9.2 WATER SYSTEMS

9.2.1 STATION SERVICE WATER SYSTEM

This system is not applicable to Waterford 3.

9.2.2 COOLING SYSTEM FOR REACTOR AUXILIARIES

Cooling water for the reactor auxiliaries is supplied by the Component Cooling Water System (CCWS) and the Auxiliary Component Coolant Water System (ACCWS).

The function of these reactor auxiliaries cooling systems is to remove heat from the reactor auxiliaries, and to transfer it to the cooling towers for rejection to the atmosphere, and to ensure continuous operation or safe shutdown of the unit under all modes of operations.

9.2.2.1 Design Bases

The design bases for the CCWS and ACCWS are:

a) The systems shall supply sufficient cooling water to remove heat from the safety related reactor auxiliaries and non safety related auxiliaries where the potential for radioactive leakage exists and to transfer it to the cooling towers during normal reactor operation.

b) The systems shall supply sufficient cooling water to the components required for normal unit shutdown.

c) The systems shall supply sufficient cooling water to components required during refueling.

d) The systems shall supply sufficient cooling water to components required for safe shutdown, and to mitigate a design basis accident assuming a single active component failure coincident with a loss of offsite power.

e) The systems shall be able to perform its safety related functions after any of the following natural phenomena:

    1) safe shutdown earthquake

    2) tornado

    3) hurricane

    4) flood

f) The systems shall be designed to withstand:

    1) the effects of external and internal missiles, as discussed in Section 3.5

    2) the effects of pipe rupture, as discussed in Section 3.6 and

3) the environmental design conditions as discussed in Section 3.11.

g) The systems shall be designed to permit periodic inspection and testing of components, to assure system integrity and capability.

h) The CCWS is designed to provide a radiation monitored intermediate barrier between the reactor auxiliaries and the evaporative wet towers (ACCWS) during normal operation.

The CCWS and ACCWS components are designed to the safety and seismic requirements listed in Table 3.2-1.

9.2.2.2 System Description

➜
The cooling system, as shown in Figure 9.2-1 (for Figure 9.2-1, Sheet 4, refer to Drawing G160, Sheet 4 and for Figure 9.2-1, Sheet 6, refer to Drawing G160, Sheet 6), for the reactor auxiliaries is divided into two separate systems:
←

a) Component Cooling Water System (CCWS), and

b) Auxiliary Component Cooling Water System (ACCWS).

The CCWS is a closed cooling water system serving all reactor auxiliaries. Heat is removed from the system by dry cooling towers (see Subsection 9.2.5), and by the CCW heat exchangers.

The ACCWS is a separate system that provides cooling water to the CCW heat exchangers, and pumps it to the wet cooling towers for heat dissipation to the atmosphere.

Design data of the CCWS and ACCWS components are listed in Table 9.2-1. Controls for the CCWS and ACCWS components are described in Table 9.2-2. The equipment served by the CCWS and ACCWS under all conditions is listed in Table 9.2-3.

9.2.2.2.1 Component Cooling Water System

The CCWS is a closed loop cooling water system that uses demineralized water buffered with a corrosion inhibitor to cool components listed in Table 9.2-3. The CCWS includes two CCW heat exchangers (tube side), three 100 percent capacity pumps, two dry cooling towers, one surge tank (baffled) and one chemical addition tank. The demineralized cooling water is pumped by the CCW pumps through the dry cooling towers and the tube side of the CCW heat exchangers, through the components being cooled and back to the pumps.

The CCW surge tank is connected to the suction side of the pumps, and accommodates fluid expansion and contraction of the system. The demineralized makeup water is normally added from the Demineralized Water System to the CCWS through a control valve which is automatically actuated by the CCW surge tank level monitoring equipment. In addition, two seismic Category I CCW makeup pumps take suction from the condensate storage pool and are capable of providing makeup.

Two CCW pumps normally operate. A third pump is provided as a standby. The motors of the two normally operating pumps are connected to buses in separate electrical divisions, A and B. The third pump is available to replace an on-line pump that is unable to perform its function. The standby pump is connected to the A/B bus and may be manually aligned to either A or B division (see Subsection 8.3.1.2.3).

The CCWS supplies cooling water to two redundant safety-related essential loops, a nonessential seismically qualified loop, and a nonessential nonseismic loop.

Each essential loop services the following equipment:

a) one emergency diesel generator

b) one essential services water chiller

c) two containment fan coolers

d) one high pressure safety injection pump and the standby high pressure injection pump (valved into one train only)

e) one low pressure safety injection pump

f) one containment spray pump

g) one shutdown cooling heat exchanger

→
h) Post-Accident Sampling System (PASS)
←

The nonessential seismically qualified loop services the following equipment:

a) one letdown heat exchanger

b) one fuel pool heat exchanger

c) four reactor coolant pump seals and motor coolers (seismically supported)

d) control element drive mechanism (CEDM) coolers (seismically supported)

e) one backup fuel pool heat exchanger

The nonessential, nonseismic loop services the following equipment:

a) waste gas compressors

b) sample coolers

c) chemical feed tank

d) boric acid and waste concentrators

→(EC-30976, R307)
During normal operating conditions, the two operating CCW pumps are connected on the pump suction and discharge, and supply cooling water into common headers serving safety and non-safety equipment. During either shutdown, refueling, or defueled operating conditions it is possible to provide adequate CC support with only one loop. CCW maintenance and modification will occur during either MODE 5, MODE 6, or when defueled on one loop at a time when conditions allow a single CC loop to provide adequate cooling for plant systems. Upon SIAS, the two redundant safety loops will be automatically isolated from each other by closure of two fail close pneumatic header isolation valves (3CC-F121B, 3CC-F123B) and the nonessential, nonseismically qualified loop will be automatically isolated from both by closure of two fail closed pneumatic valves (3CC-F133A/B, 3CC-F132A/B). The CCW pump suction and discharge header isolation valves will also close on SIAS. The outlet valve on the "A" shutdown heat exchanger CC-963A (3CC-F130A) remains closed but may be opened manually from the control room, the outlet valve CC-963B (3CC-F131B) on the "B" shutdown heat exchanger goes full open automatically. The A loop also continues to provide cooling to the Reactor Coolant Pumps via the nonessential seismically qualified loop.
←(EC-30976, R307)

Following isolation, on SIAS, separate CCWS channels are formed, and each supplies cooling water in sufficient quantity and at the required temperature to remove 100 percent of the heat necessary to shutdown the reactor.

→(EC-30976, R307)
Upon CSAS, the containment isolation valves (2CC-F146A/B, 2CC-243A/B, 2CC-F147A/B) on the supply and return lines of CCW to the Reactor Coolant Pumps and CEDM coolers are automatically isolated, and the outlet valve CC-963A (3CC-F130A) on the A shutdown heat exchanger goes full open automatically.
←(EC-30976, R307)

The required NPSH for the CCW pumps is provided by a surge tank located approximately 70 ft. above the pumps. The surge tank is provided with a baffle plate and redundant level indication and controls to ensure that water ,loss in one CCWS channel will not affect the redundant channel operation. Low Surge Tank level will isolate the respective CCW train (see Table 9.2-5). Overflow from the surge tank is piped to the waste drains leading to the Waste Management System.

The chemical feed tank in the system permits manual on-line addition of proper corrosion inhibitor. A commercial corrosion inhibitor is used to maintain proper corrosion protection for the Component Cooling Water System.

A filtration system consisting of two sets of filters arranged in series is provided on the non-essential loop for maintaining CCW water purity. Each filter housing is provided with a set of isolation valves to allow for on-line filter maintenance.

A continuously operating radiation monitor is provided in each of the redundant headers on the discharge loop of the CCW pumps. Additional radiation monitoring is provided to monitor radioactivity of the cooling water from the components inside the containment; i.e., reactor coolant pump, motor and seal coolers, and control element drive mechanism. Should activity in the system rise above the set limit, a high radiation alarm is actuated in the main control room. A more complete discussion of the CCWS radiation monitors is provided in Section 11.5.

The temperature controls for the ACCWS components are described in Table 9.2-2 and in Subsection 9.2.5. The ACCWS consists of two 100 percent capacity, independent loops. Each loop includes a pump, and an evaporative wet type mechanical draft cooling tower. Each tower has a basin which is capable of storing sufficient water to bring the plant to safe shutdown under all accident conditions. Subsection 9.2.5 contains a detailed description of the ultimate heat sink.

The system is divided into two separate loops, each serving one of the redundant CCWS trains. ACCWS water is pumped by the ACCW pumps through the shell side of the CCW heat exchangers to the wet cooling towers. The ACCW pumps then take suction from the basin of their respective cooling tower to complete the path to the CCW heat exchanger. The ACCW pumps are designed with sufficient NPSH for 105°F cooling tower basin water temperature and minimum water level. The ACCW pump motors are connected to separate Class 1E buses, one in each electrical division.

The ACCWS provides cooling water to the Essential Services Chilled Water System chillers, whenever the CCWS temperature exceeds a maximum setpoint of 105°F (102°F nominal). Chiller supply valves align automatically to ACCW when CCW temperature exceeds the nominal setpoint. Temperature control to the Chiller is described in Table 9.2-2.

Each basin is provided with an independent, non-safety related filtration/chemical addition system to maintain water purity and pH. This system consists of a pump, filter, and chemical feed tank. The pump takes suction from the bottom of the basin, and discharges through a filter housing and spray headers at the top of the basin to aerate the water.

9.2.2.2.2 Auxiliary Component Cooling Water System

The system also includes a Jockey Pump which operates when the ACCW Pump is idle to keep the piping upstream of ACC-126A(B), the CCW Heat Exchanger Outlet Temperature Control Valve, full of water and pressurized during normal operations. In the event the high point pressure decreases due to a Jockey Pump capacity, the ACCW Pump will automatically start on a low pressure signal in order to ensure the system remains full. The Jockey Pump is not required to operate post-accident.

9.2.2.3 Safety Evaluation

→(DRN 00-691)

A failure modes and effects analysis is provided in Table 9.2-4. This table demonstrates that the CCWS and ACCWS is capable of providing sufficient cooling capacity to cool the system components listed in Table 9.2-3 with only one loop in operation and bring the plant into a safe shutdown condition under all conditions.

←(DRN 00-691)

9.2.2.4 Testing and Inspection

The CCWS is continuously operating, and continuously monitored by the plant monitoring computer for performance, capability, and availability of its components. If not in continuous operation, the ACCWS is periodically started, and monitored by the computer for performance, capability, and availability of its components. Prior to installation, the CCWS and ACCWS components are tested and inspected according to the requirements of ASME Section III. The pumps are tested for performance at manufacturer shops.

The CCWS and ACCWS preoperational and functional tests are described in Section 14.2. The CCW and ACCW pumps and automatic valves will be tested as described in Subsection 3.9.6.

In-service inspection for the CCWS and ACCWS components will be performed in accordance with the requirements of ASME Code Section XI as described in Section 6.6.

9.2.2.5 Instrumentation Application

Instrumentation related to the CCWS and ACCWS is discussed in Section 7.4 and safety related display instrumentation is identified in Section 7.5. Indicating lights are provided to monitor equipment status. Each motordrive component has "On" and "Off" indicating lights; each remotely controlled open/shut service valve has corresponding open/shut light indications; and each breaker control switch has an associated open/shut indicating light. The red light is used to indicate an operating status, and the green light indicates that equipment is not in an operating status.

Indicating instruments are provided as shown in Table 9.2-5.

9.2.3 DEMINERALIZED WATER MAKEUP SYSTEM

→(DRN 01-111)

Demineralized water is produced by processing potable water from the St. Charles Parish Water System. The potable water is initially stored in the Primary Water Treatment Plant Clearwell Tank. The water is then transferred from the Clearwell Tank, via the Clearwell Transfer Pumps, to the Demineralized Water System (subsection 9.2.3.2) where it is demineralized, deaerated and stored.

9.2.3.1 Primary Water Treatment Plant

9.2.3.1.1 Design Bases

The Primary Water Treatment Plant (PWTP) is no longer used for processing raw water from the Mississippi River. The PWTP has been inactivated except for the Clearwell Tank, Clearwell Transfer Pumps, associated piping, valves, instrumentation and controls. The inactivated portions of the Water Treatment Plant have been isolated from other plant systems by closing isolation valves and opening circuit breakers.

The operable portion of the Primary Water Treatment Plant functions as a quality water source for the following plant systems and components:

a) Demineralized Water System

b) Sealing and cooling water source for the circulating water pumps and motors, screen wash pumps and the air evacuation pumps

c) Fire Water Storage Tanks (the PWTP functions as a secondary makeup water source)

9.2.3.1.2 System Description

The operable portion of the PWTP consists of a Clearwell Tank, two transfer pumps, associated piping, valves, instrumentation and controls. The Clearwell Tank acts as a water reservoir. The Potable Water System maintains a constant volume of water in the tank. The Clearwell Transfer Pumps provide water to the Demineralized Water System and makeup to the Fire Water Storage Tanks. The CW Pump Bearing Lubrication Water Pumps take suction on the Clearwell Tank in order to provide sealing and cooling water to the Circulating Water Pumps, Screen Wash Pumps and the Air Evacuation Pumps. System piping and components are shown on Figure 9.2-2.

