## 9.2 Water Systems

### 9.2.1 Essential Service Water System

The function of the essential service water system (ESWS) is to remove heat from plant components which require cooling during normal operation, for safe shutdown of the reactor and following a design basis accident (DBA). This is accomplished by providing cooling water from the essential service water (ESW) cooling tower basins to the component cooling water system (CCWS) heat exchangers (HX), emergency diesel generator (EDG) HXs and ESW pump room coolers. The function of the ESW cooling towers is to dissipate heat rejected from the ESWS during all plant modes of operation.

Ultimate heat sink (UHS) components such as the mechanical draft cooling towers and site-specific basin support systems which include the ESW makeup system, ESW blowdown system and the ESW chemical treatment system are addressed in Section 9.2.5.

#### 9.2.1.1 Design Bases

- ESWS structures, systems and components which provide essential cooling for safety-related equipment are designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles without loss of capability to perform their safety-related functions (GDC 2). Structures housing the system as well as the system components are capable of withstanding the effects of earthquakes. The seismic design of this system meets the guidance of RG 1.29 (Position C.1 for the safety-related portion, and Position C.2 for the non-safety-related portion). Table 3.2.2-1 provides the seismic and other design classifications for the components in the ESWS.

- Safety-related portions of the ESWS are designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. These shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping and discharging fluids, that may result from equipment failures and from external events (GDC 4).

- The ESWS does not share structures, systems or components important to safety with other nuclear power plant units unless it has been shown that such sharing does not significantly impair the ability to perform their safety-related functions; including, the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units (GDC 5).

- The ESWS functions to provide heat removal from the CCWS HXs, EDG HXs, and ESW pump room coolers during normal operation and accident conditions, and transfers that energy to the UHS (GDC 44).

- The ESWS is designed to permit appropriate periodic inspection of important components necessary to maintain the integrity and capability of the system (GDC 45).
- The ESWS is designed to permit appropriate periodic pressure and functional testing necessary to maintain structural and leak-tight integrity of its components, the operability and performance of the active components of the system, and the operability of the system as a whole. The ESWS is also designed to make sure the performance of the full operational sequence necessary to bring the system into operation for reactor shutdown is satisfactory. For loss of coolant accident (LOCA) conditions, operation of applicable portions of the protection system (PS) and the transfer between normal and emergency power sources is also provided (GDC 46).

The ESWS provides sufficient cooling water for removing heat from essential plant equipment and transferring the heat to the cooling towers over the full range of normal reactor operation. The ESWS flow capacity and supply capability are designed so that the temperatures in essential plant equipment remain within their specified limits.

The ESWS operates in conjunction with the CCWS and other reactor auxiliary components to provide a means to cool the reactor core and reactor coolant system (RCS) to achieve a safe shutdown. The safety-related ESWS divisions provide continued heat transfer from the fuel pool cooling system (FPCS) via the CCWS as long as any spent fuel assemblies are in the spent fuel storage pool located outside containment.

### 9.2.1.2 System Description

The ESWS consists of four separate, redundant, safety-related divisions, and one dedicated, non-safety-related division.

The ESWS cools the CCWS HX which acts as an intermediate loop isolating the ESWS from the RCS. The CCWS and ESWS are monitored to detect radioactive contamination into and out of the system.

The ESWS takes suction from the UHS cooling tower basin and provides cooling water to the CCWS HX, EDG HXs, and the ESW pump room coolers. The heated water is then returned to the UHS cooling tower. The system is shown in Figure 9.2.1-1—Essential Service Water System Piping & Instrumentation Diagram. Safety and seismic design classification of the components is provided in Section 3.2.

Each safety-related ESWS division consists of one ESWS pump, a debris filter, piping, valves, controls and instrumentation.

Provisions are made to make sure there is a continuous flow of cooling water under normal and accident operating conditions. The four safety-related divisions of the

ESWS are powered by Class 1E electrical buses and are emergency powered by the EDGs.

The non-safety-related dedicated division contains a dedicated ESWS pump, debris filter, piping, valves, controls, and instrumentation. The non-safety related ESWS pumps cooling water from the division four UHS cooling tower basin to the dedicated CCWS HX and back to the division four UHS cooling tower during severe accidents (SA). The dedicated ESWS train is powered by Class 1E electrical Division 4 and is capable of being supplied by an EDG or a station blackout diesel generator (SBODG).

Refer to Section 12.3.6.5.7 for ESWS design features which demonstrate compliance with the requirements of 10 CFR 20.1406. Refer to Section 11.5.4 and Table 11.5-1, radiation monitors R-66 through R-70 for process and effluent radiological monitoring and sampling within the ESWS.

