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OFFICE OF NUCLEAR REACTOR REGULATION

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Licensee: Washington Public Power Supply
P.O. Box 968
Richland, Washington 99352

Facility Name: WPPSS Nuclear Project No. 2 (WNP-2)

Inspection: Design Inspection

Inspection At: WNP-2 site near Richland, Washington

Conducted: November 19, 1996, through January 16, 1997

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EXECUTIVE SUMMARY

A design inspection at Washington Public Supply System WNP-2 facility was performed by the Special Inspection Branch of the Office of Nuclear Reactor Regulation (NRR) during the period November 18, 1996 through January 16, 1997, including onsite inspections during December 9-20, 1996, and January 6-16, 1997. The inspection team consisted of a Team Technical Monitor from The Office of Nuclear Reactor Regulation (NRR), and five engineers from Stone & Webster Engineering Corporation.

The purpose of the inspection was to evaluate the operational performance capability of the automatic depressurization system (ADS), portions of the standby service water (SSW) system, and the low pressure core injection (LPCI) function of train B of the residual heat removal (RHR) system; and to assess their adherence to their design bases and to licensing commitments. The inspection team followed the engineering design section of Inspection Procedure (IP) 93801. The team reviewed the relevant portions of the FSAR, the design basis documents, drawings, calculations, modification packages, surveillance procedures, and other plant documents.

The team determined that all of the reviewed systems, while modified from the original design to varying degrees, are capable of performing their intended safety functions. However, the team did identify several design errors, as well as weaknesses in calculation methodology and in maintaining design documents.

One design error was introduced as part of an engineering modification. The original design had " manual initiate" push buttons to operate the ADS valves as a group. The modification inadvertently degraded this manual operation feature. The resulting configuration no longer provided the system level manual actuation the licensee was committed to through Regulatory Guide (RG) 1.62. To compensate for the design error, operator training had to be reconfigured to initiate the ADS at the component level, thus bypassing the design error and the system level initiating manual push buttons. Additionally the design error was captured in the applicable elementary diagram but the FSAR was not updated to reflect changes to the original design configuration.

The team identified that the initiation of the containment spray at a post-LOCA elevated containment temperature could result in a pressure differential in excess of the ADS actuator's design pressure of 250 psig.

The calculation to determine RHR heat exchanger operability used non-conservative heat removal values, based on potentially inaccurate instrumentation. Subsequent reevaluation, based on the team's observation, verified heat exchanger operability with a smaller but acceptable margin.

Engineers failed to follow through with a corrective action recommendation to verify standby service water capability to mitigate an accident condition by flooding containment. This mode of SSW operation has been specified by the licensee for accident mitigation until the licensee commitments to NRC Bulletin 96-03 are satisfied.

The team assessed sections of the final safety analysis report and the design review documents (DRDs) applicable to the reviewed systems. The licensee frequently failed to incorporate changes in the plant configuration into the FSAR, resulting in inconsistencies between stated FSAR values and corresponding values in procedures and calculations. For example, variation in the equipment-specific flow values of service water as stated in FSAR Table 9.2-5 did not agree with the flow values stated in the flow balance test procedures. The DRDs varied in quality and were occasionally inaccurate. The team determined, for example, that the RHR design review document lacked sufficient detail in the area of instrumentation and controls to be useful as a design document.

The licensee implemented appropriate measures to resolve the immediate concerns identified by the team. For the other issues, the licensee initiated appropriate reviews and corrective actions, such as revision of design documents and changes to procedures.

I. Engineering

E2 Engineering Support of Facilities and Equipment

E2.1 Low Pressure Coolant Injection (LPCI) of Residual Heat Removal (RHR) B Train

The RHR system was designed as a multifunction system having normal and accident- recovery functions. The LPCI function of the RHR system was designed to deliver suppression pool water through three separate reactor pressure vessel (RPV) penetrations to the reactor following a loss-of-coolant accident. LPCI operation was designed to take precedence to all other RHR modes. A reduction in LPCI flow requirements was expected after ten minutes of LPCI operation. At such time the RHR injection valve could be closed and water diverted for other RHR modes of operation.

E2.1.1 Mechanical

E2.1.1.1 Scope of Review

The mechanical design evaluation of the RHR system consisted of a design documentation review, system walk downs, and discussions with the cognizant system and plant design engineers. The team reviewed portions of final safety analysis report (FSAR), the system design specification/design requirements document (DRD), and calculations.

Specifically, in the area of mechanical design review, the team evaluated the RHR heat exchanger heat removal capacity, the system design parameters, the engineering analysis, system safety features such as pressure relief valves, their setpoints and capacity, RHR pump specifications, pump and system curves, and net positive suction head (NPSH) calculations. The team also verified the operation, and the limitations on operations of the RHR system in the emergency operating procedures (EOPs).

E2.1.1.2 Findings

a. Emergency Operating Procedures (EOPs)

The inspectors reviewed the following calculations and procedure that support operational aspects of the RHR system identified in the EOPs:

Plant Procedure Manual (PPM) 5.5.1, "Overriding ECCS Valve Logic to Allow Throttling RPV Injection," the EOP "RPV Flooding - ATWS" present the reasoning behind and demonstrate the adequacy of, the throttling function assigned to the RHR injection valve. The procedure and the throttling action appeared to fulfill the intent of the EOPs.

EOP calculation NE-02-89-27, "Primary Containment Pressure Limit and Maximum Primary Containment Water Level Limit," was used to derive the EOP figures for "Primary Containment Pressure Limit" and "Maximum Primary Containment Water Level Limit." Throughout the EOPs, pressure and water level limits were adequately portrayed and fulfilled the intended EOP directions. The primary containment pressure limit curve had its axes switched in relation to the emergency procedures guidelines (EPGs). The licensee documented this in the calculation and explained that the axes were switched for ease of reading and operator training.