→(DRN 00-691)

The inactivated portion of the PWTP is located in the Water Treatment Building. The operable portion of the PWTP is located in the Water Treatment Building and the adjacent area north of the building.

←(DRN 00-691; 01-111)

→(DRN 01-111)

←(DRN 01-111)

9.2.3.1.3 Safety Evaluation

The PWTP serves no safety function since it is not required to achieve safe shutdown or mitigate the consequences of an accident. While the operation of the PWTP is necessary to maintain the flow of makeup water to the condensate storage pool (via the DWS and the demineralized water storage tank), the supply of water in the condensate storage pool is monitored and plant operation following receipt of a low-level alarm is described in the Technical Specifications and Subsection 9.2.6.

The majority of PWTP components are located in the Water Treatment Building and some components are located adjacent to the Water Treatment Building on the north side, which is physically separated from all seismic Category I structures. The failure of any PWTP equipment cannot affect any safety-related equipment.

As the system serves no safety function, there are no safety class or seismic design requirements.

9.2.3.1.4 Testing and Inspections

→(DRN 01-111)

All equipment will be tested prior to operation to ensure the proper functioning of all components. The equipment is proven operable through normal plant operation. Periodic maintenance insures proper operation of equipment.

9.2.3.1.5 Instrumentation Application

Instrumentation for manual control of the system is provided. Local and remote alarms are provided for low water level in the Clearwell Tank.

→(DRN 01-111)

→(DRN 01-111)
←(DRN 01-111)

9.2.3.2 Demineralized Water System

9.2.3.2.1 Design Bases

The DWS is designed to utilize vendor supplied services to provide a supply of demineralized and deaerated water sufficient for the expected makeup demands for plant startup and operation with allowance for a normal amount of downtime for maintenance.

The DWS is shown on Figures 9.2-2. The DWS is designed to normally supply approximately 200 gpm of demineralizer water to the following:

a) demineralized water storage tank

b) condensate storage tank

c) primary water storage tank

The DWS is designed to produce demineralized water at the design flow rates meeting the following effluent parameters:

Specific conductivity @ (25°C) 77°F	≤	0.1 micromho/cm
PH @ (25°C) 77°F		6-8
Sodium	≤	0.001 ppm
Silica (as $Si0_2$)	≤	0.01 ppm
Dissolved Oxygen	≤	0.100 ppm
Chloride (as Cl)	≤	0.001 ppm
Total Organic Carbon	≤	0.100 ppm

Note: The pH and conductivity apply after correction is made for dissolved $C0_2$.

→(DRN 01-111)

The system is designed to process water based on the following analysis:

←(DRN 01-111)

All quantities, except as noted, are expressed in parts per million as $CaC0_2$

Substance	Mississippi River Water (Avg)
Calcium	117
Magnesium	58
Sodium	46
Bicarbonate	132
Carbonate	0
Sulfate	53
Chloride	34
Fluoride	1
Carbon Dioxide as ($C0_2$)	2.5 (Calculated)
Silica as ($Si0_2$)	10
Turbidity (APHA units)	less than 1
pH	8.0

9.2.3.2.2 System Description

The system, located in the Water Treatment Building, consists of flanged connections for connecting the vendor equipment and a DW Analyzer Control Panel which has a variety of instruments for monitoring the quality of the water produced by contractor or rental equipment. The water flows through an automatic 3-way ball valve which will divert the demineralized water to the Regenerative Waste Sump if it does not meet minimum requirements. Alarms are provided locally and on Control Room panel CP-1 to provide indication of system anomalies. Water is supplied to the system from the PWTP clearwell transfer pumps.

→(DRN 01-111)

Flow through the system is manually controlled. Upon low level in either the primary water tank, condensate storage tank or demineralized water storage tank, the PWTP and makeup demineralizer are started manually. Water is transferred from the clearwell via the Clearwell transfer pumps to the vendor supplied services for deminaralization and deaeration. The discharge of the vendor supplied system is then normally directed to the demineralized water storage tank. Makeup water is manually transferred to the condensate storage tank and primary water storage tank when needed. The demineralized water storage tank, condensate storage tank and primary water storage tank are provided with a nitrogen blanket which maintains dissolved oxygen content of the water to approximately 50 ppb.

←(DRN 01-111)

The waste from the vendor supplied system is discharged in the regenerative waste sump and pumped to the waste processing facility of Waterford SES Units 1 and 2 where the pH is adjusted. From there the effluent is discharged into the circulating water discharge of Units 1 and 2.

9.2.3.2.3 Safety Evaluation

The DWS serves no safety function since it is not required to achieve safe shutdown or mitigate the consequences of an accident. See Subsection 9.2.3.1.3 for a discussion of the effect of loss of flow to the condensate storage pool.

Portions of the DWS are located in and adjacent to the Water Treatment Building, which is physically separated from the seismic Category I structures. The failure of any DWS equipment cannot affect any safety related equipment.

As the system serves no safety function, there are no safety class or seismic design requirements.

9.2.3.2.4 Testing and Inspection

→(DRN 00-691)

The 3-way Control Valve can be tested by operating the unit in the manual mode to check valve operation. Pumps will also be tested individually. All equipment will be tested prior to operation to ensure the proper functioning of all components. The system is proven operable through normal plant operations. Periodic maintenance ensures proper operation of equipment.

←(DRN 00-691)

9.2.3.2.5 Instrumentation Application

The DW Analyzer Control Panel contains instrumentation to monitor the following:

- pH
- Dissolved Oxygen
- Conductivity
- Silica
- Sodium
- Total organic carbon

If the water quality does not meet or exceed the setpoint for any of these instruments the 3-way automatic ball valve will divert flow to the Regenerative Waste Sump and alarm locally and in Control Room panel CP-1 to provide indication of system anomalies.

A Sample Sink is also provided in the DW Analyzer Control Panel to provide grab samples from five locations on the vendor equipment and the final demineralized water effluent.

9.2.4 POTABLE AND SANITARY WATER SYSTEM

9.2.4.1 Design Basis

The Potable and Sanitary Water System provides the plant with water suitable for human consumption, and for the operation of all sanitary plumbing fixtures and selected equipment. The Potable and Sanitary Water System provides potable water, both hot and cold, at required design pressures, flow rates and temperatures.

The Louisiana State Plumbing Code was the governing document used for the design of the PSWS.

9.2.4.2 System Description

➜
The St. Charles Parish Water System furnishes a metered supply of potable water to the site through municipal water mains. A valved connection supplies the majority of the water via a backflow prevention and metering station located at the southeast corner of the plant site. The potable water distribution system then supplies water to various buildings throughout the site.
←

➜
A branch from this system supplies the majority of the various demands inside the Protected Area including the following fixtures and equipment in the Administration Building, Chiller Building, Fuel Handling Building, Polisher Building, Reactor Auxiliary Building, Service Building, and Turbine Building:
←

➜
a) toilet and showers,
←

b) drinking fountains,

➜
c) emergency shower,
←

d) personnel decontamination areas,

e) laundry facilities,

f) mop sinks, service sinks, wash-up sinks,

g) food service equipment and kitchen units, and

→(DRN 01-111, R11-A EC-530, R303)

The water distribution system also supplies makeup water to the fire water storage tanks and to the Primary Water Treatment Plant clearwell tank located inside the protected area.

←(DRN 01-111, R11-A)

In addition, a hose connection in the makeup water supply to the fire water storage tank is provided to allow makeup to be provided from the potable water system to the wet cooling tower basins post tornado.

A separate and independent backflow prevention and metering station provides St. Charles Parish potable water to the Maintenance Support Building from a parish water main located adjacent to state road LA-18. A branch line from the potable water supply to the (MSB) with a backflow preventer is provided to allow makeup water to be supplied from the potable water system to the wet cooling tower basins post tornado.

←(EC-530, R303)

The Potable and Sanitary Water System distribution piping is sized to operate at a maximum velocity of seven ft./sec. The system provides a minimum of 25 psi pressure at the uppermost plumbing fixtures in each building.

Electric hot water heaters of sufficient heating and storage capacity are provided for all required plumbing fixtures. Circulating pumps assure readily available hot water at demand.

Sanitary waste water from all site facilities are collected in one of seven sewage lift stations located around the plant site. The waste water is ultimately transferred to the St. Charles Parish Killona sewage treatment facility.

9.2.4.3 Safety Evaluation

The Potable and Sanitary Water System is not cross connected to any fixture or equipment having the potential for containing radioactive or other toxic materials. Therefore, there is no possibility of contamination to the system.

The failure of non-safety Potable and Sanitary Water System components which could affect the operation of safety related equipment (i.e. mechanical equipment and piping, HVAC ducts, electrical cable trays and conduits, instrumentation and controls) are investigated with respect to the area of influence of the failed Potable and Sanitary Water System component. Interactions are eliminated by adherence to criteria stated in Subsection 3.2.1.

→(DRN 01-25, R11-A)

9.2.4.4 Test and Inspections

All parts of the Potable and Sanitary Water System are subject to a hydrostatic pressure test utilizing the system working pressure for a period of two hours. The system is tested and cleaned before being put into operation.

←(DRN 01-25, R11-A)

9.2.4.5 Instrumentation Application

→(DRN 06-910, R15)

The main water supply for the Reactor Auxiliary Building including sanitary and kitchen facilities located within the control room envelope can be shutoff by an electrically operated valve. The control switch is located in the control room proper. The valve is normally closed until energized by the operator and fails closed on loss of power. This design precludes the possibility of main control room flooding during a seismic event or other failure of the system.

←(DRN 06-910, R15)

9.2.5 ULTIMATE HEAT SINK

The function of the ultimate heat sink is to dissipate the heat removed from the reactor and its auxiliaries during normal unit operation, during refueling, or after a design basis accident.

9.2.5.1 Design Basis

The design bases for the ultimate heat sink are:

a) The ultimate heat sink has sufficient capacity to dissipate heat removed from the reactor and its auxiliaries during normal unit operation, shutdown and refueling.

b) The ultimate heat sink has sufficient capacity to dissipate heat removed by the CCWS and ACCWS after a design basis accident, assuming a single active failure coincident with a loss of offsite power and the historically worst combination meteorological condition of 102°F dry bulb temperature and associated 78°F wet bulb temperature.

c) The ultimate heat sink has sufficient capacity to dissipate heat removed by the CCWS and ACCWS from the reactor and its auxiliaries to permit safe shutdown of the unit coincident with a loss of offsite power, multiple tornado missiles and single active failure.

→(EC-530, R303)

d) The ultimate heat sink has a minimum of 30 days post LOCA water supply from wet cooling tower basins for long term cooling. Replenishment of the wet cooling tower basins from on site water sources and/or the Mississippi River may be required in response to a tornado event as discussed in Subsections 9.2.5.3.2 and 9.2.5.3.3.

←(EC-530, R303)

e) The ultimate heat sink equipment is able to perform design functions following any of the following design basis natural phenomena;

  1) safe shutdown earthquake

  2) tornado

  3) hurricane

  4) flood

The ultimate heat sink is designed to safety class 3 and seismic Category I requirements.

9.2.5.2 System Description

The ultimate heat sink consists of dry and wet cooling towers and water stored in the wet cooling tower basins. This arrangement is shown on Figures 1.2-24 and 25, and the design parameters of the principal components are summarized in Table 9.2-8. Each of two 100 percent capacity loops employs a dry and wet cooling tower. The fan motors of one dry and one wet cooling tower are connected to the electrical safety related bus A and those of the other to bus B. Electrical cooling tower loads will automatically be sequenced on the diesel generators in case of loss of offsite power.

Each dry cooling tower has been sized to dissipate to the atmosphere approximately 60 percent of heat removed by the CCWS after a LOCA assuming historically highest ambient dry bulb temperature (102°F), as shown in Figure 9.2-4. The heat removal capacity of the dry cooling towers varies significantly depending on the component cooling water temperature, dry bulb atmospheric temperature and heat removed by the ACCWS. The heat removal capacity under various dry bulb temperatures assuming the ACCWS is not operating and CCWS water temperature is maintained at 95° F is shown in Figure 9.2-5.

Each dry cooling tower consists of five separate cells, each cell containing two 40 ft. long vertical cooling coils, arranged in a "V" shape. Cooling air for each cell is provided by three fans, each fan driven by a 40 horsepower, two speed motor. The dry cooling tower fans can be started and shutoff automatically to maintain the CCWS temperature between 88°F and 92°F. Two speed fans assure good temperature control and quiet operation.

→(EC-32877, R306)
The cooling coils of three dry cooling tower cells of each tower (60 per cent) are protected from tornado missiles by grating located above the coils and capable of withstanding tornado missile impact. Grating design is described in Section 3.5. Dry cooling tower fans and motors are protected from tornado missiles by building walls and/or access platforms. The motor control centers and the transformers for the dry and wet cooling towers are protected from tornado missiles by grating capable of withstanding tornado missile impact.
←(EC-32877, R306)

All dry cooling tower components are designed for safe shutdown earthquake loads and the maximum pressure differentials caused by the design tornado.