### 9.2.1.3 Component Description

#### 9.2.1.3.1 Safety-Related Essential Service Water Pumps

Each of the four safety-related cooling divisions contains one 100 percent capacity pump. During normal operating conditions, two of the four divisions are operating. The required flow rate of each ESWS pump is defined by the heat to be removed from the system loads. Design parameters are listed in Table 9.2.1-1. The pumps are designed to fulfill the corresponding minimal required design mass flow rate plus an additional minimum flow margin of approximately 12.5 percent, under the following conditions:

- Minimal water level without cavitation.
- Head losses in the cooling water inlet piping according to full power plant operation.
- Fluctuations in the supplied electrical frequency.
- Increased pipe roughness due to aging and fouling.
- Fouled debris filters.
- Maximum pressure drop through the system HXs.
- Minimum water level in cooling tower basin considers minimum submergence requirements to prevent vortex effects, and net positive suction head to prevent cavitation of the ESWS pump.
- Maximum allowable water level differential across the coarse and fine screens.

Determination of the discharge head of the pumps is based on the dynamic pressure losses, the minimum/maximum water levels of the water source, and the head losses of the mechanical equipment of the associated ESWS at full load operation with an additional margin of approximately 10 percent added to the total head.

The pump motors are air cooled. To remove heat losses, an air recirculation system is installed for each division. In addition, anti-condensation heaters on the motors are switched on as soon as the pumps cease operation.

The four ESW pumps will trip on high bearing temperature, high differential pressure across the debris filter, low pump discharge flow, high pump discharge pressure, or cooling tower basin water level below low level for safe pump operation.

#### 9.2.1.3.2 Dedicated Essential Service Water Pump

The 100 percent capacity dedicated ESW pump is normally in standby mode.

This non-safety-related pump is manually started only in response to certain postulated SA conditions; it is not credited for response to any DBA.

The required flow rate of the dedicated ESWS pump is defined by the heat to be removed from the dedicated CCWS HX. Design parameters are listed in Table 9.2.1-2. The pump is designed to fulfill the corresponding minimal required design mass flow rate under the following conditions:

- Minimal water level.
- Fluctuations in the supplied electrical frequency.
- Increased pipe roughness due to aging and fouling.
- Fouled debris filter.
- Minimum water level in cooling tower basin considers minimum submergence requirements to prevent vortex effects, and net positive suction head to prevent cavitation of the dedicated ESWS pump.
- Maximum allowable water level differential across the coarse and fine screens.

The pump motor is air cooled. In addition, an anti-condensation heater on the motor is switched on as soon as the pump ceases operation.

#### 9.2.1.3.3 Debris Filters - Safety Divisions

The debris filters remove from the cooling water all debris particles that pass through coarse and fine screens and would obstruct the system user HXs.

The debris filters are designed as an automatic backwash type. With increasing fouling, the differential pressure across the filter segments increases until reaching a preset operational point. The pressure relief backwash process of the filter is initiated by either the signal of the differential pressure measuring system, a timer after the start of the ESW pump or via a manual operator initiation.

The discharge and disposal of the collected debris must be in accordance with federal and state regulations relevant to site location.

To verify the function of the safety-related filter, an alternate safety-related filter blowdown path is provided. The line includes valve 30PEB10/20/30/40AA004, Filter Emergency Blowdown Isolation Valve.

#### 9.2.1.3.4 Debris Filter - Dedicated Division

The debris filter removes from the cooling water all debris particles that pass through coarse and fine screens and would obstruct the dedicated CCWS HX.

The debris filter is designed as an automatic backwash type. With increasing fouling, the differential pressure across the filter segments increases until reaching a preset operational point. The pressure relief backwash process of the filter is initiated by either the signal of the differential pressure measuring system, a timer after the start of the dedicated ESW pump or via a manual operator initiation.

The discharge and disposal of the collected debris must be in accordance with federal and state regulations relevant to the site location.

#### 9.2.1.3.5 Piping, Valves, and Fittings

System materials must be selected that are suitable to the site location, ESW fluid properties and site installation. System materials that come into contact with one another must be chosen so as to minimize galvanic corrosion. All safety-related piping, valves, and fittings are in accordance with ASME Code Section III, Class 3 (Reference 1).

Specific chemistry requirements are defined to minimize corrosion, prevent scale formation, and limit biological and sedimentary fouling that could inhibit flow. In addition, there are chemical additives used to reduce scaling and corrosion, and to treat potential biological contaminants, which are added via the normal makeup system piping to the cooling tower basin.

A COL applicant that references the U.S. EPR design certification will provide a description of materials that will be used for the essential service water system (ESWS) at their site location, including the basis for determining that the materials being used are appropriate for the site location and for the fluid properties that apply.

Pipe diameters for all branches of the ESWS are based on limiting the flow velocity to 10 ft/sec for normal modes of operation that are expected to occur frequently. ESW piping in each train is sized to provide sufficient flow in that train to remove design heat loads from system user heat exchangers under normal operating, shutdown/cooldown, design basis accident, and (for ESW Train 4 only) severe accident conditions with flow velocities less than 10 feet per second. Refer to Table 9.2.5-1 for the total required minimum ESW flow rates and required ESW temperatures for the different operating conditions.