EOP Calculation NE-02-85-27 determined the water leg pump discharge pressure. The calculation adequately determined the maximum reactor pressure at which the RHR water leg pumps could inject water into the RPV. EOPs required this function of the water leg pump as a last resort when other pumps, specifically intended for this function, would not available.

b. RHR Heat Exchanger Test and Operability Determination

The team reviewed the analysis of the RHR B heat exchanger test conducted on March 3, 1996 in accordance with procedure PPM 8.4.42.. The test was intended to determine the heat removal capacity of each RHR heat exchanger, and to compare the results with the original design heat removal capability. The team had the following concerns:

Test results for RHR heat exchanger 1B showed that the RHR system lost 63 million BTU/hr while the standby service water (SWS) system gained 102 million BTU/hr. The SSW system gained 60% more heat than the RHR system lost. The analysis determined that the maximum acceptable combined uncertainty for these measurements was 11%. Therefore, the 60% mismatch in energies showed unacceptable test data. To complete the evaluation the licensee used the nonconservative higher heat transfer rate attributed to service water but did not justify its use. Subsequently the licensee attributed the error in heat transfer rates to defective instrumentation. The licensee stated that the accuracy of the ultrasonic flow instrumentation was not verified. Additionally, the RHR temperature was obtained from a recorder that averaged the input of six thermocouples. The actual temperature reading of each thermocouple was not verified.

The team noted that the test methodology, and the results of the analyses did not receive an independent engineering review.

The analysis was based on the as-found heat transfer rate and did not adjust for accident flow rates and for the increased fouling that would occur between testing periods.

The Code of Federal Regulations, 10 CFR Part 50 Appendix B Criterion XI, Test Control, requires that test results be evaluated to assure that test requirements have been met. The team verified that test results had not been so evaluated. Criterion XII Control of Measuring and Test Equipment requires that instruments used in activities affecting quality be properly controlled... and adjusted. The team determined that, at the time of the test, the instrumentation used in developing temperature and flow data, was suspected to be inaccurate. Failure to correct the instruments resulted in the discrepancy in the heat transfer values. This issue is identified as an Unresolved Item. (URI- 96-201-01)

Additionally, in calculating the heat removal capacity of the RHR heat exchangers, the licensee used values for design conditions that were not consistent with values found in FSAR Table 6.2-2. For example, the calculation used a service water flow of 6900 gpm and the FSAR had 7400 gpm; the calculation used a clean heat exchanger heat transfer rate of 414 BTU/hr-ft^2-°F and the FSAR had 400 BTU/hr-ft^2-°F. The licensee justified the adequacy of the 6900 gpm flow to the heat exchangers in calculation ME-02-92-245, which was approved in 1993. However, the change to the FSAR data was not controlled.

10 CFR 50.71(e) requires the periodic update of the final safety analysis report (FSAR), to assure that the information in the document contains the latest information developed. The licensee stated that the current design flow and temperature requirements will be incorporated into the applicable sections of the FSAR. The failure to update the FSAR is identified as an Unresolved Item. (URI- 96-201-02)

Subsequently, during the inspection, the licensee performed a reanalysis that conservatively determined the heat transfer rate based on the RHR heat loss parameters. The new analysis employed a different methodology (considered adequate by the inspectors) and received an independent engineering review and approval. Results of the analysis showed that the RHR heat exchanger, as tested in March 1996, could reject the design and licensing basis heat load.

c. Setpoints of RHR Relief Valves

The team reviewed setpoints of RHR relief valves as documented by Procedure PMT-45, "Safety and Relief Valve Test Record." The procedure applies a tolerance of +/- 3% to setpoints values greater than 300 psig while the FSAR, in paragraph 5.4.7.1.3, specifies +/- 10 psi. Five RHR relief valves with data sheets allowing a setpoint tolerance greater than that specified in the FSAR (RHR-RV-1A, 1B, 25A, 25B, and 25C) were noted. The FSAR tolerance bounded the as-left condition of four of these valves. The exception was valve RHR-RV-1A, where the as-left setpoint was 514 psig, 4 psi higher than allowable by the FSAR. The team determined that procedure PMT-M5 incorporated the guidance of the ASME code (NC-7513.1, opening pressure tolerance), which allowed a tolerance of +/- 3% for the pressure ranges of these valves. Therefore, the valves met the requirements of the code but were not consistent with the requirements of the FSAR. The team determined that the code requirements were acceptable. The licensee issued Problem Evaluation Report (PER) 297-0032 to update the FSAR to reflect applicable code requirements.

E2.1.1.3 Conclusions

The mechanical functions of the RHR system were acceptable. In one instance the operability determination for the RHR heat exchangers, the associated analysis used nonconservative data from inaccurate or faulty measurement instruments. This recent engineering effort did not appear to meet regulatory requirements. Additionally, both the analysis and the values used to calibrate RHR pressure relief valves used values that were not consistent with the FSAR values.

E2.1.2 Electrical

E2.1.2.1 Scope of Review

The team evaluated Class IE electrical power sources for the RHR system and components for compliance with General Design Criterion (GDC) 34 of 10 CFR Part 50, Appendix A, to verify independence and redundancy and to ensure that system safety function could be accomplished, assuming a single failure. The team also compared the drawings to the DRD, applicable sections of the FSAR, and the TSs. In addition the team reviewed fuse sizing criteria, fuse coordination and thermal overloads, as well as overcurrent and under voltage protection. The team also reviewed data for the RHR water leg pump motor and evaluated the motor's suitability for Class IE application.

E2.1.2.2 Findings

a. Documentation.

The team determined that the electrical design requirements were appropriate and consistent in the reviewed documents. No unacceptable conditions were identified during this review. However the following documentation inconsistencies were noted:

RHR pumps B and C were listed as 644 kilowatts (kW) in FSAR Table 8.3-2 "Division 2 Diesel Generator Loading, Automatic Loading of Engineered Safety Systems Bus"; whereas Table 2C Calculation E/I-02-91-03 "Div. 1, Div. 2 and Div. 3 DG Loading," specified 643.8 kW.