Component cooling water to and from each dry cooling tower coil can be isolated by manually operated valves for maintenance. Dry cooling towers can also be automatically bypassed to assure uninterrupted Component Cooling Water System operation in case of sudden damage to the coils, such as tornado missiles.

Each wet cooling tower is sized to dissipate to the atmosphere approximately 40 percent of heat removed by the CCWS after a LOCA, assuming the coincident ambient wet bulb temperature (78°F) at the historically highest ambient dry bulb temperature (102°F).

The capacity of the wet cooling tower varies significantly, depending on the component cooling water temperature to be maintained and atmospheric wet bulb temperature. The heat removal capacities under various conditions for combinations of one dry and one wet cooling tower are indicated in Table 9.2-9.

Each wet cooling tower consists of two cells, each cell is serviced by four induced draft fans, and each fan driven by a 30 horsepower, single speed motor. Principal components of the wet cooling towers are summarized in Table 9.2-8.

All wet cooling tower components are designed for safe shutdown earthquake loads and the maximum pressure differentials caused by the design tornado.

Wet cooling towers remove heat from the Component Cooling Water System by a separate Auxiliary Component Cooling Water System as described in Subsection 9.2.2. ACCWS takes water from the wet cooling tower basin, pumps it through the component cooling water heat exchanger where its temperature is raised, and then to the wet cooling tower for heat dissipation to the atmosphere (see Figure 9.2-6).

The ACCWS can also be used to maintain the CCWS temperature below the range maintained by the dry cooling tower fans during normal operation if desired. The setpoint for the ACCWS temperature control valve can be manually set below 88°F to allow ACCWS flow to modulate and control CCWS temperature.

When operating from the control room, with the fans control switch in the automatic position, the wet cooling tower fans 1 through 4 and 5 through 8 will start automatically whenever the water temperature in the basin exceeds the setpoint temperature and stop automatically.

Manual controls are provided in the main control room and on the auxiliary shutdown panel for starting and stopping the wet cooling tower fans.

➔(DRN 03-2063, R14)
Each wet cooling tower basin contains sufficient water for ultimate heat sink operation without makeup after a LOCA. Basins are interconnected by a valved Seismic Category I four inch line to allow 100 percent margin of safety for available water supply. Wet cooling towers are not required after approximately eight days following a LOCA, as indicated on Figure 9.2-4. Post LOCA water requirements are summarized in Table 9.2-10. Wet cooling tower operation during normal shutdown is intermittent and water requirements are considerably smaller.
🡐(DRN 03-2063, R14)

The wet cooling tower basins are treated to ensure that deposits from the cooling water will not collect on heat exchanger surfaces at the end of wet cooling tower operation. Makeup to the basin is demineralized water. Basin water is periodically sampled for conductivity.

9.2.5.3 Safety Evaluation

9.2.5.3.1 Capacity

The ultimate heat sink is designed, and sufficient water is stored in one wet cooling tower basin, to provide sufficient cooling for 30 days or longer and to permit safe shutdown and cooldown of the plant and maintain it in a safe shutdown condition without additional make-up water. To conserve water, the system is so designed that the dry cooling towers are operating at full capacity post accident.

Total heat removed by one train of the ultimate heat sink after the design basis conditions is shown in Figure 9.2-4. Figure 9.2-4 also shows the calculated heat dissipation by one dry cooling tower and the heat dissipation required by one wet cooling tower. Credit has been taken for storage in one wet cooling tower basin only. The basins of both wet cooling towers are interconnected, thereby providing 100 percent redundancy.

➔(EC-38632, R307)
Table 9.2-9 indicates the heat removal capacity of the ultimate heat sink under various conditions. It also indicates the required heat removal due to normal operation, shutdown and refueling operating modes. Dry cooling tower fan operability is maintained by operating in fast or auto mode.
🡐(EC-38632, R307)

Figure 9.2-4a shows the integrated heat removed by the wet cooling tower for calculation of post-LOCA water storage requirements. Table 9.2-10 shows water storage requirements in wet cooling tower basins and the assumptions used in the basin sizing calculations.

9.2.5.3.2 Meteorological Conditions

The ultimate heat sink design is based on the meteorological conditions listed in Table 2.32(a) and discussed below:

a) Heat Removal Capacity

The dry and wet cooling tower design heat removal is based on the worst combination meteorological condition of 102°F dry bulb temperature and associated 78°F wet bulb temperature. Equivalent meteorological conditions are given in Figure 9.2-5a. In addition 1.9°F has been added to the design dry bulb temperature, and 1.0°F to the design wet bulb temperature to account for possible recirculation.

b) Stored Water Requirements

Dry bulb temperature is the most significant parameter for water storage requirements of the ultimate heat sink, because it determines heat removed by dry cooling towers. A high dry bulb reduces the heat removal capacity of the dry towers, so the wet towers must reject more heat and thus evaporate more water. The following assumptions have been used in calculating the required water storage for the ultimate heat sink.

→(DRN 03-2063, R14)

1) The wet cooling towers will operate for at most eight days post-LOCA. Conservatively, the maximum 3-day average dry bulb temperature of 89°F was used in the calculations of water inventory. The maximum 7-day average dry bulb temperature is 86°F.

←(DRN 03-2063, R14)

2) 2.0°F has been added to the maximum 3-day average dry bulb temperature of 89°F to account for possible recirculation.

→(DRN 05-1652, R14-B)

3) A wet bulb temperature of 76°F and 50 percent relative humidity was used to calculate the evaporation losses over the eight day period of wet tower operation. The above wet bulb-temperature and relative humidity are associated with the maximum 24 hour dry bulb temperature.

←(DRN 05-1652, R14-B)

4) The Essential Chiller is manually realigned to the CCWS when CCWS temperature is $\leq$ 110°F.

→(DRN 03-2063, R14; 05-1652, R14-B; EC-8465, R307)

5) When adding the non-essential load of fuel pool cooling, approximately 113,807 gallons of makeup is required to the WCT basin if only one UHS Train is available. Adequate makeup can be supplied to a WCT basin by gravity feeding from the Circulating Water System or the unavailable WCT basin.

←(DRN 03-2063, R14; 05-1652, R14-B; EC-8465, R307)

→(EC-530, R303)

6) If available, additional makeup for the wet cooling tower basins can be supplied from onsite storage tanks (CST, FWST, DWST, PWST). Provisions are in place (hose connections) to draw water from these sources, post tornado, via a non-safety related, portable diesel driven pump, which will supply water via hose directly to the basin. Additional makeup can also be provided directly to the wet cooling tower basins using a fire hose from the MSB potable water supply and fire hydrant #9. In the event these sources are not available, provisions are in place to utilize the portable diesel driven pump to supply water from the Mississippi River to the Circulating Water system, which can be used to gravity feed makeup to the basin via the path described in 5) above.

←(EC-530, R303)

9.2.5.3.3 Site Related Phenomena

Wet and dry cooling towers are designed for safe shutdown earthquake loads and also to withstand differential pressure which may be induced by a tornado or postulated explosions at the site.

The wet and dry cooling towers are designed to ensure low probability of damage by tornado missiles by the following features:

a) The cooling towers are protected on all sides by the plant outside walls up to elevation + 30ft. MSL.

b) The cooling towers have been designed with multiple cells (five cells for each dry cooling tower and two cells for each wet cooling tower), and multiple fans (15 fans for each dry and eight fans for each wet wet cooling tower), to ensure that damage by tornado missiles would not significantly affect heat removal capability. Table 9.2-9 indicates approximate heat removal capacity of the system when portions of wet cooling tower components are damaged by tornado missiles.

c) In addition to the multiple cells and fans which reduce the probability of damage to the cooling towers by tornado missiles, 60 percent of the dry cooling tower coils have been protected by grating located above them and designed to withstand tornado missiles. The arrangement of safety related cooling tower components protected by grating is shown in Figure 1.2-24.\

→(DRN 05-446, R14; EC-530, R303)

Sixty percent of the dry cooling towers, in conjunction with the Emergency Feedwater System (EFS) and the wet cooling towers (without fans), will provide sufficient heat dissipation to atmosphere and will assure safe shutdown of the unit after a design basis tornado under the following conditions:

→(DRN 05-1668, R14)
←(DRN 05-1668, R14; EC-530, R303)

1) Assumed worst case single failure (loss of one emergency diesel generator), coincident with a loss of offsite power.

→(EC-530, R303; LBDCR 13-018, R308)

2) The Emergency Feedwater System is utilized to remove reactor decay heat until such time that the sum of the decay heat and the plant auxiliary heat loads are equal to or less than the heat transfer capacity of the operable dry cooling towers for 120°F CCW outlet temperature.

←(LBDCR 13-018, R308)
→(DRN 99-0999)

3) After the volume of the condensate storage pool (170,000 gallons) is exhausted, makeup water for the Emergency Feedwater System can be provided from the wet cooling tower basins (approximately 333,000 gallons).

←(DRN 99-0999; 05-446, R14)

4) Heat removal can be continuous by all or any of the following means:

(a) Prior to the wet cooling tower basins water volume being depleted makeup water to the wet cooling tower basins can be supplied by gravity from the underground Circulation Water System to permit continuous heat removal from the Component Cooling Water System. Permanent piping from the Circulating Water System to the wet cooling tower basins is provided for this purpose. This make-up piping is non-seismic. However, it terminates above the wet cooling tower basin's maximum water level and its failure, there, would not cause loss of wet cooling tower basin volume.

Additional makeup for the wet cooling tower basins is available from onsite storage tanks (CST FWST, DWST, PWST) if these water sources are available post tornado. Provisions are in place (hose connections) to draw water from these sources via a non-safety related, portable diesel driven pump, which will supply water via hose directly to the basin. Additional makeup can also be provided directly to the wet cooling tower basins using a fire hose from the MSB potable water supply and fire hydrant #9.

→(LBDCR 13-018, R308)

In the event the onsite water sources are not available, provisions are in place to utilize the portable diesel driven pump to supply water from the Mississippi River via the Circulating Water system, which can be used to supply makeup to the basin via the path described above. The analysis shows that replenishment using pumps and/or hoses from onsite water sources is required in approximately 32 hours in order not to rely on raw river water for cooling or in approximately 68 hours if the Circulating Water system gravity feed is used.

←(EC-530, R303; LBDCR 13-018, R308)

(b) By replacing or repairing damaged wet cooling tower fans to assure availability of wet cooling tower.

→(DRN 05-446, R14; EC-530, R303)

(c) In order to conserve wet tower basin water, the only auxiliary heat load that remains on the wet cooling towers is the essential chiller once the undamaged 60 percent of the available dry cooling towers are returned to service (2 hrs post tornado). At this time, plant auxiliary heat loads are dissipated using the dry cooling towers, which will operate at full capacity until the wet cooling tower can be removed from service.

←(EC-530, R303)

5) In the unlikely event of a tornado strike to the dry cooling tower, damage by the tornado missiles to the dry cooling tower coils is automatically detected by a decrease in the CCW surge tank water level and the dry cooling towers are automatically bypassed. Wet cooling tower basins have sufficient water storage capacity to remove the heat from the vital services for approximately two hours. This time period allows the operator to isolate the damaged dry cooling tower cells and put the operable dry cooling tower cells back into service.

←(DRN 05-446, R14)

9.2.5.4 Testing and Inspection

Performance of wet and dry cooling towers is monitored by the plant monitoring computer to assure its performance capability and availability.

The dry and wet cooling tower preoperational and functional tests are described in Section 14.2. In-service inspection of cooling tower components will be performed in accordance with the requirements of ASME Code, Section XI.

9.2.5.5 Instrumentation Application

Table 9.2-11 lists the safety related instrumentation associated with dry and wet cooling towers and wet cooling tower basins.

9.2.6 CONDENSATE STORAGE FACILITIES

9.2.6.1 Design Bases

Condensate Storage System is designed to:

a) provide initial fill and make-up water for the condenser hotwell,

→ (DRN 99-2227, R11)

b) provide initial fill and make-up to the auxiliary boiler feedwater subsystem,

← (DRN 99-2227, R11)

c) provide initial fill and make-up water for the condensate storage pool,

d) provide initial fill and make-up water for the refueling water storage pool,

e) provide water for the Chemical Feed System,

f) provide water to the decontamination facility and hot machine shop,

g) provide make-up water for the stator coolers,

h) provide water to the Reactor Building,

i) provide water to the ultrasonic unit, chemical cleaning line, Sampling System and CCWS radiation monitor cabinets,

j) provide make-up water to the Turbine Building Closed Cooling Water System,

k) provide water for the washing of spent fuel casks,

1) provide seal water to the instrument and station air compressors,

m) provide make-up water to the supplementary chilled water expansion tank,

n) provide make-up water to the CCW surge tank.

The only portion of the system that is designed to Safety Class 2 and seismic Category I requirements is the containment penetration piping and valves.

9.2.6.2 System Description

The Condensate Storage System is shown schematically on Figure 9.2-2.