Water hammer prevention and mitigation is accomplished through a combination of design features, surveillance, and testing measures. A keep-fill line and monitoring of water level in the tower riser of a standby train is administratively controlled to keep the water level in the tower riser above the predetermined minimum. The non-safety-related function of the tower keep-fill line is to replenish water in the cooling tower riser pipe that is lost due to leakages in the system, thereby minimizing potential water hammer effects on an actuation of the standby train due to a large air void in the piping. The keep-fill line is routed from the non-safety-related portion of the normal makeup line that is inside the ESW pump building to the highest point in the riser pipe. The safety-related manual keep-fill valve and check valve separate the non-safety-related portions of the keep-fill line to maintain the pressure boundary of the safety-related riser pipe.

The ESW pump is started against a closed discharge isolation valve. The air release valve provides a path to remove the air in the pipe between the check valve 30PEB10/20/30/40 AA204 and the pump. In addition, following a trip of the pump, the air release valves provide a path for air to enter the ESW line to prevent vacuum formation.

The pump discharge isolation valve 30PEB10/20/30/40 AA005 auto-closes on pump stop. Therefore, the leakage path from the tower riser is through the pump discharge isolation valve, and the pump discharge check valve 30PEB10/20/30/40 AA204 in series. These valves are part of the In-service Testing program (refer to Section 3.9.6) and will be leak tested in accordance with the program requirements therein. Additionally, the discharge line from the room cooler is routed so that the highest point in the room cooler discharge line will be higher than the highest point in cooling tower riser pipe. This also prevents draining of fluid through the pump room cooler following a trip of the ESW pump. The vacuum breaker valve 30PEB11 AA191, as shown in Table 9.2.1-1 provides a path for air to fill the room cooler discharge line when the ESW pump trips. The discharge line from the room cooler is submerged in the basin. Following a trip of the pump, as the water in the vertical section of the room cooler discharge line drains to the basin, the vacuum breaker valve provides a path for the air to prevent vacuum formation.

The general protection concept in case of pipe failures in the ESWS with regard to flooding is based on the principle of restricting the consequences to the affected division. In case of significant leakage from an ESWS train in a Safeguard Building

(SB), the associated motor-driven ESWS pump discharge isolation valve is automatically closed and the ESWS pump is tripped. The detection and isolation signaling is done by safety-related means. The nuclear island drain and vent system (NIDVS) sump level instrument in the non-controlled areas of the SBs provides a MAX alarm in the MCR and isolates the affected ESWS train. No operator action is required to isolate the ESWS in a large flooding event.

Primary overpressure protection on the ESWS side of the CCWS HXs is provided by thermal relief valves. Pressure relief device setpoints for the ESWS are in accordance with ASME Section III.

Secondary overpressure protection on the ESWS side of the CCWS HXs is provided by manual opening of the valve (located upstream of the relief valve) before isolation of the particular HX.

To make sure the performance of the safety-related functions, all manually operated valves in the main lines of the safety-related ESWS divisions are mechanically locked in the proper position.

In-service testing of valves shall be performed as described in Section 3.9.6.3. Leakage rates for boundary isolation valves that require testing are based on ASME OM Code, Subsection ISTC (Reference 3).

A maximum valve leakage criterion will be specified for the safety-related check valves which will be no less stringent than the API-598 metal seated check valve criterion. A hydraulic transient analysis will be performed to confirm the integrity of ESW piping to withstand the effects of water hammer.

In general, butterfly valves are used in the ESWS for isolation (open or closed) service and not for throttling. In those applications where a butterfly valve is used in the ESWS and is subject to substantial throttling service for extended periods of time, design provisions are considered to prevent consequential pipe wall thinning immediately downstream of these valves. Such design provisions include the use of erosion resistant materials, the use of thick wall pipe and installing straight pipe lengths immediately downstream of the affected valves.

For operating trains, the following describes the operation of key system valves:

The ESWS pump discharge isolation valve, 30PEB10/20/30/40 AA005, is normally open when the pump is running. Prior to train startup, the valve is closed. After pump start, the valve opens automatically. The stroke time for the ESWS pump discharge isolation valve allows cooling flow to reach the EDG in less than 120 seconds. The ESWS pump operates at the system setpoint when the valve is in the full open position. Upon receipt of an SI signal, automatic ESW actuation from the CCWS, or automatic ESW actuation from LOOP the ESWS pump discharge isolation valve will automatically receive a signal to open.

The pump minimum flow recirculation valve, 30PEB10/20/30/40 AA002 is normally shut during normal operations. Prior to train startup, the valve is closed. In the event the ESWS pump discharge isolation valve 30PEB10/20/30/40 AA005 fails to sufficiently open after a pump start by the predetermined time interval, the discharge pressure will increase and the minimum flow recirculation valve will open to establish a flow path for water from the pump back to the cooling tower basin, thereby protecting the pump from damage due to overheating. Upon receipt of an SI signal, the pump minimum flow recirculation valve will automatically receive a signal to close.