RHR DRD Section 2.2.1, item A, did not list the backup source of power for pump motors. The licensee will track this issue under Plant Tracking Log (PTL) Item A-137015. This represents an incomplete design basis documentation problem, and is identified as an Inspection followup Item. (IFI-96-201-03)

Plant Procedure Manual (PPM) 4.7.1.9, "Loss of Power to SM-8" did not reflect actual plant response in that the tripping of the (RHR pumps RHR-P-2B and 2C) that would occur during an SM-8 undervoltage trip was not described in the procedure. Operators were knowledgeable of actual plant response. The licensee has issued PTL Item A-137160 to track and revise the system operating procedure. This issue is identified as an Inspection Followup Item. (IFI-96-201-04)

b. Electrical Power Sources

Calculations 2.05.05 "Inverter Power Panels" and 2.05.01 "Battery Sizing" document AC and DC loads for Uninterruptable Power Supply (UPS) and

battery sizing. The review focused on how instrument and DC relay loads are tracked and how minimum voltage requirements for devices were met for degraded voltage conditions.

Calculation 2.05.05 included a listing of the circuits fed by the power panel and a load value for each circuit. The individual device loads in each circuit were not recorded. The calculation referenced "out" to calculation 2.05.01, where the power panel connected load was reflected as an input to battery sizing. Calculation 2.05.01 then allowed a load greater than this connected load value but less than the full capacity of the UPS. This method reserved some part of the battery spare capacity for UPS load growth. Calculation 2.05.05 was for equipment sizing only.

Calculation 2.05.01 listed DC devices energized and computed a total circuit load. Minimum voltage conditions were not determined for the circuit or each device. A partial calculation was being developed which included a complete listing of devices in each circuit along with the device load current and its minimum pickup voltage. The calculation computed the minimum voltage available at the device.

E2.1.2.3 Conclusions

The team concluded that the electrical design requirements for RHR system and its components were adequate. However, a DRD lacked design detail, and an operations procedure did not reflect actual plant response.

E2.1.3 Instrumentation and Control

E2.1.3.1 Scope of Review

The team evaluated the instrumentation and control (I&C) configuration of the RHR system by reviewing design documentation, talking with the responsible system engineer and with discipline engineers, and conducting walkdowns of the RHR system. The review concentrated on protective functions that provided emergency core cooling during a LOCA, and primary containment cooling after a LOCA. The design was assessed for the ability to meet FSAR commitments and to operate within TS limits. Attributes reviewed comprised instrumentation setpoints, instrument power and DC relay control power, and remote and alternate shutdown provisions. Documents reviewed included applicable sections of FSAR Chapters 5-9, DRDs, TSs, vendor documents, process & instrumentation diagrams (P&ID), logic diagrams, electrical wiring diagrams (EWDs), calculations, calculation modification records (CMRs), problem evaluation requests (PERs), technical evaluation requests (TERs), plant modification records (PMRs), operating experience reviews (OERs), and EOPs.

E2.1.3.2 Findings

a. Documentation

The DRD was intended to include the design bases information to establish the design and performance requirements for the system. The team

identified the following examples of inadequate design information in the area of I&C:

Section 2.5.4 required that controls and indicators be provided in the control room for RHR system flows, pressure, and temperature, as well as pump operating status, valve position information, and system alarm status. However, the DRD did not identify controls or specific flow, pressure and temperature indication provided in the main control room.

Based on a General Electric design recommendation, Section 2.5.3 called for manual startup, operation and shutdown of the RHR system, to permit control room personnel to override automatic features. However, the DRD did not describe circumstances under which manual control was allowed or specify constraints on the use of manual controls.

Section 2.5.6 incorrectly stated as a requirement that loop B of the RHR containment spray mode be incorporated into the remote shutdown configuration. The team verified that controls for the containment spray were not provided at the remote shutdown facility and that the DRD was in error.

The following regulatory guides, listed in FSAR Appendix C, were not incorporated in the licensee's DRD:

RG 1.97 instrumentation

RG 1.47 bypass and inoperable status indication

RG 1.62 manual initiation requirements

The team noted that the DRD document lacked sufficient detail to be useful as an I&C design basis document. The failure to incorporate the details of the I&C plant design requirements and their implementation into the DRD is identified as an Inspection Followup Item. (IFI-96-201-05)

FSAR I&C sections generally correctly reflected the system design. Some discrepancies in the listings of the equipment with remote shutdown provisions in FSAR Section 7.4 were identified and discussed with the licensee.

b. Setpoints

Documentation reviewed for several RHR B loop instruments included source calculations and GE design specification data, setpoint uncertainty calculations and associated CMRs, instrument master data sheets (MDSs), and instrument setpoint change requests (ISCRs). In general setpoint documentation appeared to be complete and to have been generated in accordance with approved procedures. Applicable setpoint values were within technical specification (TS) limits.

Uncertainty calculations were based on analytical limits established in other process calculations, in vendor documentation, or by engineering judgments described in the uncertainty calculation. The uncertainty calculation treated reference accuracy, calibration effect (defined as meter and test equipment effects and setting or reading effects), power supply effects, and seismic effects as independent variables. These were combined by the usual square root of the sum of the squares (SRSS) method. However, some effects, identified as dependent effects, were linearly summed as biases rather than by the traditional SRSS method. This practice resulted in conservative calculations.

This approach established maximum and/or minimum setpoint limits, rather than specific setpoints and tolerances. The actual setpoint values, setpoint tolerances, and administrative limits were officially established in either the ISCR or master data sheet (MDS) and retained with the instrument calibration records. The administrative limits were selected to include the setpoint tolerance and to be less than the uncertainty value in the calculation. Both documents referenced the uncertainty calculation but did not mention the uncertainty value from the calculation.