The Condensate Storage System consists of the following:

a) one 100 percent capacity, condensate transfer pump,

b) two 100 gpm condensate storage tank pumps,

c) one 260,000 gallon capacity condensate storage tank,

d) one 100 percent capacity, hotwell transfer pump,

e) one 500,000 gallon capacity, demineralized water storage tank,

f) piping, valves and instrumentation.

→(DRN 99-2252, R11; 01-559, R11-A)

Deaerated water from the make-up demineralizer is stored in the condensate storage tank and the demineralized water storage tank located in the yard. The condensate storage tank is blanketed with pressurized nitrogen to maintain deaerated inventory of condensate. The demineralized water storage tank is blanketed with nitrogen to approximately 2.5 inches water (gauge) pressure to maintain a deaerated inventory of condensate.

←(DRN 99-2252, R11; 01-559, R11-A)

The condensate transfer pump and the condensate storage tank pumps can take suction from either the condensate storage tank or the demineralized water storage tank. The hotwell transfer pump can take suction only from the condensate storage tank. Normally, the condensate transfer pump and the condensate storage tank pumps are isolated from the Condensate Storage Tank by a set of isolating valves. The equipment and systems listed in Subsection 9.2.6.1 normally receive their water supplies from the demineralized water storage tank. Initial fill of the condenser and the condensate system will be accomplished by transferring water from the condensate storage tank via the hotwell transfer pump and transferring water from the demineralized water storage tank via the condensate transfer pump. Make-up water to the condensers will normally be transferred from the condensate storage tank via the hotwell transfer pump.

Design data for the condensate storage tank, condensate transfer pump with condensate storage tank pumps , demineralized water storage tank and hotwell transfer pump are given in Table 9.2-12.

→(DRN 01-559, R11-A)

The condensate storage tank and the demineralized water storage tank contain a pressurized nitrogen blanket which prevents air in-leakage inside the tanks. Tank vacuum breakers are provided to preclude tank collapse if vacuum conditions develop.

←(DRN 01-559, R11-A)

The design of condensate storage pool is described in Subsection 10.4.9.

9.2.6.3 Safety Evaluation

➜
The normal supply of makeup water to the Demineralized Water Storage Tank is potable water processed through a vendor supplied system for demineralization, which is not expected to contain radioactivity. The Condensate Storage Tank may contain radioactivity temporarily, during periods of steam generator tube leakage and receipt of condenser hotwell water, but the amount of radioactivity is limited by the temporary tank limitations provided in Technical Specifications. Since this system is not serving any safety function and as failure of any of its components will not affect the function of any of the equipment required for the safe shutdown of the unit, the system, other than the containment penetration piping and valves, is not designed to any safety class or seismic requirements.
←

9.2.6.4 Test and Inspection

The tanks are hydrostatically tested after erection at the site. The pumps are shop hydrostatically tested. The entire system is flushed and hydrostatically tested after installation.

9.2.6.5 Instrumentation Application

➜
The Demineralized Water Storage Tank and Condensate Storage Tank have continuous level indication locally at the tanks and remote in the main control room. Level indication is also provided on the plant monitoring computer. Abnormally high and low level alarms are annunciated in the main control room. Low nitrogen blanket pressure alarm annunciation for the Demineralized Water Analyzer Control Panel located in the Water Treatment Building. This alarm is provided to warn of possible air intrusion into these tanks.
←

A pressure gage is installed in the condensate discharge line for local indication. A flow meter is provided in the line to the auxiliary boiler feed pump suction.

9.2.7 TURBINE CLOSED COOLING WATER SYSTEM

9.2.7.1 Design Basis

The Turbine Closed Cooling Water System is designed to provide a heat sink for power cycle equipment during normal operation and normal shutdown. The system serves no safety function, since it is not required to achieve safe shutdown or to mitigate the consequences of an accident. It is completely independent of the Component Cooling Water System.

9.2.7.2 System Description

The Turbine Closed Cooling Water System is a closed loop system which uses demineralized water to remove heat from the turbine accessories and other components in the power cycle. System component design data are given in Table 9.2-13. A schematic diagram of this system is shown in Figure 9.2-7.

The water is circulated by two turbine cooling water pumps, and the heat removed via two turbine cooling water heat exchangers is transferred to the Circulating Water System. Turbine cooling water circulates through the shell side of the heat exchangers.

A surge tank, open to the atmosphere, is connected to the Turbine Closed Cooling Water System. The tank level is automatically controlled by level switches and a level control valve, with makeup provided from the condensate storage tank. A main control room alarm is initiated on both high and low water levels.

A commercial corrosion inhibitor is used to maintain proper corrosion protection for the Turbine Cooling System. The turbine cooling water chemistry is sampled periodically, and inhibitor added from the chemical feed tank when needed to maintain a desired concentration.

The plant components cooled by the Turbine Closed Cooling Water System include:

a) turbine lube-oil cooler,

b) turbine electrohydraulic fluid coolers,

c) hydrogen seal-oil coolers,

d) generator hydrogen coolers,

e) generator stator water coolers,

f) exciter cooling units,

g) heater drain pump seal and stuffing box coolers,

h) steam generator feed pump turbine coolers,

i) condensate pump motor-bearing coolers,

j) condenser vacuum pumps heat exchangers,

k) instrument and station air compressor jackets,

l) isolated phase bus heat exchangers.

Component a,b,d,e, and h listed above, are provided with automatic temperature control valves in the cooler outlet piping.

Each of two pumps in the Turbine Closed Cooling Water System is designed to provide 100 percent of the total system capacity. Each of two heat exchangers is sized for 50 percent of the total system capacity. Table 9.2-14 shows operating flow with a corresponding calculated heat load for the plant components cooled by the Turbine Closed Cooling Water System. The Turbine Closed Cooling Water System is supplied with make-up by the Condensate Storage System.

9.2.7.3 Safety Evaluation

The Turbine Closed Cooling Water System serves no safety function and is not needed to shut down the turbine generator and accessories after a turbine trip. A failure of any component will not affect the function of any safety related equipment.

9.2.7.4 Testing and Inspection

Prior to installation in the system, each component is inspected and cleaned.

Preoperational testing consists of calibrating the instruments, testing the automatic controls for actuation at the proper setpoints and checking the operability and limits of alarm functions.

The Turbine Closed Cooling Water System is in service during normal plant operation. System performance is monitored, and data taken periodically, to confirm mechanical, hydraulic, and heat transfer characteristics.

9.2.7.5 Instrumentation Application

The turbine cooling water pump can be started and stopped from the main control room. The pump's flow is monitored by a flowmeter with flow transmitter through the plant monitoring computer. When one pump trips, the other pump will be automatically started.

There are a number of temperature controlled valves in the system, which control flow through the:

a) turbine lube-oil cooler,

b) turbine electrohydraulic fluid coolers,

c) generator hydrogen coolers,

d) generator stator water coolers,

e) steam generator feed pump turbine coolers,

f) turbine cooling water heat exchangers,

g) turbine cooling water heat exchanger bypass, and

h) seal oil unit coolers.

The turbine cooling water temperature at the outlets of the equipment listed above is monitored by the plant monitoring computer.

9.2.8 PRIMARY WATER STORAGE FACILITIES

9.2.8.1 Design Bases

Primary Water Storage System is designed to:

→(DRN 00-1054; 02-89)

a) Deleted

b) Deleted

←(DRN 00-1054; 02-89)

➜
c) Deleted
←

d) provide make-up water to various tanks, e.g., waste concentrates storage tank, dewatering tank, volume control tank, waste condensate tank, laundry tank, waste tank, etc.,

e) provide lubricating and flushing water for seals of charging pumps, and

f) provide water to the resin sluice header,

g) provide water to the reactor drain and quench tanks.

The only portion of the system that is designed to Safety Class 2 and seismic Category I requirements is the containment penetration piping and valves.

9.2.8.2 System Description

The Primary Water Storage System is shown schematically on Figure 9.2-2.

The Primary Water Storage System consists of the following:

a) one 260,000 gallons capacity primary water storage tank,

b) two 100 percent capacity primary water pumps,

c) piping, valves and instrumentation.

Design data for the primary water storage tank and the primary water pumps are given in Table 9.2-15.

The make-up demineralizer/secondary make-up water vacuum degasifier (refer to Subsection 9.2.3) provides deaerated water for the primary water storage tank located in the yard. A nitrogen blanket exists for the PWST to maintain a deaerated inventory of primary water.

The primary water pumps, located near the primary water storage tank, take water from the tank to fill and/or supply make-up water as required to those components or areas specified in Subsection 9.2.8.1.

9.2.8.3 Safety Evaluation

This water is expected to contain insignificant radioactivity; therefore, no automatic provision is made to measure radioactivity. Periodic grab samples are taken and analyzed for radioactivity and the amount of dissolved oxygen.

9.2.8.4 Tests and Inspection

The tank is hydrostatically tested after erection at the site. The pumps are shop hydrostatically tested. After the installation the entire system is flushed and tested.

9.2.8.5 Instrumentation Application

The water level in the tank is controlled by a make-up valve operated by level switches. The liquid level is continuously indicated on the main control panel through a level transmitter. Local pressure gages are installed in primary water pump discharge lines. Annunciation in the main control room is provided for abnormally high ior low levels in the tank and for low pressure in the common discharge header of the two primary water pumps. Local annunciation is provided for low nitrogen pressure in the PWST to alarm for possible air intrusion into the tanks.

The initial operation of the primary water pumps is manual. If one pump fails to start or is tripped, the other pump starts automatically.

9.2.9 ESSENTIAL SERVICES CHILLED WATER SYSTEM

9.2.9.1 Design Bases

The purpose of the Essential Services Chilled Water System is to provide chilled water for those air handling systems which cool spaces containing equipment required for safety related operations.

The system is designed to satisfy the following criteria:

a) supply 42°F chilled water to all chilled water cooling coils during normal plant operation, and during design basis accident conditions,

b) designed so that a single failure of any component, assuming a loss of offsite power, cannot result in complete loss of chilled water to those chilled water cooling coils serving the essential spaces,

c) designed to remain functional during and after a safe shutdown earthquake, and

d) provide accessibility for adjustments and periodic inspections and testing of the principal system components to assure continuous functional reliability.

The Essential Services Chilled Water System is designed to safety class 3 and seismic Category I requirements (refer to Table 3.2-1 for safety and seismic classifications).

9.2.9.2 System Description

9.2.9.2.1 General

The Essential Services Chilled Water System furnishes chilled water for space cooling purposes and rejects heat through the Component Cooling Water System to the ultimate heat sink (refer to Subsection 9.2.2).

➜
The Essential Services Chilled Water System flow diagram is shown on Figure 9.2-8 (for Figure 9.2-8, Sheet 3, refer to Drawing G853, Sheet 5. The system consists of three 100 percent capacity subsystems, each consisting of the following
←

components:

a) one water chiller,

b) one chilled water pump,

c) one chilled water expansion tank with level control actuated makeup, and

d) instrumentation and controls, piping and valves.

Additionally, for corrosion protection, each subsystem is provided with an individual and integral chemical feed system consisting of a chemical feed tank, chemical feed and drain piping and all necessary valves, fittings, accessories and appurtenances. The chemical feed system is non-safety-related. However, it is isolated from the respective safety-related essential chilled water system by means of locked-closed, manual safety-related isolation valves.

➜
These subsystems are piped such that chilled water is circulated, from any two of the subsystems, through two loops which serve equipment in various parts of the Reactor Auxiliary Building. Table 9.2-16 provides a list of safety-related and non-safety air handling units.
←

9.2.9.2.2 Water Chillers

The water chillers are located in the Reactor Auxiliary Building on elevation +46 ft. MSL. Each water chiller is a factory assembled package which is designed and built to satisfy seismic Category I requirements. The parts of the chillers classified as Code Class 3 are designed and fabricated in accordance with ASME, Section III, Code Class 3, 1974 edition up to, and including, the Summer 1975 addenda.

The compressor motor, pumpout compressor motor and lubrication oil pump motor are qualified as Class 1E equipment according to IEEE-323-1971 and IEEE 344-1975.

Each water chiller is a centrifugal, electric motor driven, hermetic, water cooled factory assembled package having the following components:

a) Structural steel base.

b) Hermetic refrigerant compressor/motor assembly with the centrifugal compressor and the electric motor contained in a single housing in which the heat generated within the motor is removed by the circulating refrigerant. The drive torque is transmitted from the motor to the compressor by a self-aligning, gear type transmission which is contained in the same housing thereby eliminating the need for a shaft seal to isolate the refrigerant circuit.

c) Shell and tube, flooded type evaporator (refrigerant on the shell side; chilled water in the tube side) with marine water boxes which have flanges for connections to the chilled water piping. Seamless copper tubes, with integral fins (chilled water side), are constructed and inspected in accordance with ASME Code, Section III, Code Class 3. Steel shell (refrigerant side) is constructed and inspected in accordance with ANSI B9.1 and ASME Section VIII Division 1.

d) Shell and tube refrigerant condenser (refrigerant on the shell side; component cooling water on the tube side) with similar construction to the evaporator, constructed and inspected in accordance with ASME Code, Section III, Code Class 3.

e) Gauge panel and solid state control panel in a locked enclosure with capacity controls wired to permit fully automatic operation during normal and design basis accident conditions.