For the dedicated train, the manual stop-check valve (30PEB80 AA002) is installed on the pump discharge side in the essential service water pump building (ESWPB). The valve and motor-operated minimum flow recirculation valve 30PEB80 AA0015 are controlled such that the recirculation valve opens on a time delay if the stop-check does not open after the dedicated ESW pump starts. This action establishes flow through the recirculation line back to the cooling tower basin, thereby preventing potential pump damage due to overheating/cavitation.

The normal blowdown flow path extends from the ESWS supply header just downstream of the debris filter to the plant waste water retention basin. Flow from the ESWS to the retention basin is established when the ESWS normal blowdown isolation valve opens. The valve positions of the ESW normal blowdown isolation valves, 30PEB10/20/30/40 AA016, are adjusted from the MCR as necessary during normal operations to maintain ESW water chemistry within established limits. The blowdown flow rate and line size are based on evaporation loss from the associated cooling tower and maintaining the number of cycles of concentration in the tower basin. The debris removal line joins the normal blowdown flow path downstream of a check valve in the blowdown line. Upon receipt of an SI signal, the ESW normal blowdown isolation valve automatically receives a signal to close. The blowdown flow path is isolated under DBA conditions.

The dedicated ESW blowdown valve, 30PEB80 AA016, is throttled as necessary during dedicated train operation to maintain ESW water chemistry within established limits.

The emergency blowdown line extends from the normal blowdown line to its terminal end just outside the ESWPB. The safety-related flow path is established when the ESWS emergency blowdown isolation valve is opened by the operator. During normal operations, this flow path is used only in the event of a failure of the normal blowdown flow path. The cooling tower emergency blowdown system isolation valves, 30PEB10/20/30/40 AA003, are motor operated valves capable of being throttled to obtain the desired blowdown flow rate based on water chemistry analysis results.

Upon receipt of an SI signal, the cooling tower emergency blowdown system isolation valves automatically receive a signal to close.

The debris filter blowdown isolation valve, 30PEB10/20/30/40 AA015, is cycled open and shut automatically as necessary during normal operations to provide a flow path for debris removal from the debris filter during the automatic backwash cycle. The pressure relief backwash process of the filter is initiated by either the signal of the differential pressure measuring system, a timer, after the start of the ESW pump, or via manual operator initiation. The debris filter blowdown isolation valve opens and the drive motor is energized. Upon receipt of an SI signal, the debris filter blowdown isolation valve will automatically receive a signal to close.

The debris filter emergency blowdown isolation valve, 30PEB10/20/30/40 AA004, is cycled open and shut automatically as necessary during abnormal operations to provide a safety-related flow path for debris removal from the debris filter during the automatic backwash cycle. Upon receipt of an SI signal, the debris filter emergency blowdown isolation valve will automatically receive a signal to close. The basin is filled with high quality water during the first 72 hours post DBA; however, periodic filter blowdown may be necessary during the period between the first 72 hours and 30 days.

The dedicated train debris filter blowdown isolation valve, 30PEB80 AA009, is cycled open and shut as necessary during dedicated train operations to provide a flow path for debris removal from the debris filter during the automatic backwash cycle.

The ESWS cooling tower return isolation valve, 30PED10/20/30/40 AA010, is normally open when the pump is running. The cooling tower return isolation valves are positioned by the operator in the MCR as necessary to maintain desired ESW cold water temperature. The stroke time for the ESWS return header isolation valve from a full closed position allows cooling flow to reach the EDG in less than 120 seconds. The ESWS pump operates at the system setpoint when the valve is in the full open position. Upon receipt of an SI signal, the ESWS cooling tower return isolation valve automatically receives a signal to open.

The ESWS cooling tower bypass isolation valve, 30PED10/20/30/40 AA011, is normally shut during normal operations. The return isolation valve and the bypass valve will be repositioned automatically under low heat load/low ambient conditions to help maintain ESWS basin water temperature above established limits. The valves are positioned by the operator in the MCR as necessary to maintain desired ESW cold water temperature. Upon receipt of an SI signal, the ESWS cooling tower bypass isolation valve automatically receives a signal to close.

The ESWS normal makeup water isolation valve, 30PED10/20/30/40 AA019, is cycled open and shut as necessary during normal operations to maintain cooling tower basin water level within the established operating band. Upon receipt of an SI signal, the valve shuts automatically, isolating the non-safety-related normal makeup water system from the safety-related emergency makeup system.

