RAS J-88

10.7 SALT SERVICE WATER SYSTEM

10.7.1 Safety Objective

The safety objective of the Salt Service Water (SSW) System is to provide a heat sink for the Reactor Building Closed Cooling Water (RBCCW) System under transient and accident conditions.

10.7.2 Safety Design Basis

1. The system is designed with sufficient redundancy so that no single active system component failure can prevent the system from achieving its safety objective.

2. The system is designed to continuously provide a supply of cooling water to the secondary side of the RBCCW heat exchangers adequate for the requirements of the RBCCW under transient and accident conditions.

10.7.3 Power Generation Objective

The power generation objective of the SSW System is to provide a heat sink for the RBCCW System and the Turbine Building Closed Cooling Water (TBCCW) System during planned operations in all operating states.

10.7.4 Power Generation Design Basis

The system is designed to function as the ultimate heat sink for all the systems cooled by the RBCCW and TBCCW during all planned operations in all operating states by continuously providing adequate cooling water flow to the secondary sides of the RBCCW and TBCCW heat exchangers.

10.7.5 Description

The entire SSW System shown on Figure 10.7-1 is designed in accordance with Class I criteria, and there is no Class II Seismic piping in the system. See Appendix C and Section 12.

The Service Water System consists of five vertical service water pumps located in the intake structure, and associated piping, valving, and instrumentation. The pumps discharge to a common header from which independent piping supplies each of the two cooling water loops, each loop consisting of one Reactor Building and one Turbine Building cooling water heat exchangers. Two division valves are included in the common discharge header to permit the SSW System to be operated as two independent loops. The water then returns to the bay from the outlet of the heat exchangers. The heat exchangers are valved such that they can be individually backwashed without interrupting system operation. Any marine growth occurring in the heat exchangers will be controlled by hypochlorination based upon residual chlorine content measured in the discharge headers.

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Sample valves have been installed in each of the independent cooling water loops, between the pumps and the heat exchangers. These valves are to be used for the following purposes:

1. To obtain a grab sample of service water.

2. To provide access to the header for venting

Each service water pump has an automatic air vent to prevent water hammer. Pump bearings are marine cutlass type, suitable for sea water application and are lubricated by water as it rises through the pump column.

The following number of pumps will be used during each of the indicated modes:

	Number of Pumps
Normal Operations	1 to 4
Accident Conditions (LOCA)	2
Shutdown Conditions	4

The number of pumps required for normal operation is selected based on plant cooling needs and SSW inlet temperature. Pressure transmitters mounted at the discharge header provide indication in the control room to allow operators to monitor SSW pump performance.

Plant Technical Specifications originally described the minimum required SSW pump performance as 2700 gpm at 55 ft TDH. Actual SSW pump rated performance is 2700 gpm at 95 ft TDH and minimum required performance for in-service testing is defined as 2700 gpm at 87.5 ft TDH. These TDH values are for the pump bowl not including the 40 ft vertical pump column. The 55 ft value represents the minimum required pressure, in feet, measured at the centerline of the pump discharge piping (EL 23.9 ft) for a pump bowl operating at 2700 GPM at 87.5 ft TDH.

The sea water tide level used in accident analysis calculations is 7.1 ft below msl, the yearly astronomical minimum low tide. This is the value used for the design basis analysis of the minimum SSW system performance required to perform the emergency containment cooling function. This low tide occurs for short periods of time during the semidiurnal tidal variations once every year. For the SSW system performance analysis, this lowest tide level is assumed to be constant, thereby yielding a conservatively low SSW system flow rate during accident analyses that span a several day period. The SSW pumps are also assumed to be operating at their minimum performance thereby providing only the required 4500 gpm to the RBCCW heat exchanger.

The minimum sea water level for maintaining SSW pump rated performance is approximately 13 feet 9 inches below msl. This represents the lowest sea water at which a SSW pump bowl operating at its rated performance of 95 feet TDH at 2700 gpm will produce a discharge head of 55 feet at 2700 gpm as measured at EL 23.9 feet. The lowest postulated instantaneous sea water level is 10.1 feet below msl(Section 2.4.4.2) caused by a hurricane producing 110 mph winds blowing directly offshore during the same critical hour at which the yearly astronomical low tide occurs. At this lowest water level, the pumps are capable of maintaining rated performance which implies that they have adequate NPSH and submergence (to prevent vortexing). It is not appropriate to assume that this condition will exist long enough to require that it be the design basis for the long term emergency cooling function of the SSW system for which these pumps are assumed to be at their minimum required performance level.

The buried portions of the 22" nominal diameter discharge piping from the last flange connections in the Auxiliary Building piping vault to the end of the discharge pipes at the Seal Well opening have been provided with a Cured-In-Place-Pipe (CIPP) lining. The 240 ft total length Loop "A" lining was installed in RFO-14 and the 225 ft total length "B" lining was installed in RFO-13. The CIPP liner material consists of a tube composed of nonwoven polyester felt material that is saturated with either an isophthalic polyester resin and catalyst system (Loop "A") or epoxy resin and hardener system (Loop "B") with a polyurethane or polyethylene inner membrane surface. The liner has a nominal 1/2" installed thickness. The resulting configuration is a rigid resin composite pipe within the original pipe with no requirements for bonding between the pipes.