In some cases the setpoint tolerances selected were biased in the direction of the analytical value. However, all values were selected in the direction of conservatism at the expense of predicting equipment behavior. It was noted that the setpoints reviewed appeared to be adequately selected so as to preclude infringing on margins for safe operation.

c. Remote and Alternate Remote Shutdown

Elementary wiring diagrams (EWDs) indicated that the transferred circuit of some valves included 1 amp fuses in the circuit indication branches downstream of the 10 amp main circuit fuses. The 1 amp fuses were sized to blow before the main circuit fuse blew. The 1 amp fuses were installed to protect the control function at the expense of the valve position indication. A 20 amp fused disconnect fed the 10 amp fused circuit. This was the original design by GE. The licensee could not retrieve any evidence to verify that these fuses will coordinate. Fuse replacement was controlled by procedure, and the Fuse Detail Report (Drawing E 555) listed the fuses that were installed. The team determined that the 1 and 10 amp fuses were in series and protected the same circuit. The loss of either fuse would have the same affect on the control circuit. Therefore, the fuse coordination would not challenge the safety design of the remote shutdown system.

The licensee changed the design of the RHR MOV limit switch for remote shutdown mode by rewiring the connections to the motor starter operating coils to bypass the control room. This change eliminated potential locations of shorts that would affect the control circuit in case of fire in the main control room while controls were transferred to the Remote Shutdown mode. The same modification however, was not performed on the alternate shutdown MOV control circuits. This issue was discussed with the licensee on March 10, 1997, during an inspection followup telephone conversation. At that time the licensee stated that, the requirements of Appendix R to 10 CFR Part 50, "Fire Protection Program for Nuclear Power Plants," for alternate shutdown capability for the RHR system would be met from the remote shutdown panel. The licensee's capability to meet the Appendix R shutdown criteria for the RHR system will be verified during a future NRC inspection. This issue is identified as an Inspection Followup Item. (IFI 96-201-06)

e. System Walkdowns

A walkdown of the RHR system focused on the remote and alternate remote shutdown controls. A sample of remote Shutdown control circuit fusing was verified against the EWDs and the Fuse Detail Report.

E2.1.3.3 Conclusions

The I&C design of the RHR system conformed to the applicable performance commitments of the FSAR and was capable of operating within TS limits. The team noted that the applicable design document, the DRD, had minimal detail about I&C system and component requirements, and in the implementation of design features to be useful as a design basis document. Potential short circuit for RHR MOVs have been eliminated for the remote shutdown panel but not for the alternate shutdown panel.

E2.2 Automatic Depressurization System (ADS)

The ADS was designed to rapidly reduce the reactor vessel pressure during a small break LOCA concurrent with failure of the high pressure core spray (HPCS) system, thus, enabling the low pressure core spray (LPCS) and LPCI systems to deliver cooling water to the reactor vessel. The ADS design was based on the use of 7 designated valves of the 18 safety relief valves (SRVs) to relieve the high pressure steam to the suppression pool. The ADS valves would be opened by the operators in case the HPCS was not delivering enough water to maintain the RPV water at a preselected level and either LPCS or LPCI would be available.

E2.2.1 Mechanical

E2.2.1.1 Scope of Review

The mechanical design review of the ADS system consisted of design documentation review, system walkdowns, and discussions with the cognizant system and plant design engineers. Documents reviewed included applicable portions of FSAR, the system DRD, drawings, calculations, and vendor documents.

Calculations addressed ADS valve actuation, design of ADS accumulators and actuators, nitrogen supply by the containment instrument air (CIA) system, and the impact of power uprate on the ADS. This included an evaluation of ASME Code ratings for pressure retaining materials as well as factory and bench testing of system components. The assessment included system accident.

response, EOP operator actions, FSAR accident analysis, and adherence to licensing commitments. The inspectors also reviewed control room operation, alarms, operator training, and simulator operation.

E2.2.1.2 Findings

a. Design Pressure of the ADS Actuators

The containment instrument air (CIA) system supplied nitrogen to the ADS accumulators, which in turn kept the ADS actuators pressurized to 186+/- 2 psig. This pressure was maintained at all times, even at a drywell temperature as low as 70°F. A check valve just upstream of the accumulators was designed to prevent backflow. No pressure relieving devices have been provided therefore, as the drywell heated up, the pressure inside the accumulators would increase without overpressure protection. Under accident conditions (0.1 ft^2 main steam line break for example), the drywell temperature could reach 285°F and remain there up to 2 hours, as described in Section 15 of the FSAR. Under these conditions, the temperature and hence the pressure in the ADS accumulators and actuators would increase to a value greater than 260 psig. With the elevated temperature and pressure in the primary containment, the differential pressure across the accumulator and actuator walls would remain within the design parameters of the equipment. However, if operators actuated the containment spray, pressure in the containment would drop, resulting in a differential pressure across the actuator walls that would exceed the ADS actuator design pressure of 250 psig. While the use of the containment spray is not required to mitigate the accident, the initiation of the spray to control containment pressure is permitted by the emergency operations procedure (EOP). This scenario did not assume any failure with either the ADS or the CIA system.

The low drywell pressure condition was not recognized in the WNP-2 accident analysis. Calculation 5.46.05, "Maximum and Minimum CIA System Pressure," evaluated the minimum and maximum pressures to be delivered to the ADS accumulators by the CIA system. This calculation took credit for high drywell pressure that reduced the pressure differential across the actuator wall.