9.2.9.2.3 Chilled Water Pumps

The chilled water pumps are designated as Safety Class 3 equipment and designed to meet ASME Section III, Code Class 3 requirements, 1986 Edition, No Addenda, Subsections ND and NF. They are designed to pump demineralized water at 42°F from the evaporator through the associated chilled water piping loop and back to the evaporator. Each chilled water pump is directly driven by an electric motor qualified as Class 1E equipment. The assembly is mounted on a structural steel bedplate and satisfies seismic category I requirements.

9.2.9.2.4 Chilled Water Piping and Valves

→(DRN 06-843, R15)

The piping and valves which are necessary to provide chilled water to safety related air handling units are designed to ASME Section III, Code Class 3 requirements (piping 1971 edition, up to and including the Winter 1972 addenda (ASME Section III, Winter 1981 Addenda, was used to forego further hydrotesting of welds that had been found to be undersized and had been rewelded); butterfly valves, 1974 edition, up to and including the Summer 1975 addenda; other valves, 1971 edition, up to and including the Winter 1972 addenda).

←(DRN 06-843, R15)

The chilled water A/B train is connected by piping to the chilled water supply header with normally closed isolation valves 3AC-B138A and 3AC-B139B to permit flow either into the A train or the B train, but not to both simultaneously during design basis accidents. Similarly, the chilled water return is controlled by normally closed isolation valves 3AC-B145A and 3AC-B146B depending on which train is being substituted for by the A/B train.

→ (DRN 00-418)

Makeup water for the chilled water system is normally supplied by the non-safety condensate system. If the condensate system is unavailable or unable to maintain level in the chilled water expansion tanks, makeup water can be manually supplied by the control room via the component cooling water makeup system. The component cooling water makeup system is a safety-related, seismic category I system which takes suction from the condensate storage pool.

← (DRN 00-418)

The condenser water piping consists of valved connections to the inlet and discharge nozzles of each chiller condenser water box from the Component Cooling Water System. Heat rejected from the chiller refrigerant is transferred to the component cooling water which is pumped to the ultimate heat sink.

9.2.9.2.5 Chilled Water Expansion Tanks

The chilled water expansion tank has a capacity of 180 gallons to accommodate system volume changes, maintains positive pressure in the piping system and provides means of adding makeup water to the chilled water system while permitting air to be vented out of the system.

Makeup water is admitted through solenoid valves 3AC-E611A, 3AC-E612B, and 3AC-E613A/B when energized from their respective level controllers for each expansion tank. Each solenoid operated makeup valve is provided with a normally closed valve bypass to permit makeup water to flow when solenoid valve maintenance is being performed.

The tanks are designed to ASME Section III, Code Class 3 requirements 1974 edition up to, and including, the Summer 1976 addenda.

9.2.9.2.6 Chiller Operation and Controls

Each chiller is equipped with a solid state capacity control system. The refrigerant heat removal capacity is controlled by positioning the compressor suction inlet guide vanes. A temperature sensing device in the chilled water line downstream from the chiller produces signals which are transmitted to an automatic guide vane operator. A decrease in the chilled water temperature causes the guide vanes to move toward the closed position.

→(DRN 00-691)

Each chiller, its associated chilled water pump, motor operated valves, the systems served by it and the control systems are all connected electrically to the associated A, B and AB safety channel. Each chilled water pump is interlocked with its associated chiller so that the chiller operates when the pump is activated.

←(DRN 00-691)

There are three separate and independent means of activating each chiller and pump combination:

a) each combination can be energized directly from a control switch in the main control room,

b) each combination can be energized directly from its own local integrally mounted control panel, and

→ (DRN 00-691, R11-A)

c) each combination is energized automatically as a result of a loss of offsite power or SIAS Signal

← (DRN 00-691, R11-A)

When a pump is started, its chiller will operate if both chilled water and condenser water flows are established after a time delay determined by flow switches located in the chilled and condenser water outlet piping. Once the chiller is started, it remains under the control of the temperature controller located in the chilled water discharge piping of that chiller. Should a chiller become non-operational due to an action of an internally wired safety cutout, the chilled water pump will continue to operate until stopped manually.

In the event of a loss of offsite power, each of the two normally operating chillers and pumps will be loaded automatically on its corresponding diesel generator. This equipment is connected three minutes into the diesel generator timing sequence. An internal time delay of approximately one minute is required to restart the chillers. Thus, as a result of the chillers' internal control timer, a total of four (4) minutes will be required to restart the chiller motors after Loss of Offsite Power.

9.2.9.3 Safety Evaluation

→ (DRN 02-1623, R12-B)

The Essential Services Chilled Water System is a safety-related system designed with functional reliability to assure chilled water flow to cooling coils of the air handling units which provide air conditioning for the essential equipment rooms and main control room during normal operation and operation following a design basis accident. In addition, the system is protected from the effects of a pipe rupture (ER-W3-2000-0563-00).

← (DRN 02-1623, R12-B)

Each chiller refrigerant compressor casing and chilled water pump casing is designed to withstand penetration by missiles generated within that casing. The chilled water system is protected from any external missiles which could be generated outside of the Reactor Auxiliary Building by virtue of its location inside the building.

A failure modes and effects analysis for the Essential Services Chilled Water System is provided in Table 9.2-17. The system is designed with complete component redundancy and isolation features to assure that chilled water will be provided to A or B piping loops following a design basis accident assuming a single failure in any one operating train.

9.2.9.4 Inspection and Testing

All inspections, testing and a specific cooling capacity test conducted at the factory where the chillers are fabricated are documented prior to the delivery of the chillers. The chilled water pumps are tested hydrostatically at the factory. The tests are documented prior to delivery. The hydrostatic test pressure is 1.5 times the shutoff discharge pressure but at least 150 psig. Each pump is tested for vibration and accepted only if within 0.003 in. double amplitude measured at each bearing housing. Field tests to demonstrate performance are in accordance with provisions of ASME Power Test Code for Centrifugal Pumps. Following the installation of the system, preoperational inspection and system tests of all Essential Services Chilled Water System functions are performed and the instrumentation and controls are used to balance the system for design flows, temperatures and pressures.

➜
In-service inspection of Code Class 3 components are discussed in the Technical Specifications.
←

9.2.9.5 Instrumentation Requirements

The instrumentation and controls for the Essential Services Chilled Water System is designed to function during normal and emergency plant operating conditions. Normally, the system operates automatically after manual starting of the pumps and the water chillers. The automatic controls for each pump and chiller are so arranged as to prevent a start-up of a water chiller without having its associated chilled water pump establish a flow in the system. The chiller will start running only after a time delay, when flow has been proven by the flow switches located in the chilled water and condenser water outlets of the chiller. After establishing the initial start-up, each chiller will be under the control of its own internal automatic control system to maintain the required water temperature. Temperatures of the water leaving the chillers are also monitored in the main control room and high temperature conditions are alarmed. Flow switches in the chilled water and condenser water discharge lines will monitor for flow failure and individually alarm on the main control board.

The following alarms are provided in the main control room for each chiller:

a) Electrical Failure - control circuit under voltage, overcurrent and ground condition, chilled water pump, oil pump and compressor

b) Chiller Failure - low chilled water temperature, low chilled water flow, low condenser water flow, low oil pressure, high condenser pressure and low refrigerant pressure.

c) motor compartment high temperature.

Indications in the control room allow the operator to identify the failed element except for chiller internal malfunction which the operator can identify at the integral local chiller panel. Each of these is also identifiable through the plant monitoring computer.

The following malfunctions are annunciated to a common alarm provided in the main control room for each chiller:

a) low oil pressure,

b) high condenser pressure, and

c) low refrigerant pressure.

Makeup water to the chilled water expansion tanks is automatically controlled by means of level switches. The level switches "Low" and "High" will open and close the solenoid valves 3AC-E611A, 3AC-E612B or 3AC-E613 A/B to admit makeup water to their respective expansion tanks. "High-High" and "Low-Low" water levels are annunciated in the main control room.

DESIGN DATA FOR THE COMPONENT COOLING WATER SYSTEM
AND AUXILIARY COMPONENT COOLING WATER SYSTEM COMPONENTS

1. Component Cooling Water Pumps

Type	Centrifugal, horizontal split, double suction pump
Quantity	3
→(DRN 05-1652, R14-B)	
Capacity, each, gpm, rated	6800
←(DRN 05-1652, R14-B)	
Head, ft., (TDH)	145
NPSH, ft.	
required	25
available	44
Material	
Case	ASME SA 351-CF8
Impeller	ASTM A 351-CF8
Shaft	ASTM A 237-4140 CL"A"
Bearing	Sleeve type (radial); Kingsbury type (thrust)
Motor	300 hp, 4000 V, 60 Hz, 3 phase, 1800 rpm
Enclosure	WP II
Insulation	F
Code	ASME, Section III, Class 3, 1971 Edition up to and including 1973 Winter addenda

2. Component Cooling Water Heat Exchangers

Type	Horizontal, counterflow, straight tubes rolled into tube sheets
Quantity	2

TABLE 9.2-1 (Sheet 2 of 5) Revision 14-B (06/06)

2. Component Cooling Water Heat Exchangers (Cont'd)

		Shell Side	Tube Side
Flow, gpm			
	Normal (Max)	6,500	6,500
→(DRN 05-1652, R14-B)	Accident	4,500	6,900
←(DRN 05-1652, R14-B)	Shutdown (Max)	6,500	6,500

Design duty, each, BTU/hr: 40×10^6 (normal)

→(DRN 05-1652, R14-B)

54.62×10^6 (accident)

←(DRN 05-1652, R14-B)

Heat transfer area, each, ft^2: 10,514

Design pressure, psig: Shell side: 125 Tube side: 125

Design temperature, °F: Shell side: 125 Tube side: 175

Material

- Shell: Carbon Steel ASME SA-285 Gr C
- Tube: Stainless Steel ASME SA-249
- Tube Sheet: ASME SA-516-70

Code: ASME, Section III, Class 3, 1971 Edition up to and including 1973 Winter addenda

3. Surge Tank

Type	Vertical
Quantity	1
Design pressure, psig	15
Design temperature, °F	150
Volume, gal.	550
Material	
Shell	ASME SA-283 Gr C Steel

3.	Surge Tank (Cont'd)	
	Dished	ASME SA-283 Gr C Steel
	Baffle	ASME SA-283 Gr C Steel
	Code	ASME, Section III, Class 3 1974 Edition up to and including 1974 Summer addenda
4.	Chemical Addition Tank	
	Type	Vertical
	Quantity	1
	Volume, gal.	70
5.	Auxiliary Component Cooling Water Pumps	
	Type	Centrifugal, horizontal split, double suction pump
	Quantity	2
→(DRN 05-1652, R14-B)		
	Capacity, each, gpm, rated	6500
←(DRN 05-1652, R14-B)		
	Head, ft. (TDH)	145
	NPSH, ft.	
	required	23
	available	26
	Material	
	Case	ASME SA 351-CF8
	Impeller	ASTM A 351-CF8
	Shaft	ASTM A 237-4140 CL"A"
	Bearing	Sleeve type (radial); Kingsbury type (thrust)
	Motor	300 hp, 4000V, 60 Hz, 3 phase, 1800 rpm
	Enclosure	Dripproof

5. Auxiliary Component Cooling Water Pumps (Cont'd)

Insulation	F
Code	ASME, Section III, Class 3, 1971 Edition up to and including 1973 Winter addenda

6. Component Cooling Water Makeup Pump

Type	Centrifugal, horizontal split, double suction pump
Quantity	2
Capacity, each, gpm	600
Head, ft. (TDH)	150
Material	
Case	ASME SA 351-CF8
Impeller	ASTM A 351-CF8
Shaft	ASTM A 276-410
Bearing	Antifriction ball
Motor	40 hp, 460 V, 60 Hz, 3 phase, 1800 rpm
Enclosure	Dripproof
→(DRN 06-843, R15) Insulation ←(DRN 06-843, R15)	B
Code	ASME, Section III, Class 3, 1971 Edition up to and including 1973 Winter addenda

7. Piping

→(EC-26241, R305)
Piping material: Carbon Steel, ASTM A 106 Gr B Seamless or equivalent
←(EC-26241, R305)

	CCWS	ACCWS	CCWMUS
Design pressure, psig	125*	125	125
Design temperature, °F	175	125	120

TABLE 9.2-1 (Sheet 5 of 5) Revision 13 (04/04)

7. Piping (Cont'd)	
Construction:	*A portion of the system is designed to 135 psig, 150 psig and 200 psig
2-1/2 in. and larger	Butt welded except at flanged connections
2 in. and smaller	Socket welded except at flanged connections
Code	ASME, Section III, Class 3, 1971 Edition up to and including 1972 Winter addenda*
8. Valves	
2-1/2 in. and larger	
Gate, Ball and Globe	Carbon steel, butt weld ends, ASME and ANSI, 150 psi and higher
Check and butterfly	Carbon steel and cast iron, flanged, butt weld, and/or wafer, ASME and ANSI, 150 psi and higher
→(DRN 02-1197, R13)	
2 in. and smaller	Carbon and Stainless Steel, socket weld ends, ASME and ANSI, 150 psi and higher
←(DRN 02-1197, R13)	
Code	ASME, Section III, Class 3, 1971 Edition up to and including 1972 Winter addenda for gate, globe and check valves, and 1971 Edition up to and including 1973 Summer addenda for butterfly valves, 1989 Edition for BNL check valves, and 1977 Edition up to and including 1978 Summer addenda for ball valves.