The ESWS emergency makeup water isolation valve, 30PED10/20/30/40 AA021, is shut during normal operations. Upon receipt of an SI signal, the valve opens automatically to establish the flow path from the ESWS emergency makeup system to the tower basin. After 72 hours have elapsed under DBA conditions, the emergency makeup water system isolation valves (modulate) the flow of emergency makeup water to the cooling tower basins to maintain tower basin water levels within the established operating limits. The limits prevent overfilling and maintain the level higher than the minimum necessary for safe pump operation through the receipt of control inputs from the tower basin water level controls. If the water level in the cooling tower basin continues to rise, an alarm will alert the operator at the high level. Operator action will be performed to remove water from the cooling tower basin through the use of the safety-related emergency blowdown to maintain water level. In accordance with Section 9.2.5, a COL applicant that references the U.S. EPR design certification will provide site specific information for the UHS support systems including emergency makeup water.

A keep-fill line and monitoring of water level in the tower riser pipe of a standby train is administratively controlled to keep the water level in the riser above the pre-determined minimum. The keep-fill line delivers water from the normal makeup supply to the top of the UHS tower riser pipe through a manually-operated safety-related boundary isolation valve (30 PEB 10/20/30/40 AA024) and check valve 30 PEB 10/20/30/40 AA025). Level is monitored in the tower riser and level indication is provided in the MCR and locally at the keep-fill valve. The non-safety related function of the tower keep-fill line is to replenish water in the cooling tower riser pipe that is lost due to leakages in the system thereby minimizing potential water hammer effects during train startup due to air voids in the piping. The safety-related manual keep-fill valve and check valve separates the non-safety-related portions of the keep-fill line to maintain the pressure boundary of the safety-related riser pipe. This design provision eliminates the need for the start of the whole train by operator action.

The ESWS air release valve, 30PEB10/20/30/40 AA190, is integral to ESW debris filter and opens and shuts as necessary during normal operations to provide a flow path to remove air from the system.

The ESWS vacuum relief valve, 30PEB11/21/31/41 AA191, opens and shuts as necessary during normal operations to provide an air flow path for vacuum relief.

### 9.2.1.4 Operation

#### 9.2.1.4.1 Normal Operating Conditions

**Safety-Related Divisions**

The ESWS supply is vital for all phases of plant operation and is designed to provide cooling water both during power operation and shutdown of the plant. During normal plant operation, two of four pumps are in operation with the remaining divisions in standby. The pumps are switched over periodically, thus changing the operational divisions.

The four divisions are filled and vented prior to operation. Under normal system operating conditions on a per division basis, the ESWS pump is in operation, the differential water level across coarse and fine screens is within limit, and the debris filter is functioning and all the valves in the main line are open. If the differential pressure across the debris filter reaches the predefined setpoint, automatic filter cleaning is initiated. In addition, if the differential water level across coarse and fine screens reaches alarm level, inspection and clearing of screens is initiated.

During standby, the divisions not in operation are aligned for normal operation (manual valves in the main line are open) and the system is filled and vented. The debris filter is in standby and ready to start. The system can be started manually from the main control room or automatically. In all cases, only the start signal needs to be actuated; preparatory measures are not necessary. The stopping of a particular division is performed manually.

Four ESWS divisions are normally running to achieve cold shutdown in the minimum time. Only two divisions are required to achieve cold shutdown.

During refueling, when the core is almost discharged to the Fuel Building (FB), two or three ESWS divisions are in operation. During this phase, maintenance can be performed on one division. When the core is totally offloaded and in the FB, only two ESWS divisions are required to be in operation.

**Non-Safety-Related Division**

The dedicated ESW division is not in use during normal plant operation. The ESW side of the dedicated CCWS HX is separated from the rest of the system. The ESW inlet and outlet isolation valves are closed and this section is filled with demineralized water to prevent corrosion. The rest of the system is filled with site specific ESW fluid.

The dedicated ESW cooling chain is activated in case of an SA. This requires closing the ESW isolation valve downstream of CCW HX #4, manually opening the dedicated

ESW isolation valves upstream and downstream of the dedicated CCW HX, and manually starting the dedicated ESW pump.

Dedicated ESWS motor-operated components are capable of being supplied by a standby EDG or a station blackout diesel generator (SBODG) that is provided as an alternate ac power source.

### 9.2.1.4.2 Abnormal Operating Conditions

#### Non-LOCA Design Basis Event During Power Operation

The ESWS operates as described for normal operating conditions, supplying the operating CCWS divisions as required.

#### Loss of Offsite Power

In case of loss of offsite power (LOOP), at least three of the safety-related ESWS divisions are available assuming one division is not available due to preventive maintenance. The four ESWS pumps belonging to the four safety-related divisions have power supplied by the EDGs.

In case of LOOP, the dedicated ESWS division is available but in standby condition. Power is supplied by the EDG. The dedicated ESWS division is also capable of being powered by the SBODGs so that the function is available even in case of LOOP with simultaneous loss of all EDGs.

If one safety-related ESWS pump fails during normal operation, a switchover to the other ESWS division is carried out. This switchover is done automatically for the entire cooling chain.

