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1.0 INTRODUCTION

1.1 Purpose and Scope

This system description provides an overview of the Circulating Water System, describes the system's major components, and explains their operation and control. The Circulating Water System contains the following major components and sub-systems:

- Intake Structure
- Traveling Screens
- Screen Wash System
- Circulating Water Pumps
- Main Condenser (A and B)

1.2 System Overview

The purpose of the Circulating Water System is to remove heat from the power plant steam cycle by circulating cooling water through the tubes of the main condenser. The system removes the latent heat of vaporization from the turbine exhaust steam, condensing the steam which is then collected in the condenser hotwell as condensate. This serves two purposes:

- Creates a very low pressure (usually 26 to 29” Hg (vacuum)) at the turbine exhaust, increasing turbine and ultimately Unit efficiency.

- Recovery of the turbine exhaust steam as condensate to be pumped back to the boiler for re-use.

1.2.1 System Primary Flowpath

The Circulating Water System primary flowpath begins at the intake structure and ends at the seal well. The system circulates water through the main condenser tubes to remove heat, condensing the exhaust steam from the main turbine. The heat transferred to the circulating water in the condenser is then rejected to the river.

The two circulating water pumps, located in the intake structure, take suction from the Mississippi River. The circulating water passes through a set of traveling screens before entering the circulating water pump suction areas.

Each circulating water pump discharges through a 60”, motor-operated butterfly valve (MOV-1018 and MOV-1019) into a common 78” discharge header. The underground header routes the circulating water west to the north side of the two twin pass condenser water inlets. Circulating water enters condenser 1A through manually operated inlet butterfly valves (V-1020 and V-1021). After passing through condenser 1A, the circulating water exits the condenser through manually operated outlet butterfly valves (V-1024 and V-1025), into the common circulating water return header for return to the river via the seal well and discharge canal. Circulating water also enters condenser 1B through manually operated inlet butterfly valves (V-1022 and V-1023). After passing through condenser 1B, the circulating water exits the condenser through manually operated outlet butterfly valves (V-1026 and V-1027), into the common circulating water return header for return to the river via the seal well and discharge canal.

The circulating water piping between the plant and intake structure is lined and coated steel pipe which is buried under ground. Transition pieces are located downstream of the valve pit and upstream of the condenser and the seal pit. The top of the weir in the seal pit is at elevation 181’ to maintain a siphon on the system at low water levels.

1.2.2 System Secondary Flowpath(s)/Components

The Circulating Water System also contains or interfaces with the following systems and/or components:

- Cooling Water System
- Circulating Pump Lube Water
- Traveling Screen Wash Water

Cooling Water System

The Cooling Water System, which cools various heat loads throughout the plant including the auxiliary cooling water system, is supplied by the cooling water pumps which take their suction through a 24” line off the circulating water header.

Circulating Pump Lube Water

The circulating water pumps are supplied with water for the lubrication and cooling of the pump packing glands. The water is normally supplied from the potable water header through a set of manual isolation valves. This water supply also provides cooling to a bearing oil cooler located in each circulating water pump motor. The potable water supply can be supplemented in an emergency from service water.

Traveling Screen Wash Water

The traveling screens are equipped with a wash system designed to continuously remove filtered debris from the traveling screens. The system consists of two wash pumps with a single inlet filter, and spray nozzles to direct wash water over the traveling screens. The screen wash pumps take suction from the circulating water header to supply wash water to the traveling screens. The screen wash system can be cross connected with the Unit 2 screen wash system if necessary.

Each set of screens receives wash water through separate lines containing manual isolation valves. The individual wash lines are located within the traveling screen structure. Each line contains several nozzles which direct the wash water across the mesh panels. This action flushes any debris from the screen surface. The flushed debris flows back through a trough to a drainage pond south of the intake structure.

2.0 MAJOR COMPONENTS AND SUBSYSTEMS

2.1 Intake Structure and Seal Well

2.1.1 Function

The function of the intake structure is to transfer river water to the suction of the circulating water pumps. The intake structure also houses the Unit 2 circulating water pumps and traveling screens.