* ASME Section III, Winter 1981 addenda, was used to forego further hydrotesting of piping welds that had been found to be undersized and had been rewelded.

TABLE 9.2-2 (Sheet 1 of 3) Revision 305 (11/11)

CCWS AND ACCWS TEMPERATURE AND FLOW CONTROL DESCRIPTION

	NORMAL	NORMAL SHUTDOWN	REFUELING	ACCIDENT
→(EC-8477, R305) Fuel Pool Heat Exchanger (or Backup Fuel Pool Heat Exchanger)	The temperature control valve 3CC-FM138A/B maintains the fuel pool cooling water temperature leaving the heat exchanger to between 98°F - 105 °F, not to exceed 120°F.	Same as normal	Same as normal, except not to exceed 140°F.	Upon SIAS, CCW A division continues to flow through a portion of the non-essential loop to the RCP seal coolers. CCW A division flow to the fuel pool heat exchangers is shut by closure of the valve 3CC-FM138A/B. Valve 3CC-FM138A/B will automatically close on a SIAS (A Channel), or closure of CCW B division non-essential isolation valves 3CC-F121B and 3CC-F123B, or closure of CCW A division non-essential isolation valves 3CC-F120A and 3CC-F122A. 3CC-FM138A/B may be manually re-opened.
←(EC-8477, R305) Reactor Coolant Pump (RCP)	Flow through the RCP coolers and the CEDM air cooler is set by manually operated outlet valves; the CCWS flow to each pump is shut- off automatically by inlet valves 3CC-B188A1, -189B1, -190A2, and -191B2, whenever the pump is not operating; CCWS flow to the CEDM air cooler can also be shutdown from the main control room by closing the inlet valve 3CC-B187A/B.	Same as normal	Same as normal	Upon SIAS the A division and B division CCW essential loops will be isolated from each other and the non-essential, non-seismic loop. The A division CCW will continue to supply CCW to the RCP seal coolers. Upon CSAS, containment isolation valves 2CC-F146A/B, 2CC-0F243A/B and 2CC-F147A/B will be automatically closed, thereby shutting CCWS flow to the reactor coolant pump coolers and CEDM air cooler.
Letdown Heat Exchanger	The temperature control valve 3CC-TM169A/B maintains the letdown water temperature below 140°F.	Same as normal	Same as normal	Temperature control valve 3CC-TM169A/B closes automatically when either containment isolation 2CH-F151BA/B or 1CH-F2501A/B in the letdown line closes. The TCV will return to its normal temperature control mode when both of these containment isolation valves open. These latter valves are closed on SIAS or CIAS.
HPSI, LPSI and Containment Spray Pumps	The required flow is set by manually adjusting the respective outlet valves.	Same as normal	Same as normal	Same as normal
Waste Gas Compressors, Sample Coolers, Boric Acid Concentrators	The required flow is set by manually adjusting the respective outlet valves.	Same as normal	Same as normal	The SIAS automatically closes the isolating valves 3CC-F133A/B and 3CC-F132A/B, thereby shutting the CCWS flow to the waste gas compressors sample coolers, and concentrators.
Diesel Generator	Outlet valves 3CC-F268A and 3CC-F269B are closed. Bypass valves are set to maintain approximately 100 gpm through each diesel generator.	Same as normal	Same as normal	On loss of offsite power, the diesel generators start automatically. The starting of diesel generators will automatically open the outlet valves 3CC-F268A and 3CC-F269B, to pass 800 gpm through each diesel generator. The flow is set by manual vales 3CC-B27A, -B28A, -B31B, and -B32B.

TABLE 9.2-2 (Sheet 2 of 3) Revision 307 (07/13)

CCWS AND ACCWS TEMPERATURE AND FLOW CONTROL DESCRIPTION

	NORMAL	NORMAL SHUTDOWN	REFUELING	ACCIDENT
Containment Fan Coolers	Only three containment fan coolers are operating. One fan cooler is isolated by closing the containment isolation valves to and from that particular cooler. The control valves 3CC-TM148A and 3CC-TM149B control the CCWS flow through the coolers, at 670 gpm for the channel in which the isolated cooler is located, and at 1340 gpm for the other channel.	Same as normal	Same as normal	Post LOCA, the control valves 3CC-TM148A and 3CC-TM149B open fully to permit 2700 gpm through two fan coolers of each channel.
→(EC-30976, R307)				
Shutdown Heat Exchanger (SDHX)	Outlet valves CC-963A (3CC-F130A) and CC-963B (3CC-F131B) are closed. Bypass valves are set to maintain approximately 100 gpm flow through the SDHX.	Outlet valves CC-963A (3CC-F130A) and CC-963B (3CC-F131B) are opened fully by operator. Opening of the valves will provide each SDHX with 3000 gpm, controlled by the flow restricting orifices 3CC-K296A and 3CC-K297B. The operator has the capability from the main control room to partially close the discharge valves to a predetermined position, to reduce the CCWS flow through each SDHX to 2000 gpm.	Same as normal shutdown	Upon SIAS, SDHX B outlet valve will automatically open to pass 3000 gpm; the SDHX A outlet valve will remain as is. Upon CSAS, the SDHX A outlet valve will open automatically to pass 3000 gpm. The operator has the capability to manipulate these valves from the control room to adjust either valve to a pre-set flow.
←(EC-30976, R307)				
Chillers	CCWS flow through each chiller is set at 850 gpm, by manually adjusting valves 3CC-V34A, 3CC-V35A/B, and 3CC-V36B. One chiller is normally isolated.	Same as normal	Same as normal	The chiller water supply valves (3CC-F272A, -F273B -F274A, -F275B, -F276A, -F277B, -F278A, & -F279B) align automatically when temperature exceeds a nominal set point of 102°F to supply cooling water to the chillers from the ACCW. Valves will realign automatically to supply cooling water to the chillers from CCWS when the cold CCWS temperature decreases below 95°F. This realignment can be accomplished manually through operator control. Post LOCA, this manual realignment can occur when CCWS cold temperature decreases below 110°F to conserve wet cooling tower basin water.

CCWS AND ACCWS TEMPERATURE AND FLOW CONTROL DESCRIPTION

	NORMAL	NORMAL SHUTDOWN	REFUELING	ACCIDENT
→ CCW Heat Exchanger	CCWS temperature is maintained by either (a) automatic DCT fan operation between 88°F and 92°F, or (b) control valves 3CC-TM290A and 3CC-TM291B modulate ACCWS flow to control CCWS at a manual setpoint below 88°F.	The set point for the control valves 3CC-TM290A and 3CC-TM291B can bed adjusted by the operator from the main control room to maintain the CCWS cold temperature at 80°F to permit faster shutdown.	Same as normal shutdown.	The set point for the control valves 3CC-TM290A and 3CC-TM291B automatically readjust on receipt of a SIAS and if the wet cooling tower basin is ≥ 74°F to maintain the CCWS cold temperature at 115°F. This feature is required to reduce water consumption the wet cooling tower post LOCA.

←

TABLE 9.2-3 (Sheet 1 of 2) Revision 307 (07/13)

HEAT REMOVAL AND WATER REQUIREMENTS
FOR THE CCWS

			ACCIDENT(9)			NORMAL SHUTDOWN			REFUELING			NORMAL OPERATION		
ITEM	NO. OF UNITS	EQUIPMENT	NO. OF UNITS OPERAT-ING PER TRAIN	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm	NO. OF UNITS OPERAT-ING	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm	NO. OF UNITS OPERAT-ING	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm	NO. OF UNITS OPERAT-ING	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm
➔(DRN 03-2063, R14; 05-1652, R14-B)														
1	2	Shutdown Heat Exchanger	1	Note 1	3100	2	179.74	6000	1	23.9	3000	0	-	200
➔(EC-8465, R307)														
2	4	Containment Fan Coolers	2	165.2(1)	3000	3	4.7	2010	0	0	0	3	4.7	2010
←(EC-8465, R307)														
3	2	Diesel Generators	1	9.71	950	0	0	200	0	-	200	0	-	200
4	3	HPSI Pumps	1	0.1	25(14)	0	0	40	0	-	40	0	-	40
5	2	LPSI Pumps	1	0.1	25(14)	2	0.2	40	2	0.2	40	0	-	40
6	2	Containment Spray Pumps	1	0.1	10(14)	0	0	10	0	-	10	0	-	10
←(DRN 05-1652, R14-B)														
7	3	Chillers	1	5.1(2)	850(2)	2	6.3	1700	2	6.3	1700	2	6.3	1700
8	4	Reactor Coolant Pumps and Motors	0	-	-	2	5.04	1560	0	-	-	4	10.08	1560
9	1	Letdown Heat Exchanger	0	-	-	1	3.0	300	0	0	0	1	19.92(3)	1200(3)
➔(EC-8477, R305)														
10	1	Fuel Pool Heat Exchanger(6)	0 (12)	-	-	1	6.54(8)	495	1	45.4(13)	4499	1	20.17(7)	1230
←(EC-8477, R305)														
11	3	Boric Acid Concentrators	0	-	-	0	-	-	2	23.4	1170	2	23.4	1170
12	2	Component Cooling Water Filters (6 vessels per filter)	0	-	-	-	-	-	2	-	600	2	-	600
➔(DRN 06-898, R15)														
13	5	Sample Coolers	0	-	-	0	-	-	5	0	160	5	2.46	160
14	2	Waste Gas Compressor	0	-	-	0	-	-	1	0.05	5	1	0.05	5
←(DRN 03-2063, R14; 06-898, R15)														

HEAT REMOVAL AND WATER REQUIREMENTS
FOR THE CCWS

			ACCIDENT(9)			NORMAL SHUTDOWN			REFUELING			NORMAL OPERATION		
ITEM	NO. OF UNITS	EQUIPMENT	NO. OF UNITS OPERAT-ING PER TRAIN	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm	NO. OF UNITS OPERAT-ING	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm	NO. OF UNITS OPERAT-ING	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm	NO. OF UNITS OPERAT-ING	MAX HEAT TRANS-FERRED TO COM-PONENT COOLING WATER SYSTEM 10^6 BTU/HR	MAX FLOW REQUIRE-MENTS -gpm
➔(DRN 03-2063, R14; 06-898, R15)														
15	1	CEDM Cooler	0	-	-	1	4.0(4)	700(4)	0	-	-	1	4.0	700
16	1	Post-Accident Sampling System(10)	1			0	-	-	0	-	-	0	-	-
←(DRN 06-898, R15)														
➔(DRN 05-1652,R14-B;EC-8477,R305; EC-8465, R307)														
		TOTALS		180.3	7960		210.75	13055		98.15	11424		91.08	10825
		TOTAL PER TRAIN		180.3	7960		105.38	6527.5		55.5	7300(15)		45.54	5413.5

←(DRN 05-1652, R14-B; EC-8477, R305; EC-8465, R307)

NOTES: (1) Maximum post LOCA heat load removed from containment by shutdown heat exchangers and containment fan coolers concurrently. The heat Load for the shutdown Heat Exchanger is included with the heat Loads for the containment fan coolers

(2) Cooling water supplied from the ACCWS.

(3) Maximum load during plant loading.

(4) Cooling required until reactor coolant temperature decreases from to 350° to 300°F.

➔(EC-8477, R305)

(5) CCW Pump design capacity is 6800 gpm at 145 ft. T.D.H. CCW Pump run out is 8300 gpm.

←(EC-8477, R305)

➔(DRN 99-1097, R11)

(6) FPHE is capable of removing maximum fuel pool heat load of 52.5 x 10^6 BTU/hr. This is not indicated in this table since this load will not be present during any of the four operating modes listed.

←(DRN 99-1097, R11)

➔(EC-8477, R305)

(7) Maximum heat load with 23 batches in pool plus fresh batch decayed 15 days after shutdown.

(8) Maximum heat load with 23 batches in pool with newest batch 1.5 year old.

←(EC-8477, R305)

(9) Maximum heat load with only one train available.

(10) PASS not in continuous service. PASS heat load and flow requirements during sampling are negligible compared to the total heat load on the CCW system.

(11) The data in this table is also applicable to the Backup Fuel Pool Heat Exchanger, except for full core discharge heat load given in Note (6).

(12) Fuel pool cooling restored before fuel pool temperature exceeds 180°F.

➔(EC-8477, R305)

(13) The fuel pool heat Load is for a full core offload and is administratively controlled.

←(DRN 03-2063, R14; EC-8477, R305)

➔(DRN 05-1652, R14-B)

(14) Total CCW flow through HPSI, LPSI, and CS pumps together is 60 gpm.

