure to atmosphere until the system pressure is stabilized. As the Master pressure control takes over and the header pressure returns to its set point the vent valve will close.

Phosphate is injected directly into the Water Drum or "Mud Drum" of the Boiler. The on stream conductivity analysis and laboratory analysis of the boiler blow down flows, is the basis for the amount of chemical injection and the amount of blow down needed to maintain the quality of the boiler feed water.

The chemical injection is needed because of the hardness in the water coming from the inlet water stream and also iron and copper corrosion products returning with the condensate. They must be controlled to inhibit deposit formation on heat transfer surfaces and to prevent tube failures, which is why normally a coordinated phosphate program is used to prevent this from occurring. Conductivity is a good indication of the cycles in the boiler but samples must always be used to verify the silica and hardness levels in the steam drum as these are the constituents that must be kept at a minimum to ensure minimal loss of heat transfer in the boiler tubes.

As feed water hardness enters the Boiler Steam Drum, insoluble hardness sludge is produced. This sludge must be conditioned to prevent deposition before the boiler circulation carries it to the boiler's high heat zones. Phosphate reacts with calcium and magnesium to form precipitates; which are still relatively adherent to boiler metal surfaces, particularly under high heat transfer conditions. These precipitates must be removed by blow down through the continuous blow down line and the intermittent blow down line. The intermittent blow down is used to purge solids that will collect in low spots.