2.1.2 Detailed Description

Circulating water is obtained through a two unit intake structure located in the west bank of the Mississippi River, about 1000 ft. east of the levee. Two 108" diameter steel gravity-flow pipes supply water to the traveling screen and pump chambers of the intake structure. Breasting dolphins are located north and south of the pipe inlets to prevent damage from river traffic.

The intake structure is a concrete structure buried in the west bank of the Mississippi River. The top of the intake structure is located at ground level. Access to the pump chambers and circulating water pump discharge valves is through steel covers which are mounted in the top of the intake structure. The equipment installed at the intake structure is exposed to the weather; therefore, all electrical gear to be located in waterproof enclosures. A 35-ton bridge crane, which is supported by a steel I-beam structure, is provided for servicing Unit 1 and Unit 2 equipment. Normal access to the intake structure is by a gravel road between the levee and the river bank. If the access road is flooded, the intake structure can be reached by using the concrete trestle bridge that leads from the levee to the intake structure.

After passing through the condenser, circulating water discharges through a seal well to a discharge canal which leads back to the Mississippi River. The Unit 1 seal well is located adjacent to the Unit 2 seal well on the north side. The top of the seal well weir is located at elevation 181' to maintain a siphon on the circulating water system. This reduces the work required by the circulating water pumps to move river water through the condenser. The seal wells are located east of the fuel oil day tank on the river side of the levee.

The seal well discharges into a 2500' long canal which passes through a concrete discharge structure before reaching the river. Water is directed away from the river bank by two submerged pipes which are protected by breasting dolphins. The discharge structure is located about 3300' downstream of the intake structure.

The circulating water header crosses over the top of the levee, both on the condenser supply and return sides. This results in high spots in the circulating water piping where air pockets can form and reduce the circulating water flow through the condenser. To prevent this, an air removal system is installed to ensure the circulating water piping is filled at all times.

A series of vents are located on the supply and return circulating water headers where they cross over the levee. These vents are connected to the air evacuation system located in a building on top of the levee and west of the seal wells.

Two Nash vacuum pumps take suction on a vacuum tank which in turn is connected to the circulating water vents. The vacuum pumps are operated by level switches located on the vacuum tank. Each vacuum pump is driven by a 10 HP 480 VAC motor. A cross-connect line is installed between the Unit 1 and Unit 2 systems to permit one air evacuation system to draw from both circulating water systems.

2.1.3 Operation, Control, and Safety

The intake and discharge structures require no Operator attention other than periodic inspections for debris buildup. The circulating air removal system is normally operated in automatic mode. The vacuum pumps' operation is controlled by the level of water in the vacuum tank. Water level in the vacuum tank is a function of the pressure in the tank. As vacuum increases, tank level will increase. If tank vacuum decreases, the water level in the tank will decrease to a new operating level. One vacuum pump runs continuously with the standby pump controlled by two level switches. LS-967 starts the standby pump and LS 966 stops it. If vacuum tank water level reaches LS-965, both vacuum pumps are tripped due to high water level. If water level decreases to LS-968, an Air Evacuation Trouble alarm is activated in the Control Room.

2.1.4 Technical Design Data

Circulating Water Air Evacuation Pumps	
Manufacturer	Nash
Type	Positive Displacement
Size	SC214
Speed	1750 rpm
Motor Manufacturer	Marathon Electric
Motor Horsepower	10
Motor Voltage	480 volts
Motor RPM	1740 rpm

2.2 Traveling Screens

2.2.1 Function

The function of the traveling screens is to continuously remove debris from the incoming river water before it is drawn in by the circulating water pumps. If this debris were to enter the system, damage to the pumps and pluggage of the system piping could occur.

2.2.2 Detailed Description

There are two traveling screens, 1A & 1B, located in the intake structure on the east side of the levee. The traveling screens filter debris from the river water entering each circulating water pump cell (the suction source for the pumps). One set of screens filters river water for each circulating water pump. Figure 2.1 illustrates the 1B traveling screen.