←(DRN 05-1652, R14-B)

➔(EC-8477, R305)

(15) Fuel Pool Cooling Single Failure Analysis assumes only one CCW train available.

←(EC-8477, R305)

TABLE 9.2-4 (Sheet 1 of 2) Revision 15 (03/07)

FAILURE MODES AND EFFECTS ANALYSIS FOR THE CCWS AND ACCWS POST LOCA

FAILURE MODE	EFFECT ON SYSTEMS	METHOD OF DETECTION	MONITOR	REMARKS
One diesel generator(D-6) fails to start	One channel of the CCWS and ACCWS is out of service	D-G speed switch Flow meter	CRI	The redundant channel is operating and is sufficient to shutdown the unit. The nonessential headers are isolated by valves which close on power failure, and by redundant valves which are powered from different bus. Isolating valves, which close after the accident to form two separate CCWS channels, are redundant and powered from different buses.
Loss of one CCW pump	One CCWS channel is temporarily out of service	Flow meter	CRI	The operator has the capability to start the standby CCW pump, thereby maintaining 200% capacity of the CCWS.
Failure of an active valve to operate (CCW)	No effect	Limit switch	CRI	Redundant valves are provided.
→(DRN 06-500, R14-B; 05-1663, R15) CCW supply line thermal relief valve (CC-6443)				
A) Fails to open	Thermal overpressure protection Lost For portion of CCW supply line bounded by containment isol. valve CC-641 and isolation valves CC-661A(B), CC-651A(B), CC-660A(B), CC-666A(B) & CC-646	None	None	
B) Fails to shut	No effect	None	None	Water inventory loss would be limited since containment isolation valve CC-641 will be shut following an isolation signal.
←(DRN 06-500, R14-B; 05-1663, R15)				
→(DRN 00-1638) CCW return line thermal relief valve (CC-7102)				
A) Fails to open	Thermal overpressure protection lost for portion of CCW return line bounded by containment isolation valves CC-710 and CC-713.	None	None	
B) Fails to shut	No effect	None	None	Water inventory loss would be limited since containment isolation valves CC-710 and CC-713 would be shut following an isolation signal.
←(DRN 00-1638) Failure of one CCWS control valve to SDHX or to diesel generator, or to containment fan coolers	No cooling to one SDHX or one diesel generator or two containment fan coolers	Flow meter	CRI	The unit can be shutdown safely without one SDHX or one diesel generator, or two containment fan coolers.

TABLE 9.2-4 (Sheet 2 of 2) Revision 307 (07/13)

FAILURE MODES AND EFFECTS ANALYSIS FOR THE CCWS AND ACCWS POST LOCA

FAILURE MODE	EFFECT ON SYSTEMS	METHOD OF DETECTION	MONITOR	REMARKS
Failure of chiller cooling water transfer valves				
A) ACCWS supply valve or ACCWS discharge valve fails to open	Loss of ACCWS coolant for one chiller	Flow meter - Limit switch	CRI	The redundant chiller is sufficient to shutdown the unit.
B) CCWS supply valve fails to close	High cooling water temp. to one chiller	Thermocouple Limit switch	CRI	The redundant chiller is sufficient to shutdown the unit safely.
C) CCWS discharge valve fails to close	No effect	Limit switch	CRI	Pressure in the CCWS return header is higher than in ACCWS header, and return flow would be directed to the wet cooling towers
➔(EC-41355, R307) Loss of air	No effect			The active valves are provided with accumulators and/or springs to ensure proper alignment of the system. Safety related accumulators are capable of providing motive air to pneumatically operated valves for 10 hours. Procedures are established for operating manual handwheel overrides or lining up backup air supplies for continued safety function after 10 hours.
🡐(EC-41355, R307) Loss of water in CCW surge tank	Loss of one channel	Level switch	CRI	The surge tank is separated by internal baffles to ensure that water loss in one channel will not effect the operation of another channel
Loss of one ACCW pump	One ACCWS channel is out of service	Flow meter	CRI	Cooling capacity by the two remaining CCWS channels and redundant ACCWS channel is sufficient to shutdown the unit safely.
Failure of an active valve to operate (ACCW)	Loss of one ACCW train	Limit Switch Flow Meter	CRI	“
Excessive valve leakage following a Loop (i.e. ACC-114, ACC-108, ACC-1045)	Loss of one ACCW train	Periodic Testing		“

TABLE 9.2-5 (Sheet 1 of 3) Revision 15 (03/07)

CCWS AND ACCWS INSTRUMENT APPLICATION

System Parameter & Location	Indication Local	Indication Control Room	Alarm* High	Alarm* Low	Control Function	Instrument Range
CCW Heat Exchanger						
1. Outlet Temperature		CP-8	X(CP-8)	X(CP-8)	Start auxiliary CCW pumps on high temp.	50-130°F
2. System Pressure	X	PMC	X(CP-33)		Start ACCW Pump on low pressure	0-80 psig
3. Outlet Pressure		CP-8		X(CP-8)		0-150 psig
4. Outlet Flow		CP-8		X(CP-8)		0-10,000 gpm
Shell Side						
1. Outlet Flow		CP-33		X(CP-33)		0-7500 gpm
Shutdown Heat Exchanger						
1. Outlet Pressure	X					0-150 psig
2. Outlet Flow		CP-8		X(CP-8)		0-7000 gpm
Fuel Pool Heat Exchanger (or Backup Fuel Pool Heat Exchanger)						
1. Outlet Flow		CP-8				0-6500 gpm
Containment Fan Coolers						
1. Outlet Flow		CP-18		X(CP-18)		0-1500 gpm
2. Inlet Temperature		CP-18				40-150°F
→(DRN 03-1988, R15)						
3. Outlet Temperature		CP-18				40-240°F
←(DRN 03-1988, R15)						
Reactor Coolant Pump						
1. Inlet Pressure			X(CP-2)			10-200 psig
2. Pump Seal Cooler Outlet Pressure			X(CP-2)			10-200 psig
3. Pump Seal Cooler Outlet Temperature		CP-2	X(CP-2)			60-160°F
HPSI Pump						
1. Outlet Flow				X(CP-8)		-

TABLE 9.2-5 (Sheet 2 of 3) Revision 11-A (02/02)

System Parameter & Location	Indication Local	Alarm* Control Room	High	Low	Control Function	Instrument Range
LPSI Pump						
1. Outlet Flow				X(CP-8)		-
Containment Spray Pump						
1. Outlet Flow				X(CP-8)		-
Boric Acid Concentrator						
1. Outlet Flow				X(CP-4)		-
Waste Management Concentrator						
1. Outlet Flow				X(CP-4)		-
Waste Gas Compressors						
1. Outlet Flow				X(CP-4)		-
Letdown Heat Exchanger						
→(DRN 00-691)						
1. Outlet Pressure	X					0-150 psig
2. Outlet Flow		CP-8		X(CP-4)		0-1400 gpm
Chemical Feed Tank						
1. Outlet Pressure	X					0-160 psig
CCW Pump						
1. Discharge Pressure		X				0-150 psig
CCW Surge Tank						
1. Level 2. Level 3. Level	X	CP-8	X(CP-8)	X(CP-8)	1. Control makeup flow into tank (Primary Water Pumps) 2. Automatic bypass of dry towers on low level in corresponding side of surge tank. 3. Isolates CCW Trains and operates CCW Make-up Pumps.	0-100%

←(DRN 00-691)

* All alarms indicated are in the main control room.

TABLE 9.2-5 (Sheet 3 of 3) Revision 9 (12/97)

System Parameter & Location	Indication Local	Alarm* Control Room	High	Low	Control Function	Instrument Range
Water Chiller						
1. Inlet Temperature	CP-18	X(CP-18)	X(CP-18)			40-150°F
2. Outlet Temperature	CP-18					40-150°F
3. Inlet Pressure		CP-18				0-125 psig
4. Outlet Pressure		CP-18				0-100 psig
→						
5. Outlet Flow		CP-18				0-1500 gpm
←						

* All alarms indicated are in the main control room.

TABLE 9.2-6 Revision 11-A (02/02)

DESIGN DATA FOR PWTP COMPONENTS

→(DRN 01-111)

1) Raw Water Service Pumps *

Quantity	2

2) Flush Pumps *

Quantity	2

3) Upflow Filters *

Quantity	2

4) Clearwell Tank

Quantity	1
Capacity, gallons	12,000
Diameter, feet	12

5) Transfer Pumps

Quantity	2
Flow rate, gpm	275

6) Primary Water Treatment Drain Pumps *

Quantity	2

* Equipment inactivated in place

←(DRN 01-111)

TABLE 9.2-7 (Sheet 1 of 2) Revision 8 (5/96)

DESIGN DATA FOR DWS COMPONENTS

DELETED SPECIFIC
DATA

TABLE 9.2-7 (Sheet 2 of 2) Revision 9 (12/97)

Equipment Abandoned

TABLE 9.2-8 (Sheet 1 of 2) Revision 11 (05/01)

PRINCIPAL COOLING TOWER COMPONENTS

DRY COOLING TOWERS

Type	dry, forced draft
Quantity	2
Number of Fans	15/tower
Number of Coils	10/tower
Tube design pressure, psi	155
Net Effective Heat Transfer Surface Area, each, ft^2	42,255/tower
Material	
Tubes	ASME SA 178, Gr C
Tube Bundles	ASME SA-36
Header	ASME SA-516 Gr 70
Fin	extruded aluminum
Fan Blades	fiberglass reinforced epoxy
Fan Hub	ASTM - A48, Class 35
Motor	40 hp, 460 V, 60 Hz, 3 phase, 2 speed 1800 rpm high speed, 900 rpm low speed
→ (DRN 99-2235) Motor Insulation	Class H
← (DRN 99-2235) Motor Enclosure	TEFC
Gear Reducer	
Type	helical
Bearings	antifriction
Governing Code for Pressure Retaining Portions	ASME Section III, 1974/Summer 1974 Addenda

TABLE 9.2-8 (Sheet 2 of 2) Revision 11-B (06/02)

PRINCIPAL COOLING TOWER COMPONENTS

WET COOLING TOWERS

Material	
Cell Distribution Piping	Hot dip galvanized carbon steel
Nozzle	316 Stainless Steel
Drift Eliminators	SS 304
Fan Blade	cast aluminum w/phenolic coating
Fan Hub	cast aluminum w/phenolic coating
Motor	30 hp, 460 V, 60 Hz, 3 phase, 900 rpm
Motor Enclosure	TEFC
→(DRN 01-1323)	
Motor Insulation	Class B or Better
←(DRN 01-1323)	
Governing Code for Pressure Retaining Portions	ASME Section III, 1974 Edition

TABLE 9.2-9 Revision 309 (06/16)

ESTIMATED WET-DRY COOLING TOWER HEAT DISSIPATION FOR ALL OPERATIONS

	(Note 1) Cold CCW Temperature (°F)	Ambient Dry Bulb/Wet Bulb Temperature (°F)	Heat Dissipated by One UHS Train - 10^6 BTU/HR: (Note 2) Dry Tower	CCW Heat Exchanger	(Note 3) Wet Tower	(Note 4) Total Heat Dissipated	Heat Removal Requirements
→(DRN 03-2063, R14) Normal Operation - 100% of dry and wet cooling Towers	95	92/83	27.25	18.29	18.29	45.54	45.54 x 10^6 BTU/HR per one loop
→(EC-8477, R305) Refueling - 100% of dry and wet cooling towers are in service	80[5]	80/55[6]	26.12	29.34	29.34	55.5	53.60 x 10^6 BTU/HR per one loop
←(EC-8477, R305) Normal Shutdown - 100% of dry and wet cooling towers are in service	105	92/83	80.43	24.95	24.95	105.38	105.38 x 10^6 BTU/HR per one loop
→(DRN 05-1652, R14-B; EC-8465, R307) Accident - 100% of dry and wet cooling towers are in service ←(DRN 05-1652, R14-B; EC-8465, R307)	115	102/78	117.36	57.84	62.94	180.3	180.3 x 10^6 BTU/HR per one loop
→(DRN 05-446, R14; EC-530, R303) Tornado Missile Analysis – T = 0 to 2 hrs. DCT out of service, WCT in natural draft mode.	120	86/76	0	13.17	18.27	18.27	18.27 x 10^6 BTU/HR per one loop
Tornado Missile Analysis – T = >2 hrs, 60% DCT in service, WCT in natural draft mode.	120	86/76	33.67	0	5.1	38.77	38.77 x 10^6 BTU/HR per one loop
→(LBDCR 15-032, R309) Tornado Missile Analysis – T = 172 hrs, 60% DCT in service, WCT in natural draft mode, enter SDC mode. ←(DRN 03-2063, R14; 05-446, R14; EC-530, R303, LBDCR 15-032, R309)	120	86/76	69.49	0	5.1	74.59	74.59 x 10^6 BTU/HR per one loop

Note:
1. The design temperature of CCWS is 120°F
2. A 1.9°F/2.0°F was added for dry bulb temperatures of 102°F <102°F respectively to account for hot air recirculation effects.
3. A 1°F wet bulb temperature was added to account for tower hot air recirculation effects.
4. Total capacity of the UHS is the sum of the dry tower and wet tower

→(DRN 05-446, R14)
←(DRN 05-446, R14)
→(EC-8477, R305)

5. Cold CCW Temperature based on Fuel Pool Cooling Heat Exchanger with single active failure after full core offload commencing four days after shutdown.
6. Ambient Temperature based on single failure where only one Fuel Pool Cooling Pump and one Component Cooling Water pump are available after a full core offload that commenced four days after shutdown. Administrative controls will require additional in-reactor hold time depending on expected ambient conditions. For example, maximum temperature experienced during the time period between October 20 and April 27 would typically require full core offload to be delayed until at least nine days after shutdown.