The Salt Service Water System is designed to provide a heat sink for the Reactor Building Closed Cooling Water System under accident and transient conditions. Section 14.5 describes the Containment Cooling System analysis for a design basis loss of coolant accident (LOCA) at both a salt water inlet temperature of 65°F and 75°F.

To ensure that the safety design basis in Section 10.7.2 is achieved, flow condition is improved by the addition of baffle plates in the west side service water bay and a rear sluice gate allows maintenance and operational flexibility. The gate is normally closed and does provide a barrier to common mode failures. It does not provide a separation function as the salt service water pump bay is a single bay. It was not sized to allow supply of a seawater pump.

To ensure that sufficient seawater flow is maintained through the RBCCW heat exchangers (minimum of 4500 gpm for each heat exchanger), motor-operated butterfly valves on the TBCCW heat exchanger outlets will automatically adjust to preset throttling positions and the RBCCW outlet valves will simultaneously open. Automatic adjustment of the outlet valves occur following a loss of coolant accident (LOCA) with a coincident Loss of Offsite Power (LOOP), or a LOCA with degraded voltage on the safety buses while being supplied from the startup transformer. If a LOCA occurs without a LOOP or degraded voltage condition, the heat exchanger outlet valves remain as-is. Manual adjustments of the outlet valves will be made by operators to achieve adequate cooling water flow.

The loss of AC power will trip all service water pumps and will close one of the two division valves in the common pump discharge header, effectively dividing the service water system into two independent loops. Two pumps would be connected to each loop. The two division valves are arranged to permit the fifth (middle) pump to be operated on either loop. The operator preselects the division valve to be closed and thereby determines which loop will be connected to the middle pump. Either valve can also be closed by a hand switch.

For the limiting design basis emergency condition, the Circulating Water System pumps (Section 11.6) are not operating. This assumption is based on the need for the containment heat removal function of the SSW System versus the Circulating Water System when the Main Condenser is not being used as the heat sink. For either emergency containment heat removal or normal shutdown cooling, the SSW System is the main heat sink for the reactor core decay heat only after the discharge of steam to the Main Condenser has stopped. For the bounding design basis LOCA (Section 14.5), it is only the RHR, RBCCW, and SSW Systems that provide containment heat removal. To maximize the containment heat removal from a single loop of these systems, when required, the circulating water pumps are secured so that the level in the SSW pumps bay(s) will be equal to the ocean tide level and unaffected by operation of the Circulating Water System.

There are a number of single failures that can result in a SSW System configuration where one SSW pump will be supplying flow to both trains of SSW during the first ten minutes of an accident. Should this occur, operators are then expected to align the SSW System for optimal performance by starting additional pumps and/or closing division valves as required. This mode of operation has been analyzed and determined to be acceptable.

The pumps are separated into two loops electrically. In the event of the loss of the preferred AC power source, the two SSW pumps on loop A are powered by diesel generator A. They provide cooling to RBCCW loop A (also powered by diesel generator A) which provides cooling to all Core Standby Cooling System components loaded on diesel generator A. The two salt service water pumps on loop B have the same relationship, both to their standby AC power source, diesel generator B, and to RBCCW Loop B. The fifth pump is loaded on a common emergency service bus which can be powered from either standby AC power source.

Initiation of standby AC power following loss of the preferred AC power source will automatically start at least one pump in each loop during normal conditions. Following a LOCA and loss-of-offsite power one and only one pump will start in each loop because of diesel load limitations. Additional pumps are started manually by the operator as additional cooling loads are established and diesel capacity is made available.

10.7.6 Safety Evaluation

The SSW System is designed with sufficient redundancy so that no single active system component failure nor any single active component failure in any other system can prevent it from achieving its safety objective. Two independent closed loops with full heat transfer capacity on each loop are provided.

The existence of single failures which place the SSW system in the mode of one pump supplying both trains of heat exchangers for the first ten minutes of an accident has been analyzed and found to be acceptable. Operator action is credited after ten minutes to realign the system for optimal performance.

The 22 inch discharge headers leave the Reactor Building at an elevation of 15 ft 7 in msl. The two parallel lines run approximately parallel to the shoreline with a 2.8 percent slope. At a point approximately in line with the edge of the intake structure the lines turn and then parallel the centerline of the discharge structure with a 1.98 percent slope. At an elevation of -6 1/2 ft msl the two discharge lines turn and enter the side of the discharge structure sealwell.

Detection of leakage in the Reactor Building auxiliary bay is provided by two water level detectors mounted in each area. The detectors provide control room personnel with early indication of flooding such that personnel can be dispatched to the area to identify the source and effect isolation.