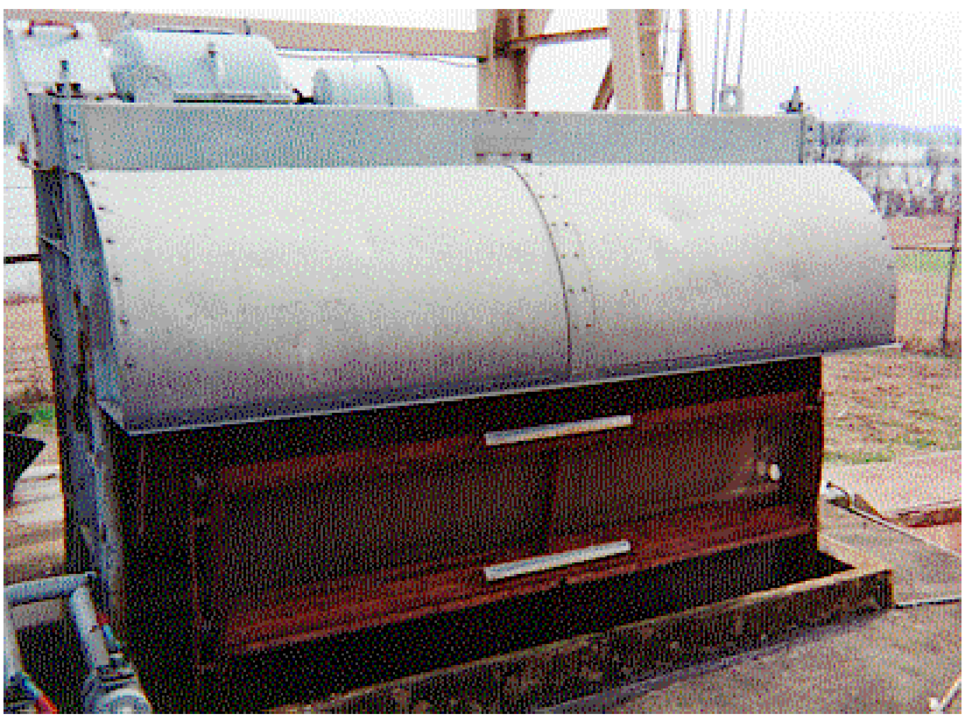

Figure 2.1 1B Traveling Screen

The traveling screens are a series of 85 mesh panels linked to form a continuous chain. The mesh panels are constructed of stainless steel wire with 3/8” openings. The screens, manufactured by the Link Belt, are arranged vertically in the intake cell. The screens rotate around upper and lower sprockets that are set approximately 79’ apart. The upper sprocket of each traveling screen is rotated by a 5 HP, 480 VAC electric motor manufactured by Westinghouse.

The electric motor rotates the screens through a speed reducer and a chain-belt assembly. The reducer output produces a screen speed of 10 fpm in fast and 5 fpm in slow speed. Under normal conditions, the slower speed is sufficient to filter the river water.

Instrumentation is provided to monitor the level differential across the traveling screens. A high level differential activates an alarm in the Control Room. Large differences in level across the screens indicates dirty and clogged panels.

Located along the base and the drive section of the screens are internal spray headers containing several spray nozzles. These spray headers receive water which is discharged from the screen wash pumps. The water is sprayed through the screens (in a direction opposite to that of the river water flow through screens) to remove any marine life or debris. All debris flushed from the screens is directed to a drainage pond south of the intake structure.

2.2.3 Operation, Control, and Safety

The traveling screens are aligned for service any time the circulating water pumps are in service. This ensures that the river water drawn in by the pumps is free of debris which could damage the system.

The traveling screens require that three systems be in service for support. The first system is the screen wash system, without which the screens would clog and the water level at the river intake pumps would drop. The second support system is the electrical distribution system, without which the traveling screen motors could not be operated. The third system is the circulating water system which supplies water for the screen wash pumps.