←(EC-8477, R305)

TABLE 9.2-10 Revision 307 (07/13)

WATER REQUIREMENTS FOR WET COOLING TOWERS POST LOCA ESSENTIAL LOADS

→(DRN 03-2063, R14)

	WCT A	WCT B
→(DRN 05-1652, R14-B; EC-8465, R307) Evaporation, gallons	93,378	93,378
5% Allowance for Concentration of solids, gallons	4,669	4,669
Drift, gallons	8,589	8,589
Total Consumption, gallons ←(DRN 05-1652, R14-B; EC-8465, R307)	106,636	106,636
WCT Basin Capacity, gallons (based on Technical Specification	174,000	174,200
→(DRN 05-1652, R14-B; EC-8465, R307) Margin, gallons ←(DRN 05-1652, R14-B; EC-8465, R307)	67,364	67,564

Assumptions:

1. Maximum three day average dry bulb temperature (89°F) is used for dry cooling tower heat removal. Actual post-LOCA operation of the wet cooling towers is approximately eight days.

2. Fifty percent relative humidity and 76°F wet bulb temperature are used in the calculations.

3. Essential Chiller is manually realigned back to the CCWS when CCWS cold temperature is below 110°F.

→(DRN 00-703, R11-A; 05-1652, R14-B; EC-8465, R307)

4. Does not include Spent Fuel Pool heat loads. When adding the non-essential load of fuel pool cooling, approximately 113,807 gallons of makeup is required to the WCT basin if only one UHS Train is available. Adequate makeup can be supplied to a WCT basin by gravity feeding from the Circulating Water System or the unavailable WCT basin.

←(DRN 00-703, R11-A; 03-2063, R14; 05-1652, R14-B; EC-8465, R307)

TABLE 9.2-11 Revision 7 (10/94)

COOLING TOWER INSTRUMENT APPLICATION

→ Systems Parameter & Location	Indication Local	Indication Control Room	Alarm High	Alarm Low	Control Function
Wet Cooling Towers					
1. Motor Vibration			X(3)		
2. Fan Operation		X(1)			
Wet Cooling Tower Basin					
1. Level		X(2)	X(2)	X(2)	open/close make-up valves
2. Temperature		X(1)	X(1)		Start Wet Cooling Tower Fans
Dry Cooling Tower					
1. Motor Vibration			X(3)		Fans are automatically controlled by CCWS temperature
2. Fan Operation		X(1)			

Notes

(1) Control Panel CP-33
(2) Control Panel CP-8
(3) Control Panel CP-13
←

DESIGN DATA FOR CONDENSATE STORAGE SYSTEM

A.	Condensate Storage Tank	
	Quantity	1
	Capacity, gal.	260,000
	Height, ft.	36
	Diameter, ft.	35
→(DRN 01-559)		
	Operating Pressure	Positive with respect to atmospheric pressure
←(DRN 01-559)		
	Operating Temperature, °F	0-100
	Design Pressure, psig	1
	Design Temperature, °F	100
	Material	Carbon Steel
B.	Condensate Transfer Pump	
	Quantity	1
	Type	Horizontal, Radial Flow
	Capacity, gpm	500
	Total Dynamic Head, ft.	50
	Shutoff Head, ft.	70
	Runout Capacity, gpm	700
	Speed, rpm	1800
	Brake Horsepower	8.6
	Efficiency, %	74
	Materials of Construction	
	Bedplate	Cast Iron
	Casing	Ductile Iron
	Impeller	Cast Iron
	Shaft	316 SS
	Driver	
	Type	Electric-Induction Motor
	Rating/Speed	10 hp/1800 rpm
	Voltage/Phase/Frequency	460 V/3 ph/60 hz
	Service Factor	1.0
C.	Condensate Storage Tank Pumps	
	Quantity	2
	Type	In Line
	Capacity, gpm	100
	Total Dynamic Head, ft.	220
	Speed, rpm	3600

Materials of Construction	
Casing	316 SS
Impeller	316 SS
Shaft	Carbon Steel
Driver	
Type	Electric-Induction Motor
Rating/Speed	15 hp/3600 rpm
Voltage/Phase/Frequency	460 V/3 ph/60 hz
→(DRN 04-92, R13-B)	
Service Factor	1.0 or 1.15
←(DRN 04-92, R13-B)	

D. Demineralized Water Storage Tank

Quantity	1
Capacity, gal.	500,000
Height, ft.	42
Diameter, ft.	50
Operating Pressure, inch WC	2.5
Operating Temperature, °F	0-100
Design Pressure, psig	1
Design Temperature, °F	120
Material	Carbon Steel

E. Hotwell Transfer Pump

Quantity	1
Type	Horizontal, Radial Flow
Capacity, gpm	500
Total Dynamic Head, ft.	50
Shutoff Head, ft.	70
Runout Capacity, gpm	700
Speed, rpm	1750
Brake Horsepower	8.6
Efficiency, %	74
Materials of Construction	
Bedplate	Cast Iron
Casing	Ductile Iron
Impeller	Ductile Iron
Shaft	316 SS
Driver	
Type	Electric - Induction Motor
Rating/Speed	10 hp/1800 rpm
Voltage/Phase/Frequency	460 V/3 ph/60 Hz
Service Factor	1.0

TABLE 9.2-13 (Sheet 1 of 2)

DESIGN DATA FOR
TURBINE CLOSED COOLING WATER SYSTEM COMPONENTS

Turbine Cooling Water Heat Exchangers

Type	Horizontal, straight-tube, single pass
Quantity	2 half capacity
Design Duty, Each, Btu/hr.	45×10^6
Heat Transfer Area, Each, $Ft.^2$	11,400 effective
Design Pressure, psig	125 shell side, 50 tube side
Design Temperature, F	150 shell side, 150 tube side
Material	
Shell	Carbon steel, ASTM A-285, Grade C
Tubes	TP-304S/ASTM A-249
Tube Sheet	ASTM A-516, Grade 70
Codes	TEMA, Class C, ASME Sections VIII and IX, 1971 Edition, 1973 Summer Addenda

Turbine Cooling Water Pump

Type	Horizontal centrifugal
Quantity	2 full capacity
Capacity, Each, gpm	12,000
Head, ft.	144
Material	
Case	Cast iron, ASTM A-48
Impeller	Cast iron, ASTM A-48
Shaft	Carbon Steel, AISI-1045
Motor	600 hp, 4000 V, 3 phase, 60 Hz, 1180 rpm
Insulation Class	B
Enclosure	TEFC

TABLE 9.2-13 (Sheet 2 of 2)

DESIGN DATA FOR
TURBINE CLOSED COOLING WATER SYSTEM COMPONENTS

Turbine Cooling Water Pumps (Cont'd)	
Codes	NEMA, Standards of Hydraulic Institute
Turbine Cooling Water Surge Tank	
Type	Vertical
Quantity	1
Design Pressure, psig	5
Design Temperature, F	125
Volume, gal	550
Material	ASTM A-283, Grade C
Code	ASME Section VIII, 1974 Edition, 1974 Summer Addenda
Chemical Feed Tank	
Type	Vertical
Quantity	1
Design Pressure, psig	125
Design Temperature, F	125
Volume, gal	46
Material	Carbon Steel SA-106B
Code	ASME Section VIII, 1971 Edition, 1972 Winter Addenda

TABLE 9.2-14 Revision 9 (12/97)

TURBINE PLANT OPERATING FLOW RATES
AND CALCULATED HEAT LOADS

Component Description	Flow/Unit (gpm)	Heat Load/Unit (Btu x 10^6/hr)
Turbine Lube-Oil Coolers (1)	3400	13.478
Turbine Stator Coolers (2)	1280	11.8
Turbine E-H Fluid Coolers (2)	20	0.1
Hydrogen Seal Oil Unit (1)	100	0.365
Air Seal Oil Unit (1)	260	1.04
Hydrogen Coolers (4)	1227	9.8
Exciter Air Cooler Units (4)	90	0.323
Feedwater Turbine Lube-Oil Coolers (2)	80	0.30
→ Vacuum Pumps (1)	150	0.57
(2) ←	180	
Condensate Pump Motor-Bearing Coolers (3)	20	0.1
Air Compressors (5)	75	0.31
Heater Drain Pump Seal Coolers (3)	10	0.05
Heater Drain Pump Motor Coolers (3)	5	0.018
Isolated Phase Bus Cooler (1)	200	0.71

TABLE 9.2-15 Revision 11-A (02/02)

DESIGN DATA FOR PRIMARY WATER STORAGE SYSTEM

Primary Water Storage Tank	
Quantity	1
Capacity, gal.	260,000
Height, ft.	36
Diameter, ft.	35
→(DRN 01-559)	
Operating Pressure	Positive with respect to atmospheric pressure
←(DRN 01-559)	
Operating Temperature, F	0-100
Design Pressure, psig	1
Design Temperature, F	100
Material	Carbon Steel
Primary Water Pumps	
Quantity	2
Type	Horizontal, Radial Flow
Capacity, gpm	300
Total Dynamic Head, ft	231
Shutoff Head, ft	240
Runout Capacity, gpm	750
Speed, rpm	3500
Brake Horsepower	28.2
Efficiency, %	62
Materials of Construction	
Bedplate	Cast Iron
Casing	Stainless Steel
Impeller	Stainless Steel
Shaft	316 SS
Driver	
Type	Electric-Induction Motor
Rating/Speed	40 hp/3600 rpm
Voltage/phase/Frequency	460 V/3 ph/60 hz
Service Factor	1.0

SAFETY-RELATED AND NON-SAFETY-RELATED AIR HANDLING UNITS

Safety-Related Air Handling Units

Elevation (ft. MSL)	Quantity per subsystem	Tag No.	Area Served
+46	1	AH-12	Control Room
+46	1	AH-26	Control Room (Mechanical Equipment Room)
+46	1	AH-25	Switchgear Area, Cable Vault and Battery Rooms
+21	1	AH-24	CCW Heat Exchangers
+21	1	AH-20	CCW Pump AB
+21	1	AH-10	CCW Pumps
+ 7	1	AH-30	Switchgear Area
-35	1	AH-21	Safeguard Pump AB
-35	2	AH- 2	Safeguard Pumps
-35	1	AH- 3	Shutdown Heat Exchangers
-35	1	AH-17	Emergency Feedwater Pumps
-35	1	AH-18	Charging Pumps
-35	1	AH-22	Charging Pumps AB

Non-safety Air Handling Units

Elevation (ft. MSL)	Quantity per subsystem	Tag No.	Area Served
→			
+ 7	1	AH- 5	HVAC Area
←			
+ 7	1	AH- 6	Chemical Lab
+ 7	1	AH- 8	Decontamination and First Aid Area
→			
+ 7	1	AH-36	I & C Room
←			
+46	1	AH-32	Decontamination Room
+46	1	AH-33	Hot Machine Shop

TABLE 9.2-17

ESSENTIAL SERVICES CHILLED WATER SYSTEM
FAILURE MODE AND EFFECTS ANALYSIS

Component/Identification & Quantity	Failure Mode	Effect on System	Method of Detection	Monitor	Remarks
Water Chiller (2)	1- Loss of power 2- Loss of refrigerant 3- Condenser/Evaporator tube leakage	Loss of cooling capacity	1- Breaker trip 2- Water temperature indicator with sensor at chiller outlet 3- Temperature alarm with sensor at operating main control room air handling unit supply fan discharge	CRI*	100 percent capacity standby system will be operable.
Chilled Water Pump Motor (2)	Loss of power	Loss of chilled water flow	Flow switch at chiller outlet	CRI	100 percent capacity standby system will be operable.
Chilled Water Piping	Rupture	1- Loss of chilled water flow 2- Increase in chilled water temperature 3- Increase in room air temperature	1- Flow switch in chilled water piping be operable 2- Temperature indicator with sensor at chiller outlet 3- Temperature alarm with sensor at operating main control room air handling unit supply fan discharge 4- Temperature alarm from each safety related pump room	CRI	100 percent capacity standby system will
CCW Water Piping	Rupture	1- Increased in chilled water temperature 2- Increase in supply air temperature	1- Temperature indicator with sensor at chiller outlet 2- Temperature alarm with sensor at each main control room air handling unit supply fan discharge	CRI	100 percent capacity standby chilled water system will be operable.

*CRI = main control room indication