At the conclusion of the inspection, the licensee described several initiatives to address this issue. These included an evaluation of the effects of containment spray on drywell pressure and temperature following the postulated accident scenario, and the possibility of requalifying the ADS actuators to an adequately high design pressure. This item remains unresolved pending NRC review of the licensee's proposed corrective action. (URI 96-201-07)

The team reviewed Calculation Modification Record (CMR) 94-1154, which assessed the effect of power uprate on calculation 5.46.05, "Maximum and Minimum CIA System Pressure." The conclusion, that CIA maximum or minimum pressure was unchanged as a result of power uprate, was justified because the maximum normal operating pressure of 1055 psig did not change as a result of the power uprate. However, the CMR did not note that the calculation included a section calculating the total decay heat by using the old reactor power of 3462 megawatts thermal (MWt) as an input parameter rather then the uprated (current) power of 3629 MWt. In response to the finding the licensee issued PER 297-0028 and notified the inspection team that although the CMR missed this issue, the final results would not change. The team verified that a new analytical model done at the time of power uprate reduced the maximum suppression pool temperature from 220 to 204°F. This lower suppression pool temperature would eliminate the effect of uprated power on the pressure in the ADS accumulators.

b. Maximum SRV Tailpipe Level Limit

EOP calculation NE-02-89-18, Rev. 2, established that the maximum SRV tailpipe level limit and the minimum SRV reopening pressure. The methodology was adequate, but the input data for quencher support and tail pipe support were not available. The licensee stated that calculation NE-02-89-18 will be revised to include current design data and to recalculate the SRV tail pipe level limit. The licensee has issued RFTS-96-12-016 to document and resolve this issue.

The inspectors identified the incomplete documentation for quencher support and tail pipe support design as an Inspection Followup Item. (IFI-96-201-08)

E2.2.1.3 Conclusions

In general, the mechanical functions of the ADS were acceptable. However, a postaccident scenario that has the potential to result in overpressurized ADS actuators was not fully evaluated by the licensee. While there was no immediate safety concern, the licensee initiated evaluations for possible corrective actions. The calculations to determine the maximum pressure in the ADS actuators were nonconservative in the assumption of drywell temperatures.

E2.2.2 Electrical

E2.2.2.1 Scope of Review

The team reviewed Class IE electrical power sources for the ADS and its components and assessed compliance with General Design Criterion (GDC) 34 of 10 CFR Part 50, Appendix A, to verify independence and redundancy, and to ensure that system safety function can be performed, assuming a single failure. The team also compared the drawings and the DRD, applicable sections of the FSAR, and TS requirements.

E2.2.2.2 Findings

Electrical Power Sources

The observations on electrical power sources in the RHR section of this report of the Electrical Power Source review also apply to the ADS. The observations are generic to the powering of all instruments and DC control

devices. The remarks on RHR battery sizing calculations also apply to the ADS design.

E2.2.2.3 Conclusions

The team determined that the electrical design requirements, like those for the RHR system, were appropriate and consistent in the reviewed documents. No unacceptable conditions were identified during this review.

E2.2.3 Instrumentation and Control

E2.2.3.1 Scope of Review

The I&C assessment of the ADS consisted of design documentation reviews, discussions with the responsible system engineer and discipline engineers, and walkdowns of accessible portions of the system. The assessment focused on FSAR commitments, operation within TS limits, and the ability of the ADS to perform its protective functions. The following design attributes were reviewed: instrumentation, instrument power and DC relay control power, and remote and alternate remote shutdown provisions. Documents reviewed included the applicable sections of FSAR Chapters 5-9, DRDs, applicable TSs, vendor documents, process instrumentation diagrams (P&IDs), logic diagrams, electrical wiring diagrams (EWDs), calculations, calculation modification records (CMRs), problem evaluation requests (PERs), technical evaluation requests (TERs), plant modification records (PMRs), operating experience reviews (OERs), and EOPs.

E2.2.3.2 Findings

a. Documentation

Figure 2.6-2 in DRD 307 for the main steam system incorrectly designated safety relief valves RV-2A, RV-2C and RV-3B as ADS valves with control transfer for alternate remote shutdown. The design documentation, including wiring diagrams and panel layout drawings, correctly indicated that RV-3D, RV-5B, and RV-5C were the actual ADS alternate remote shutdown valves. The licensee initiated corrective action to resolve the discrepancy. This issue was identified as an Inspection Followup Item. (IFI-96-202-09)

b. Design Configuration Control

The team reviewed General Electric (GE) Functional Control Diagram (FCD) 731E788 and verified that the FCD called for a seal-in of the timer A and B logic and for a second seal-in of the manual-initiate function in the C and D logic. The intent of this configuration was to allow simultaneous manual initiation of the ADS valves. The team determined however, that the FCD, which has been incorporated into the FSAR, did not agree with the installed configuration of the manual initiation of the ADS because the original design was inadvertently altered.

The licensee introduced the design error in 1985 as part of a modification to install an inhibit switch to prevent the automatic actuation of the ADS system following a reactor vessel low level condition. Since then, operators are trained to activate the ADS system automatic actuation inhibit switch immediately upon entry into the EOPs from a reactor vessel low water, Level 3, condition. Because of a wiring error, the actuation of the ADS inhibit switch defeats the manual-initiate function, as shown in the FCD. If the manual-initiate buttons of the ADS are depressed, the ADS valves open in groups as intended; however, due to the loss of the intended seal-in feature, if the manual-initiate buttons are released the logic relay de-energizes and the ADS valves re-close.

To compensate for the loss of the intended system level manual-initiate function, the licensee trained operators to manually open the ADS valves at the component level using the individual switches located on the main control board. The team verified that the control room simulator correctly mimics the existing plant configuration.

The modified manual initiation appeared to be inconsistent with elements of the manual-initiate operation described in Regulatory Guide 1.62, "Manual Initiation of Protective Actions". The regulatory guide identified the following applicable guidelines for manual initiation of a protective action:

1. Initiate protective functions at the system level regardless of the provision of manual control at the component level.
2. Perform all actions performed by automatic operation.
3. Initiate action from the main control room.
4. Minimize amount of equipment to be operated by the operator.
5. Once initiated the protective action should go to completion.

The existing configuration, as implemented by the operators following an accident, would only meet Items 3 and 5 of the guidelines. The operation of the seven auto-manual component level switches required more than the minimum number of actions the original design intended at the system level. Also, the original design, whereby the valves initially opened in two distinct groups of 4 and 3 valves together has been altered; and the seven valves now have to be opened sequentially.