The screens can be run prior to starting the circulating water pumps by using service water as a supply for the screen wash pump. This would be performed if necessary to remove debris and marine life from the screens accumulated while the circulating water system was shutdown. If material does accumulate on the screens during pump operation, high differential levels across the screen assemblies would develop. These high differential levels, sometimes called "water falls", can damage the screen assemblies if they become excessive. To protect the screens and alert the Operators of such a condition, the water level differential across the screens is monitored and high level conditions are alarmed in the Control Room.

The screens when originally installed were designed for both automatic and manual operation. The automatic mode of operation was controlled by the differential level measured across the screens. Each screen is now manually operated locally from its respective control station using the FAST-OFF-SLOW or JOG switches.

During operation, the traveling screens rotate continuously to filter debris from the suction of the circulating water pumps.. Traveling screen operation is usually controlled manually in conjunction with the screen wash pumps, which will be discussed in the next section. Under normal conditions, the traveling screens are operated once a shift, except when river conditions require more frequent use.

It is important to monitor the operation of the traveling screens. If they should become plugged (usually the result of not rotating), an excessive water level differential may result across the screens. This can cause the screens to fail due to the differential pressure. In extreme cases, it can even result in the inlet cell being pumped so low that the circulating water pumps lose suction.

2.2.4 Technical Design Data

Traveling Screens	
Manufacturer	Link Belt
Type	4-Post
Capacity (Minimum Water Level)	95,000 gpm
Velocity (Minimum Water Level)	3.72 fps
Sprocket Centers	79'-0"
Basket Size	10'-0" x 24"
Number of Baskets	85
Screen Material	0.080" dia. Type 304 Stainless Steel
Speed	10/5 fpm
Motor Manufacturer	Westinghouse
Motor Horsepower	5/2.5
Motor Voltage	480 volts
Motor RPM	1800/900 rpm

2.3 Screen Wash System

2.3.1 Function

The function of the Screen Wash System is to remove debris from the traveling screens as they rotate and to flush the debris to a drainage pond.

2.3.2 Detailed Description

The traveling screens are equipped with a wash system designed to continuously remove filtered debris from the traveling screens. The system consists of two screen wash pumps, 1A & 1B, a common inlet strainer, traveling screen spray nozzles, and a cross connect with the Unit 2 screen wash pump. Figure 2.2 illustrates the 1A screen wash pump.

The screen wash pumps normally take their suction through a twin inlet strainer from the Unit 1 circulating water pumps discharge header, and supply wash water to both traveling screens. The pumps suction can also be lined up to receive water from the Unit 2 circulating water header, or from the service water system. The screen wash pumps discharge through check valves and manual discharge valves into a common header which directs the wash water to both traveling screens. A cross connect line with a manual isolation valve also connects the Unit 1 screen wash discharge header with the Unit 2 screen wash discharge header.

Each set of screens receives wash water through two separate lines containing manual isolation valves, which supply the two sets of wash nozzles, one in the drive section and one in the boot section of the traveling screen.

The individual wash lines are located within the traveling screen structure. Each line contains several nozzles which direct the wash water across the mesh panels. This action flushes any debris from the screen surface. The flushed debris flows back through a trough located east of the traveling screens which directs debris to a drainage pond south of the intake structure.