A spurious closure of the isolation valve in a safety-related ESWS division has the same consequences as the failure of the respective pump for that division.

A failure of the cleaning function of the debris filter in a safety-related division is monitored by the elevated differential pressure or function alarm. In this case, the operator initiates a division switchover.

A blockage of the fine screen in a safety-related division is monitored by the elevated differential level or function alarm. A blockage of the coarse or fine screens will result in an operator-initiated division switchover.

### 9.2.1.5 Safety Evaluation

The ESWS pump buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena.

Sections 3.3, 3.4, 3.5, 3.7 and 3.8 provide the basis for the adequacy of the structural design of these structures.

The ESWS is designed to remain functional after a safe shutdown earthquake (SSE). Sections 3.7 and 3.9 provide the design loading conditions that are considered. Sections 3.5, 3.6 and 9.5.1 provide the hazards analyses to verify that a safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

The four division design of the ESWS provides complete redundancy; therefore a single failure will not compromise the ESWS system safety-related functions. Each division of ESWS is independent of any other division and does not share components with other divisions or with other nuclear power plant units.

Considering a single failure and preventative maintenance, two ESW divisions may be lost, but the ability to achieve the safe shutdown state under DBA conditions can be reached by the remaining two ESWS divisions. In case of LOOP the four ESW pumps have power supplied by their respective division EDGs.

During SAs, containment heat is removed by the dedicated cooling chain consisting of the severe accident heat removal system (SAHRS), dedicated CCWS, and dedicated ESWS. This cooling chain is manually actuated. In case of loss of the dedicated ESWS division, the SAHRS cooling chain is lost. This condition is outside the DBA.

In the event of an LOCA during power operations, the engineered safety features system (ESFS) (refer to Section 7.3) initiates a safety injection and containment isolation phase 1 signal. The ESWS divisions previously not in operation are automatically started by the PS.

#### 9.2.1.6 Inspection and Testing Requirements

The ESWS is initially tested with the program given in Section 14.2, Test # 48.

The installation and design of the ESWS provides accessibility, as described in Section 6.6.2, for the performance of periodic inspection and testing, including inservice inspection. Periodic inspection and testing of all safety-related equipment verifies its structural and leak tight integrity and its availability and ability to fulfill its functions. Inservice inspection and testing requirements are in accordance with Section XI of the ASME BPV Code and the ASME OM Code.

Sections 3.9 and 6.6 outline the inservice testing and inspection requirements. Refer to Section 16.0, Surveillance Requirement (SR) 3.7.8 for surveillance requirements that verify continued operability of the ESWS.

Pursuant to the recommendations included in Generic Letter 89-13 (Reference 2), the design of safety-related portions of the ESWS considers the potential for capability and performance degradation and subsequent system failure due to siltation, erosion, corrosion, protective coating failure, and the presence of organisms that subject the system to microbiological influenced corrosion, as well as macro-fouling. A combination of design means, such as chemical treatment to reduce biological challenges; provisions to permit regular, periodic inspections, preventative maintenance, testing and performance trending; the use of best design practices for piping material selection and layout to minimize erosion and corrosion; and administrative controls in the form of operating, maintenance and emergency procedures, provide a level of assurance that the ESWS is able to perform its safety function when required.

Consistent with GL 89-13, design provisions of the ESWS accommodate performing the following:

- Identify and reduce the incidence of flow blockage problems caused from biofouling.
- Verify the heat transfer capability of safety-related heat exchangers connected to or cooled by the ESWS.
- Conduct routine inspection and maintenance activities of ESWS piping and components to provide assurance that corrosion, erosion, protective coating failure, silting, and biofouling cannot degrade the performance of safety-related systems supplied by ESW.

### 9.2.1.7 Instrumentation Requirements

Instrumentation is provided in order to control, monitor and maintain the safety-related and non-safety-related functions of the ESWS.

#### 9.2.1.7.1 ESWS Safety Related I&C Functions

##### 9.2.1.7.1.1 ESW Actuation from SIS

Upon receipt of a safety injection signal, the four ESWS trains are started to supply the CCWS heat exchangers, EDG heat exchangers and ESW pump room coolers.

For this function, the following ESW actuations are automatically initiated by the PS:

- The ESWS pumps 30PEB10/20/30/40 AP001 are started.
- The ESW pump discharge isolation valves 30PEB10/20/30/40 AA005 are opened.
- The ESWS cooling tower return isolation valves 30PED10/20/30/40 AA010 are opened.
- The ESWS normal blowdown isolation valves 30PEB10/20/30/40 AA016 are closed.