The WNP-2 FSAR Appendix C included Regulatory Guide 1.62 as a design commitment requiring full compliance. The failure by the licensee to fully implement the guidelines of the regulatory guide for manual initiation of a protective function is identified as an Unresolved Item. (URI-96-202-10)

The new configuration, including the design error, was captured in GE Elementary Diagram 807E180TC, while the FCD and the FSAR retained the original design. Failure to update the FSAR is another example of Unresolved Item (URI) 96-201-02.

The licensee stated that the inconsistencies between the applicable FSAR section, FCDs, and elementary drawings would be corrected and the physical plant would be modified to reflect the intent of the original design for manual initiation. Simulator and operator training would be appropriately revised.

c. Setpoints

The observation on setpoints in the RHR section of this report of the setpoint review also apply to the ADS. The observations are generic to the setpoint program. The ADS setpoints were developed and documented in the same manner as the RHR setpoints.

E2.2.3.3 Conclusions

The ADS review identified a design error introduced by the licensee. The error resulted in the loss of the original design manual initiation action of the system. To compensate for the loss, the licensee implemented an alternate method for manual initiation which involved changing the simulator and operator training. However, the licensee failed to recognize that the new configuration did not meet the positions of Regulatory Guide 1.62 as committed to in the FSAR concerning the manual initiation of a protective system.

E2.3 Standby Service Water (SSW) System

The SSW system was designed to cool emergency plant equipment during and after transients and accidents, including ECCS pumps and motors, emergency diesel generators (EDGs), RHR heat exchangers, and cooling coils of air handling units essential for the operation of critical components and ventilation of the control room.

Other functions of the SSW system were to serve as a heat sink for the RHR system during normal shutdown operation, provide backup cooling and makeup water for the fuel pool in the event of loss of normal cooling, and supply water for flooding the reactor vessel and containment if required during the post-LOCA period.

The SSW system was designed as an open cooling water system with two redundant, independent trains (A and B). A third independent train dedicated to cool high pressure core spray (HPCS) components was also installed. In each train, a vertical service water pump takes suction from its associated spray pond and returns the service water to the spray ponds by direct dump or through spray ring headers, depending on spray pond temperature. The SSW system was designed to automatically initiate upon the receipt of an engineered safeguards signal.

The SSW system was designed to perform its required cooling functions following a LOCA, assuming a single active failure and a loss of offsite power (LOOP). With the exception of the spray pond makeup, and the keepfull subsystems, the carbon steel system piping was constructed to seismic Category I and ASME Code Section III, Class 3 requirements.

E2.3.1 Mechanical

E2.3.1.1 Scope of Review

The mechanical design review of the SSW system consisted of a design documentation review, system walkdowns, and discussions with the cognizant system and plant design engineers. Documents reviewed included applicable portions of FSAR Chapters 5-9, the system DRD, applicable TSs, and selected calculations and drawings.

The scope of the review was to verify the appropriateness and correctness of design assumptions, boundary conditions, and system models; verify that the design bases were in accordance with the licensing bases, commitments, and regulatory requirements; and verify the adequacy of testing requirements.

E2.3.1.2 Findings

a. Reactor Vessel and Containment Flooding Function

FSAR Section 9.2.7.1 and DRD Section 2.4.7 stated that a function of the SSW system was to flood the reactor vessel and containment, if required, during the post-LOCA period. This beyond-design-basis function used a flowpath through a cross-tie from the SSW system B loop to the RHR system B loop, as shown on SSW P&ID M524, Sheet 2, Revision 88. EOP PPM 5.5.2, Revision 5, provided the operators with the necessary directions for establishing this system lineup. The licensee's self-assessment of the SSW system (Technical Assessment 90-015, dated December 1990) identified concerns that SSW system operation in this lineup could result in SSW pump runout and possible insufficient cooling water flow to the Division II EDG. The concerns were detailed in PER 290-0804. The closure of the PER concluded that the EDG would receive adequate cooling water while the RPV was being flooded, and SSW pump runout would occur for a "relatively short" time. However, no documentation, calculations, or references substantiated these conclusions. The team also noted that the licensee response to NRC Bulletin 96-03," Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling Water Reactors," Supplement 1, identified the SSW crosstie to the RHR loop B, as an interim accident mitigating action.

In response to the team's concerns, the licensee initiated preliminary evaluations indicating that the EDG would receive an adequate cooling water flow, and SSW pump runout would not occur. The licensee also issued Corrective Action Plan No. 1 to PER 290-0804 to formally document an evaluation of SSW system operability in the reactor pressure vessel/containment flooding mode.

The team identified the inadequate design documentation to demonstrate containment flooding capability as an Inspection Followup Item. (IFI-96-201-11)

b. Corrosion Monitoring of the HPCS Service Water System

The uncoated carbon steel piping of the SSW system was found to be susceptible to general corrosion. Corrosion rates may be accelerated in portions of the piping that experience cyclic wet and dry conditions resulting from system draindown following routine testing. PER 295-1229 documented a pinhole leak in a pipe nipple to sock-o-let weld on a loop B SSW system vent line. Failure analysis determined that the cause of the leak was corrosion in the sock-o-let crevice along with local pitting.

The team reviewed the PER root cause, generic implications, operability, and corrective action assessments. The assessments appeared reasonable and comprehensive. Corrective actions included improved corrosion-monitoring and water treatment programs, annual nondestructive examination (NDE) wall thickness measurements at selected locations, and trend analysis of general corrosion. However, the assessments and corrective actions were incomplete in addressing only SSW loops A and B. The HPCS service water loop, which would be susceptible to the same corrosion mechanisms as the remainder of the SSW system, was not included in the program. The licensee issued PTL A-137114 to supplement the PER 295-1229 generic-impact discussion and to add a HPCS service water system piping location to the NDE wall thickness monitoring program.