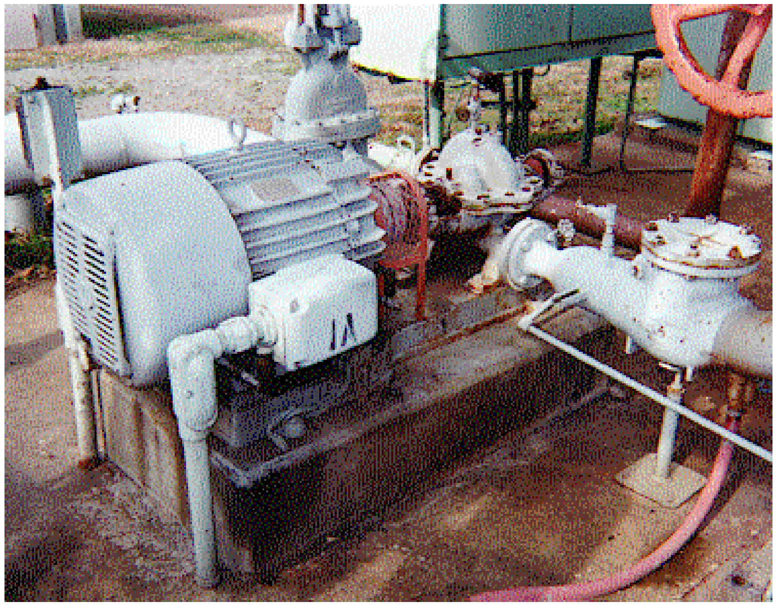

Figure 2.2 1A Screen Wash Pump

The screen wash pumps are single-stage, centrifugal pumps manufactured by Peerless. Each pump is rated to deliver 600 gpm of water at a discharge head of 200 feet, and are driven by a 50 hp, 3560 rpm, 480 VAC motor. The screen wash pumps are located west of the circulating water pumps.

2.3.3 Operation, Control, and Safety

The Screen Wash System must be placed in service before the traveling screens are started. This ensures that wash water is available to flush any debris that may have collected on the screens when they are not in operation. The system is operated in the manual mode of operation.

The Screen Wash System is placed in service by aligning the system valves and starting one of the screen wash pumps. During normal system operation, the Unit 1 screen wash pumps are used. The Unit 2 screen wash pump can be used if both the 1A or 1B pump is unavailable. A back-up water supply from the Service Water System can also be used by opening the supply valves which are located on the south side of the 1B screen.

The traveling screens and screen wash pumps are operated locally with manual control switches. Each traveling screen is equipped with a FAST-OFF-SLOW control switch and a JOG pushbutton. Each screen wash pump is equipped with a RUN-OFF-AUTO control switch.

During normal operation, the screen wash pumps and the traveling screens are operated manually. At least once a shift the traveling screens and screen wash system are operated to ensure a filtered supply of water is available at the suction of the circulating water pumps. The system is operated manually by positioning the desired wash pump selector switch to the RUN position. Once positioned, the screen wash pump starts. Once the screen wash water pressure exceeds approximately 100 psig, the traveling screens should be started by placing the control switch in the SLOW position.

WHITE run indicator lights are provided on the BTG board for both the 1A and 1B intake screens, and RED run indicator lights are also provided for both the 1A and 1B screen wash pumps.

The system is allowed to operate for several minutes to ensure that the screens are free of debris and the water supply for the circulating water pumps is adequate. After it has been determined the screens are clean and the screen water level differential is normal, the system can be shutdown by placing the selector switch in the OFF position.

The original automatic mode is no longer used. In this mode, the water level differential across the traveling screens controlled the operation of the traveling screens and the wash pumps. Level switches were used to control the operation of each screen and the screen wash pumps. When the level differential exceeded a high level setpoint, the selected wash pump would start and the traveling screens began rotating. When the level differential fell below the low level setpoint, the system would then shutdown.

It is important to monitor the operation of the Screen Wash System to ensure the screens are properly cleaned. If the screens should become plugged, an excessive water level differential may result across the screens. This can cause the screens to fail due to the high differential pressure. In extreme cases, it can even result in the inlet cell being pumped so low that the circulating water pumps lose suction. An Intake Screen Differential High alarm is provided in the Control Room.

The suction line of the screen wash pumps contains a twin strainer that is monitored locally with inlet and outlet pressure indicators. A differential pressure of approximately 2.5 psid indicates the strainer should be switched and cleaned.

2.3.4 Technical Design Data

Screen Wash Pumps 1A & 1B	
Pump Manufacturer	Peerless
Pump Type	Single stage, centrifugal
Total Discharge Head	200 feet
Rated Discharge Flow	600 gpm
Motor Manufacturer	General Electric
Motor Horsepower	50
Motor Voltage	480 volts
Motor Speed	3560 rpm

2.4 Circulating Water Pumps

2.4.1 Function

The function of the circulating water pumps is to supply circulating water to the condenser for condensing turbine exhaust.