Dewatering of a major pipe rupture is accomplished by two 14 inch drain lines in each area which direct the water to the torus compartment. The discharge of the drain lines is submerged in a water trough to ensure that a sufficient water seal exists between the torus compartment and the Reactor Building auxiliary bay. The drain line dewatering capacity is sized on the maximum possible flooding rate which results from a single failure in any one line.

Numerous small diameter floor drains in the RBCCW compartments are plugged to prevent chloride and nitrate intrusions in radwaste. Therefore, normal leakage can accumulate to a level of four inches before overflowing the lip around the fourteen inch dewatering lines located in each of the RBCCW compartments. All safety related equipment in the RBCCW compartments will be unaffected by flooding four inches above the floor level. Normal leakage will not prevent safety related systems or components from performing their intended safety functions.

A major pipe break in this area will not result in a loss of both RBCCW and TBCCW Systems because the redundant portions of each system are separated by a watertight barrier. The watertight barrier consists of a watertight door and a spray barrier. The spray barrier is located in the pipeway immediately above the watertight door. Position switches provide station personnel with status information for the watertight door at all times.

In order to evaluate Pilgrim Station's susceptibility to damage due to a major oil spill in Cape Cod Bay near the Pilgrim Nuclear Power Station, previous oil spills have been examined relative to power plant and industrial proximity to the spill and the effects observed. Additionally, the various mechanisms by which spilled oil can be transported in water have been analyzed relative to the station design. The basis for these comparisons was Systems Study of Oil Cleanup Procedures (Dillingham Corporation, 1969) and the American Petroleum Institute (API) Conference on Prevention and Control of Oil Spills (December 1969).

Floating oil would be prevented from entering the intake structure by various devices. The primary oil containment device of the intake structure is its entrance skimmer wall, which functions as a submerged baffle. Minimum submergence of the baffle is 5 ft at design low water level. A secondary oil containment device is a concrete baffle wall inside the intake structure, downstream from the trash racks and upstream of the traveling screens and pumps. This baffle provides 2.2 ft submergence at mlw level. The final and most effective oil containment devices in the intake structure are the sluice gates through which the service water pump suction water must flow. The sluice gates are designed to allow isolation and dewatering of either circulating water bay. Positioning of the gates halfway closed would allow effective baffling to a submergence of 5 ft at design low water level.

In the unlikely event of some oil penetrating the aforementioned barriers, the minimum submergence at design low water level of the service water pumps of 11 ft would prevent the oil from being drawn into the pump suction.

Should slight amounts of emulsified oil reach the salt service water pump suction the observable effects would be limited to a small decrease in pumping efficiency and higher system head losses due to slightly increased fluid viscosity.

10.7.7 Inspection and Testing

Testing is performed on the SSW pumps, safety related check valves, and all safety related motor and air operated valves in the SSW system in accordance with the In-Service Testing (IST) program. The testing is performed per the ASME code as required by 10 CFR 50.55a(f), to demonstrate compliance with plant technical specifications for the SSW pumps. Operational performance testing is also conducted on the SSW system to verify that the system meets design criteria. Examinations are conducted on SSW system components in accordance with the In-Service Inspection (ISI) program.

10.7.8 Nuclear Safety Requirements for Plant Operation

General

This section represents the nuclear safety requirements for the SSW System for each BWR operating state which result from the stationwide BWR systems analysis of Appendix G. The following referenced portions of the safety analysis report provide important information justifying the entries in this section:

Reference	Information Provided
1. Section 10.7.5	Description of the SSW System hardware
2. Station Nuclear Safety Operational Analysis, Appendix G	Identifies conditions and events for which SSW System action is required

Each detailed requirement in the following analysis is referenced, if possible, to the most significant station condition originating the need for the requirement by identifying a matrix block on Table G.5-3. The matrix block references are given in parentheses beneath the detailed requirements in the "minimum required for action" section. The matrix block references identify the BWR operating state, the event number and the system number. For example, F39-99, identifies BWR operation state F, event (row) No. 39, and system (column) No. 99, on Table G.5-3.

System Action

The SSW System provides a heat sink for the RBCCW System.

Number Provided by Design

This system consists of two open loops. Each loop has two pumps (plus a common spare), piping, valving, instrumentation, and controls as necessary to provide coolant to one RBCCW heat exchanger and one TBCCW heat exchanger on each loop.

Minimum Required for Action

BWR Operating States A, B, C, D, E, & F:
Two pumps with associated controls and instrumentation on one loop must be operable and the following valves on that loop operable:

1. One TBCCW heat exchanger outlet valve unless valve is throttled

2. One RBCCW heat exchanger outlet valve unless valve is open

3. One discharge header valve (for loop separation unless valve is fully closed

(A35-99)	(B35-99)
(C39-99)	(D39-99)
(E39-99)	(F39-99)

10.7.9 Current Technical Specifications

The current limiting conditions for operation, surveillance requirements, and their bases are contained in the Technical Specifications referenced in Appendix B.