10 CFR Part 50 Appendix B Criterion XVI, "Corrective Action" requires that measures be established to assure that conditions adverse to quality are promptly identified and corrected. The team found that the licensee's closure of PER 295-1229 did not address corrective action regarding corrosion monitoring of the HPCS service water loop. This issue is identified as an Unresolved Item. (URI-96-201-12)

c. Calculations

The team reviewed mechanical design calculations relating to the SSW system. The calculations generally appeared to be acceptably performed, with clearly identified purpose, assumptions, inputs, and references. However, the team noted several apparent discrepancies or deficiencies, as discussed in the following paragraphs.

Calculation ME-02-91-50, Revision 1, sized reservoir tanks for the Division I and II EDG cooling water systems. The water in the reservoir tanks absorbs heat rejected from diesel engine operation until SSW flow to the diesel cooling water heat exchangers is established. The calculation used as input a service water pump motor load of 1377 kW (motor rating), obtained from the FSAR as it existed when the calculation was performed. A subsequent FSAR amendment revised this value to 1279 kW (actual load). PMR 95-0097-0 replaced the SSW pump SW-P-1B motor with a more efficient motor (actual load = 1261 kW, as determined in Calculation E/I-02-91-03, Rev. 0). For the purposes of calculation ME-02-91-50, a smaller value for

SSW pump motor load was conservative because it maximized the initial EDG load before SSW system flow was established thereby maximizing EDG cooling water temperature (the initial EDG load was the rated capacity minus the SSW pump motor load). The team found no evidence that the licensee had evaluated the impact of the SSW pump motor replacement on the calculation.

Calculation ME-02-91-50 contained a single page of data tabulating SSW system flow as a function of time following startup of pump SW-P-1B. The calculation did not identify sources for the data. When questioned by the team, the licensee produced Temporary Procedure TP 8.3.73,"B Standby Service Water System Pre-operational Test Following Implementation of PMR 02-86-0324-1", Revision 0. These test results formally documented the subject pump startup data. The calculation did not reference this test procedure.

Calculation ME-02-91-50 included the assumption that the SSW water flow divided equally between the two diesel engines associated with the EDGs. This was not the case when the calculation was prepared. Data taken to trend EDG cooling water heat exchanger performance demonstrated that a flow imbalance existed, as documented in Calculation ME-02-92-014, Revision 1. However, a modification completed in 1993 (PMR 91-0309-0) installed flow orifices in the SSW lines to the EDG engines to equalize SSW flow to each engine. Therefore, the equal SSW water flow assumption in calculation ME-02-91-50 is currently correct. An independent calculation performed by the team indicated that the EDG cooling water reservoir tank sizing continued to be adequate. The licensee issued CMR 97-0015 to follow up with appropriate revisions to the calculation.

Calculation ME-02-93-004, Revision 0, performed a hydraulic analysis of the SSW system to determine flow rates to each served component, including SSW flow to the fuel pool cooling (FPC) heat exchangers. The SSW system provided backup cooling for the fuel pool in the event that normal pool cooling (provided by the non-safety-related reactor building closed cooling water system) would be lost. The calculation concluded that certain components served by the SSW system would experience low SSW flows, which required further evaluation. However, no evaluation was identified. The licensee provided a copy of CMR 93-0037, which performed the subject evaluation. The CMR acceptably addressed the calculated low flow values. The team had no further concerns with this issue.

Calculation ME-02-96-03, Revision 0, determined the minimum required SSW flow rate to the RHR pump 2A and 2B seal coolers. SSW system flow balance tests performed early in 1996 measured a flow rate to the RHR pump 2B seal cooler of 8.1 gpm, whereas the required flow rate specified in Plant Procedure Manual (PPM) 7.4.7.1.1.2 (Standby Service Water loop B Valve Position Verification), Revision 17, was 9 gpm, as documented in PER 296-0028. The team questioned the use of an initial SSW supply temperature of 77°F rather than the design basis maximum calculated spray pond temperature of 88.7°F. The licensee stated that the seal cooler evaluation was performed with the RHR seal water at its maximum temperature of 358°F, which occurs when the shutdown cooling mode of RHR.

operation is initiated. Prior to initiation of shutdown cooling, heat rejected to the spray ponds would be insignificant and the pond temperature would not exceed the TS limit of 77°F. As shutdown progressed, the RHR seal water temperature would decrease rapidly while spray pond temperature would rise slowly. Therefore, the RHR seal water and SSW supply water temperatures used in the calculation were conservative. The team had no further concerns with this issue.

PER 295-1002 documented the discovery of a through-wall leak of approximately 0.25 gpm in the SSW loop A return line, downstream of a flow orifice (SW-FE-1A). The identified failure mode was localized erosion caused by cavitation induced by flow conditions developed by the orifice. One of the corrective actions identified in the PER resolution was an evaluation of other potential locations for cavitation within the SSW system. Calculation ME-02-96-28 was referenced as documenting this evaluation. However, when the team requested a copy for review, the licensee could not locate it. The licensee indicated that, except for flow orifices at SW-FE-1A (the leak location) and the corresponding location in SSW loop B at SW-FE-1B, no other potential cavitation locations had been identified. The licensee issued PER 297-0036 to regenerate the missing calculation ME-02-96-28. This issue is identified as an Inspection Followup Item. (IFI-96-201-13)

d. System Modifications

The team selected eight modification packages and reviewed associated 10 CFR 50.59 safety evaluations, supporting analyses, and impact evaluations. The team also reviewed selected design documents to confirm correct updates following implementation of the modifications.