- The cooling tower emergency blowdown system isolation valves 30PEB10/20/30/40 AA003 are closed.
- The ESWS debris filter emergency blowdown isolation valves 30PEB10/20/30/40 AA004 are closed.
- The debris filter blowdown isolation valves 30PEB10/20/30/40 AA015 are closed.
- The ESWS cooling tower bypass isolation valves 30PED10/20/30/40 AA011 are closed.
- The ESWS normal makeup water isolation valves 30PED10/20/30/40 AA019 are closed.
- The ESWS pump recirculation isolation valves 30PEB10/20/30/40 AA002 are closed.
- The ESWS emergency makeup water isolation valves 30PED10/20/30/40 AA021 are opened.
- UHS fans 30PED10/20/30/40 AN001 and 30PED10/20/30/40 AN002 are automatically operated at full speed.

#### 9.2.1.7.1.2 Automatic ESW Actuation from CCWS

To ensure cooling of the safety related users of the NI cooling chain, the ESWS is automatically actuated when the associated CCWS train is started. The following actions occur:

- The ESW pump 30PEB10/20/30/40 AP001 is started. If one ESWS pump fails during normal operation, a switchover to the other ESWS train is carried out. This switchover is done automatically for the entire cooling train and is initiated by the CCWS Switchover sequence.
- The ESW pump discharge isolation valve 30PEB10/20/30/40 AA005 is opened.
- UHS fans 30PED10/20/30/40 AN001 and 30PED10/20/30/40 AN002 are started.

#### 9.2.1.7.1.3 Automatic ESW Actuation from LOOP

To ensure cooling of the safety related EDG (30XJA10/20/30/40), the ESWS is automatically actuated by a LOOP signal. The ESW system is started according to the EDG load sequence. The following actions occur:

- The ESW pump 30PEB10/20/30/40 AP001 is started.
- The ESW pump discharge isolation valve 30PEB10/20/30/40 AA005 is opened.
- UHS fans 30PED10/20/30/40 AN001 and 30PED10/20/30/40 AN002 are started.

#### 9.2.1.7.1.4 Manual ESW Actuation

The ESWS pumps 30PEB10/20/30/40 AP001 and UHS cooling tower fans 30PED10/20/30/40 AN001 and 30PED10/20/30/40 AN002 can be started manually from the MCR and/or RSS and the ESWS pump discharge isolation valves 30PEB10/20/30/40 AA005 and ESWS cooling tower return isolation valves 30PED10/20/30/40 AA010 can be opened manually from the MCR and/or RSS to cool the plant to cold shutdown conditions following a DBA. This functionality is a backup to the automatic actuation.

#### 9.2.1.7.1.5 Automatic Valve Alignments on Pump Start/Stop

The following valves are automatically re-aligned in response to a pump start/stop:

- ESWS pump discharge isolation valves 30PEB10/20/30/40 AA005 (open/closed).

#### 9.2.1.7.2 System Monitoring

The ESWS system is monitored for the following parameters:

- Fluid flow rate and pressure downstream of the ESWS pumps and the dedicated ESWS pump.
- Differential pressure at the ESWS and the dedicated ESWS debris filters, CCWS HXs, and Essential Service Water Pump Building Ventilation System (SAQ) room cooler.
- Fluid flow from the CCWS and EDG HXs.
- Temperature of the ESWS and the dedicated ESWS pump discharge.
- Temperature at the outlet of the CCWS and EDG HXs and pump room coolers.
- MOV position status.
- Pump operating status (energized/de-energized)

#### 9.2.1.7.3 System Alarms

- High temperature ESW and dedicated ESW.
- ESW and dedicated ESW pump abnormal.
- Low flow across the CCWS and dedicated CCWS HX.
- High $\Delta P$ across the CCWS, dedicated CCWS HX, and SAQ room cooler.
- Low temperature ESW.

Table 9.2.1-3—Alarm Summary provides additional information.

### 9.2.1.8 References


1. ASME Boiler and Pressure Vessel Code, Section III: "Rules for Construction of Nuclear Facility Components," Class 3 Components, The American Society of Mechanical Engineers, 2004.

2. Generic Letter 89-13, NRC Letter to All Holders of Operating Licenses or Construction Permits for Nuclear Power Plants, "Service Water System Problems Affecting Safety-Related Equipment." U.S. Nuclear Regulatory Commission, July 18, 1989.

3. ASME OM Code, "Code for Operation and Maintenance of Nuclear Power Plants," The American Society of Mechanical Engineers, 2004 edition.