2.4.2 Detailed Description

There are two, 70,000 gpm, 50% capacity circulating water pumps installed in the Circulating Water System. The circulating water pumps, 1A & 1B, are located at the intake structure on the east side of the levee, south of the Unit 2 pumps. The pumps take suction from the intake cells which are supplied by the Mississippi River. Each pump discharges through a motor-operated discharge valve into a common discharge header. The underground header routes the circulating water westward to the north side of Unit 1 where it enters the condensers. Figure 2.3 illustrates the Circulating Water Pump Motors.

Figure 2.3 Circulating Water Pump Motor

The circulating water pumps are manufactured by Ingersoll-Rand. Each circulating water pump is a vertically mounted, mixed flow, two-stage, centrifugal pump designed to deliver a large volume of water at a relatively low discharge head (80 feet).

Each pump is directly coupled to a 1750 HP, 4000 VAC electric motor through a vertical shaft. The pump shaft is supported by sleeve-type bearings. The area where the shaft penetrates the pump casing is sealed using a stuffing box. Packing contained in the stuffing box prevents circulating water from leaking out. Lubrication water, from the potable water header at the rate of 30 - 35 gpm and at 70 - 75 psig, is injected into the pump stuffing box to provide cooling and lubrication to the shaft packing and pump bearings. A backup supply of cooling water is provided by the service water system.

Each circulating water pump motor is equipped with upper and lower bearing housings with oil level gauges. The upper bearing contains an oil reservoir, and is equipped with fill and drain plugs and an oil cooler. Potable water flows through the tube side of the cooler to remove heat from the oil.

Each circulating water pump discharge line is equipped with a pressure indicator and a motor-operated discharge valve (MOV-1018 and MOV-1019). The discharge valves are located just west of the associated pump, and prior to pump startup are maintained in the closed position.

2.4.3 Operation, Control, and Safety

The Circulating Water System is generally one of the first systems placed in service and one of the last systems shutdown. The Circulating Water System, and thus at least one circulating water pump, must be in service anytime the turbine is in service.

In normal operation, both circulating water pumps are in service. At very low loads (as during startup) or when the river water is very cold, only one pump may need to be operated. Since both pumps discharge to a common header, one pump can serve both condenser sides, although with a lower circulating water flow as compared to two pump operation. This causes the condenser vacuum to decrease (absolute pressure to increase); however, with low river water temperature, the decrease may be small and acceptable with little or no load reduction. If the river water temperature is not very low, it may be necessary to reduce load in order to avoid excessively high condenser pressure (low vacuum).

The circulating water pumps require that three systems be in service for support. The first system is the potable water supply, without which the motor bearings would fail and the packing gland would overheat. The system is aligned by opening the manual isolation valves which supply each pump. If the backup source is necessary, the service water header valves must be aligned properly.

The second support system is the electrical distribution system, without which the pump motors and motor-operated valves could not be operated. The third system is the traveling screen and wash systems which prevent debris from entering the circulating water pumps.

The circulating water pumps move a considerable mass of water. It is important that the discharge valve of the circulating water pump be closed before it is started. Interlocks prevent starting the pump unless the discharge valve is closed. In addition, a complete flowpath must be established through at least one pass of the condenser.

At pump startup, the discharge valve is closed when the pump control switch is placed in the START position. The discharge valve first opens 25% then the pump starts to allow circulating water to flow at a reduced rate to the condenser in order to prevent damaging the system due to water hammer. When the condenser and system piping has been filled, the discharge valve is fully opened by pressing a red pushbutton on the BTG located above the respective pump operating switch. This control configuration ensures a gradual increase in system pressure while preventing undue stress of the downstream piping and components.

When the circulating water pump is manually stopped or trips, the discharge valve automatically closes. Other permissives associated with starting a circulating water pump include the following:

- Condenser side 1 or side 2 isolation valves must be open.
- Adequate bearing cooling and lube water must be available.

Each circulating water pump is operated remotely from the Control Room. The pumps are controlled manually using START/STOP spring-to-center control switches. When the switch is placed in the START position, the pump starts provided all the starting permissive have been satisfied. The controller returns to the normal (center) position and the pump runs. The pump continues to run until the controller is placed in the STOP position or the pump trips due to an abnormal condition. Each control switch is equipped with RED run and GREEN stopped indicating lights. Each pump discharge valve also has RED open and GREEN closed indicating lights.

The starting current to the circulating water pump motors is approximately 520% of the full load running current. This heavy current increases magnetic forces on the stator coils and heats the rotor cage and stator windings. The motor starting limits must be followed to prevent any damage to the motor windings.

Except for emergencies, an Operator should be stationed at the intake structure whenever a circulating water pump is started or stopped. This is especially critical during shutdown of one pump, as the discharge valve must be verified closed. If the discharge valve is not fully closed, reverse water flow through the pump will cause the pump to spin backwards and pump damage may result.

During normal operation, the circulating water pumps can be monitored both locally and from the Control Room. Each pump is equipped with local indicators to monitor pump discharge pressure. It is important that the pump discharge pressure is maintained to prevent damage to the system piping. Circulating water pump trips are alarmed in the Control Room. In addition, the local indication of bearing lube water flow is provided.

The Circulating Water System may be shut down only after both of the following conditions exist:

- The turbine is on the turning gear, and vacuum on the condenser is broken.
- Cooling water demand is not required.

2.4.4 Technical Design Data

Circulating Water Pump	
Pump Manufacturer	Ingersoll-Rand
Pump Type	Vertical, two stage, centrifugal
Total Discharge Head	80 feet
Rated Discharge Flow	70,000 gpm
Motor Manufacturer	General Electric
Motor Horsepower	1750
Motor Voltage	4000 volts
Motor Speed	356 rpm

2.5 Main Condensers

2.5.1 Function

The function of the condensers is to convert the exhaust steam from the low pressure (LP) turbines to condensate for re-use in the power plant steam cycle. The removal of the latent heat of vaporization from the LP turbine exhaust condenses the steam which is then collected in the condenser hotwells.

2.5.2 Detailed Description

The condensers, 1A & 1B, are a shell and tube-type heat exchanger, which are basically a large metal box with many tubes passing through it. Cooling water from the Circulating Water System flows through the tubes and absorbs the heat rejected by the LP turbine exhaust steam as it is condensed. The steam is then collected in the condenser hotwells as condensate. This serves two purposes:

- It creates a very low pressure (usually 26 to 29” Hg vacuum) at the turbine exhaust, increasing turbine, and ultimately, Unit efficiency.
- It recovers the turbine exhaust steam as condensate to be pumped back to the boiler for re-use.

The main condenser is a Yuba, two pass, twin shell surface condensing unit consisting of two 82,500-square-feet condensers, each installed under its respective double flow low pressure turbine. At rated load, the condenser is designed to use 140,000 gpm of circulating water with an inlet temperature of 90° F, and an outlet temperature of 114.3° F.

Each condenser is divided into two sections by means of separate water boxes. This construction, for practical purposes, may be considered as two condensers placed side by side. This makes it possible to isolate one side for cleaning or inspecting the tubes while the Unit is on-line.

The condenser has 18,680, 1” in diameter tubes. The tubes are fabricated from admiralty steel. The tubes are approximately 34’ in length with a normal condensing surface area of 165,000 square feet. The tubes are sealed at the ends in the tube sheets by rolling. A common location for leakage (often due to tube end erosion) is at the tube sheets.

The circulating water pumps supply cooling water to the condenser tubes through a common discharge header. The underground header routes the circulating water westward where it enters condenser 1A through manually operated butterfly valves (V-1020 & V-1021), and condenser 1B through manually operated butterfly valves (V-1022 & V-1023). The heated circulating water exits condenser 1A through manually operated butterfly valves (V-1024 & V-1025), and condenser 1B through manually operated butterfly valves (V-1026 & V-1027). The inlet and outlet valves are 42" diameter valves.