**Table 9.2.1-1—Essential Service Water Design Parameters**

| Essential Service Water Pump 30PEB10/20/30/40 AP001 | |
|---|---|
| Description | Technical Data |
| Number | 4 |
| Type | Wet Pit Vertical Turbine |
| Normal Flow Rate | 19,340 gpm |
| Required Pump Head at Normal Flow Rate | 185 ft/$H_2O$ |
| Required Minimum Water Level in the Basin for NPSH and Vortex Suppression | 95 inches (above suction inlet) |
| Design Cold (UHS Outlet) Water Temperature, (Max, DBA) | 95°F |
| Max Cooling Tower Basin Temperature Limit during Normal Plant Operation to Verify UHS Performance in a DBA, (Max) | 90°F |
| System Design Pressure | 190 psig |
| System Design Temperature | 135°F |

**Table 9.2.1-2—Dedicated Essential Service Water Design Parameters**

| Dedicated Essential Service Water Pump 30PEB80 AP001 | |
|---|---|
| Description | Technical Data |
| Number | 1 |
| Type | Wet Pit Vertical Turbine |
| Normal Flow Rate | 2737 gpm |
| Required Pump Head at Normal Flow Rate | 150 ft/$H_2O$ |
| System Design Pressure | 100 psig |
| System Design Temperature | 150°F |
| Required Minimum Water Level in the Basin for NPSH and Vortex Suppression | 46 inches (above suction inlet) |

**Table 9.2.1-3—Alarm Summary**
**Sheet 1 of 2**

| MCR / RSS | Division | Setpoint Name | Function |
|---|---|---|---|
| CCW HX differential pressure Hi | 1/2/3/4 | Max 1 | Alarm alerts operator to high CCW HX DP |
| CCW HX Lo flow | 1/2/3/4 | Min 1 | Alarm alerts operator to low CCW HX Flow |
| EDG coolers Lo flow | 1/2/3/4 | Min 1 | Alarm alerts operator to low EDG HX Flow |
| CCW Hx Lo flow + EDG coolers Lo flow = Pump Discharge Flow | 1/2/3/4 | Min 1<br>Min 2 | Min 1: Alarm (Pump discharge Flow low)<br>Min 2: Alarm (Pump discharge Flow low-low)<br>and Pump Trip |
| SAQ room cooler differential pressure ESW side | 1/2/3/4 | Max 1 | Max 1: Alarm alerts operator of high DP |
| ESW debris filter differential pressure Hi | 1/2/3/4 | Max 4<br>Max 3<br>Max 2<br>Max 1 | Max 4: Alarm and Pump Trip<br>Max 3: Alarm alerts operator to filter trouble/DP too high –operator initiates division switchover<br>Max 2: Auto-Start Strainer Motor (Backwash)<br>Max 1: Status display in MCR |
| ESW pump abnormal (bearing temperature Hi) | 1/2/3/4 | Max 2<br>Max 1 | Max 2: Alarm and Pump Trip<br>Max 1: Alarm alerts operator to bearing trouble |
| ESW pump discharge pressure Hi/Lo | 1/2/3/4 | Max 2<br>Max 1<br>Min 1<br>Min 2 | Max 2: Alarm and Pump Trip<br>Max 1: Alarm alerts operator of high discharge pressure<br>Min 1: Alarm (if Pump is Running)<br>Min 2: Alarm alerts operator of Train Switchover Sequence (if Pump is Running) |
| Cooling tower basin temperature Hi-Hi | 1/2/3/4 | Max 2 | Alarm and Part of the System Start Permissive (if below Max 2) |
| Cooling tower basin temperature Hi | 1/2/3/4 | Max 1 | Alarm alerts operator to position cooling tower return isolation valve and/or adjust fan speed |

**Table 9.2.1-3—Alarm Summary**
**Sheet 2 of 2**

| MCR / RSS | Division | Setpoint Name | Function |
|---|---|---|---|
| Cooling tower temperature Lo | 1/2/3/4 | Min 1 | Alarm alerts operator to position cooling tower return isolation valve and/or tower bypass valve and/or adjust fan speed |
| Cooling tower basin temperature Lo-Lo | 1/2/3/4 | Min 2 | Alarm alerts the operator to manually place the affected ESW train into operation and/or adjust fan speed and/or direction |
| Cooling tower basin water level Hi-Hi | 1/2/3/4 | Max 2 | Alarm alerts operator to remove basin inventory |
| Cooling tower basin water level Hi | 1/2/3/4 | Max 1 | Auto-Close Normal Makeup Isolation Valve |
| Cooling tower basin water level Lo | 1/2/3/4 | Min 1 | Auto-Open Normal Makeup Isolation Valve |
| Cooling tower basin water level Lo-Lo | 1/2/3/4 | Min 2 | Alarm alerts operator to insufficient makeup |
| Cooling tower basin water level Lo–Lo-Lo | 1/2/3/4 | Min 3 | Alarm and:<br>-Part of the System Start Permissive (if >Min2)<br>-Pump Start Permissive (if >Min2) for Emergency Makeup System |
| Cooling tower basin water level Lo–Lo–Lo-Lo | 1/2/3/4 | Min 4 | Alarm and Pump Trip-Trouble with Emergency Makeup System |
| Cooling tower riser level | 1/2/3/4 | Min 1 | Alarm alerts operator to low water level in tower riser – Operator initiates refill actions |
| | | Min 2 | Alarm alerts operator to leakages in the system - Operator to start ESW pump |