The inlet and outlet water boxes on the condenser are of steel plate, bonnet cylindrical-type construction, each equipped with quick opening manholes to facilitate inspection of the water boxes and tube ends. The design pressure of the water boxes is 40 psig, and they have been hydrostatically tested to 45 psig.

The bottom of the condenser, where condensate is collected, is called the hotwell. The hotwell can store a large volume of condensate. The hotwell provides suction to the condensate pumps which are discussed in detail in the Condensate System.

Air removal from the condenser is accomplished by a Nash vacuum pump. See the Unit 1 Main Turbine System Description for information regarding the condenser air removal system.

The purpose of the air removal system is to maintain a vacuum in the condenser shell by removing air and other non-condensable gases. Maintaining a vacuum in the main condenser increases cycle efficiency by lowering the LP turbine exhaust back-pressure. The system includes two condenser vacuum pumps, and the piping and valves to and from the air removal portion of the condenser.

2.5.3 Operation, Control, and Safety

In general, the lower the pressure (the higher the vacuum) in the condenser, the more efficient the Unit is. This makes sense for two reasons. First, the lower the pressure of the steam at the turbine exhaust, the more the steam may be expanded through the turbine blades. This allows more energy to be extracted as work. Secondly, the cooler the steam is when it leaves the turbine, the less energy it has per pound. This decrease in energy is another indication that more of the energy in the steam has been extracted by the turbine.

There is another aspect of efficiency in the condenser that is a bit more difficult to understand intuitively. Plant efficiency improves as the heat that is rejected in the condenser is rejected at lower and lower temperatures. Since the temperature in the condenser decreases as the pressure decreases, lower pressures are more efficient for this reason as well.

The pressure in the condenser is determined, in large part, by the temperature of the circulating water entering the condenser. As the circulating water temperature decreases, the condenser pressure decreases as well, with all other factors constant. In fact, the temperature of the circulating water defines the lower attainable limit for condenser back-pressure. That is, the pressure in the condenser can be no lower than the saturation pressure for the temperature of the circulating water. However, no condenser actually reaches this limit. The performance of the condenser determines how close to that limit it gets, and the condenser performance is determined by its heat transfer capabilities. The better the condenser's heat transfer capabilities, the closer it approaches the limit.

Condenser inlet and outlet temperatures are monitored continuously to determine condenser performance. Temperatures are displayed in the Control Room on the BTG. During normal operation, the main condenser requires relatively little attention. Tubes and water boxes should be kept clean and free of debris and marine growth.

During circulating water pump startup, the condenser water box inlet and outlet valves are opened fully. Manual vent valves on the water boxes are open to allow air to be purged from the condenser tubes. Once a steady stream of circulating water appears from the vents, the vent valves are closed. The water box inlet and outlet valves are manually operated at the valves.

2.5.4 Technical Design Data

Main Condenser	
Manufacturer	Yuba
Total Surface Area	165,000 sq. ft.
Number of Condenser Tubes	18,680
Condenser Tube Material	Admiralty
Tube Sheet Material	Muntz
Tube Size	1"
Effective Tube Length	34'
Heat Rejection	1.58×10^9 BTU/LB
Circulating Water Temperature	90° F
Circulating Water Flow	130,000 gpm
Circulating Water Velocity	7.0 fps

3.0 REFERENCES

P&IDs

a. Flow Diagram Water Systems, Ebasco Drawing No. G-156948.

Control Logics and Loops

None

Electrical Single Line Diagrams

None

Electrical Schematics

None

Instruction Manuals

None

Miscellaneous

a. Ebasco Major Equipment List and Project Description.

4.0 SIGN OFF & RECORD OF REVISIONS

____ ___________
REVIEWED BY: OPERATOR DATE

Glenn Freeman 11/19/97
APPROVED BY: OPERATIONS SUPERVISOR DATE

RECORD OF REVISIONS		
Revision	**Explanation**	**Date**
Rev. A	Initial Issue	February 28, 1997
Rev. 1	General Revision	November 21, 1997