In 1984, according to Plant Modification Record (PMR) 84-1077-0, strainers were installed in the SSW cooling water supply lines to the SSW pump A and B motor bearing coolers. A concern later arose (PER 293-0300) that plugging of these strainers by debris and matter suspended in the spray pond water could result in the common mode failure of both SSW pumps. The PER concluded that the probability of plugging even a single strainer is extremely low and recommended periodically blowning down the strainers to remove collected material. The inspection team verified that general operating procedure PPM 3.1.10, Revision 12, "Operating Data and Logs," included a requirement to blow down the strainers when the SSW pumps were running. Maintenance also cleaned the strainers annually as part of the scheduled maintenance program. These provisions appeared to be adequate, and the team had no concerns on this issue.

e. Procedures

The team reviewed SSW system procedures including normal, abnormal and emergency operating procedures, TS surveillance testing procedures, in-service testing procedures, and performance monitoring (Generic Letter 89-13) procedures. Operation and testing of the SSW system generally appeared to be in accordance with the system design bases, with the following exceptions noted by the team:

In surveillance procedures PPM 7.4.7.1.1.1, Revision 22, and PPM 7.4.7.1.1.2, Revision 20, "Standby Service Water loop A (B) Valve Position Verification," the annual flow balance did not include the fuel pool heat exchangers in the SSW system lineup. In addition, the flow balance procedure for SSW loop B did not include control room emergency chiller CCH-CR-1B in the lineup. The system drawing (P&ID) indicated that SSW loop B normally supplied this component. Since Calculations ME-02-92-43, "Room Temperature Calculation for DG Bldg, Reactor Bldg, Radwaste Bldg, and SW Pumphouse Under Design Basis Accident Conditions", ME-02-93-004, "Service Water System Flow Distribution" and ME-02-95-25, "Evaluation of Standby Service Water Capability", indicated that all served components would receive adequate SSW flows, the team had no safety concerns with this issue. However, the team considered the lack of inclusion of the fuel pool heat exchangers and the control room emergency chiller CCH-CR-1B in the flow balance tests to be a weakness in the test procedures. This issue is identified as an Inspection Followup Item. (IFI 96-201-14)

The licensee initiated the drafting of a new test procedure (PPM 8.4.81) to address this issue. The licensee initiative was being tracked as PTL A-137197. The new procedure was scheduled for implementation at the next refueling outage.

f. SSW Keepfull Pumps

FSAR Section 9.2.7 identified a small keepfull system to keep the SSW system piping full of water under normal, standby conditions. The applicable design review document (DRD) also credited the keepfull pumps with maintaining water inventory in the SSW piping while the system was in the standby mode.

The team determined that the keepfull pumps were deactivated by a procedure modification and by Safety Evaluation 93-213 (in October 1993). The deactivated status was indicated by a note on the SSW system P&ID. TER 93-0226 was issued October 1993 to evaluate removal of the keepfull pumps. This resulted in PMR 93-226 which initiated removal of the equipment but was never implemented. Licensing Document Change Notice (LDCN) 96-092 was initiated in November 1996 to revise the FSAR to state that the system was deactivated in place. Currently the equipment remains deactivated with implementation of the modification package deferred until 1998.

The team concluded the system was deactivated with a clear intention to permanently remove it from service. Effectively the facility change was made at that time. The proposal to identify the changes to the facility description in the FSAR was developed 3 years after the change to the facility. This is considered untimely maintenance of the FSAR.

The failure to incorporate the facility change into the FSAR as required by the 10 CFR 50.71(e) is identified as another example of Unresolved Item, (URI 96-201-02).

The licensee also agreed the DRD information concerning the keepfull pump function was incorrect and that the standby service water DRD would be completely reviewed for other potentially erroneous information and corrected as needed.

The inspectors identified DRD documentation inconsistencies regarding SSW keepfull pumps as another example of Inspection Followup Item, (IFI 96-202-04).

g. System Walkdowns

The inspection team performed walkdowns of selected portions of the SSW system. The HPCS service water loop was in operation during the walkdowns. The material condition of the system and the general housekeeping was good. While in the HPCS pump room, the team observed that local flow indicator SW-FI-27 was pegged high. This instrument measured the HPCS service water flow through the HPCS pump room cooler (RRA-CC-4) and should have been reading about 45 gpm. The inspector verified service water flow rates to all other HPCS loop components served to be greater than minimum required values, as indicated on local flow indicating instrumentation. The licensee initiated work request W/R 96005298 to calibrate SW-FI-27.

h. FSAR Review

The team assessed the accuracy of the FSAR description of the SSW system and identified the following discrepancies:

FSAR Table 9.2-5,"Equipment Requiring Standby Service Water to Ensure Plant Shutdown," listed the SSW flow rate and heat load for each component served by the SSW system. The component SSW flow rates listed were generally original design values taken from vendor equipment data sheets. However, the SSW system flow balance test procedures for the A, B, and HPCS SSW loops (PPMs 7.4.7.1.1.1, 7.4.7.1.1.2, and 7.4.7.1.1.3) allowed minimum flow rates that in some cases were less than the FSAR values.

The test procedure minimum values were justified in calculations that considered the actual heat transfer duty of the subject coolers and heat exchangers. The following table shows examples of differences between the test procedures and FSAR Table 9.2-5:

	Test Procedures	FSAR Table 9.2-5
RHR heat exchangers	6,900 gpm	7,400 gpm
LPCS pump motor bearings	3.5 gpm	4 gpm
RHR pump seal coolers	7 gpm	12 gpm
HPCS diesel generator	780 gpm	910 gpm
HPCS diesel generator room coolers	137 gpm	144 gpm
HPCS pump room cooler	35 gpm	50 gpm

The licensee has stated that the flow rates listed in FSAR Table 9.2-5 were consistent with the spray pond thermal analysis. These values did not necessarily represent minimum required values to satisfy the heat removal requirements of the coolers and heat exchangers. The licensee has initiated RFTS 97-01-008 to evaluate the applicability of the information contained in Table 9.2-5 (e.g., spray pond analysis, SSW pump sizing, minimum flows for component heat removal) and revise the table as appropriate.

For Division II, the table listed the RHR pump C seals; however, based on NCR 286-0264 and drawing M524, Sheet 2, Note 32, this component was valved out in 1986.

For Division II, the table listed control room cooler WMA-CC-51B; however, drawing M775, Revision 19, showed that SSW loop B normal alignment was to the condenser of control room emergency chiller CCH-CR-1B rather than to the control room cooler.

The multiplicity of design temperature values in FSAR Section 9.2.7 and Table 9.2-5, was confusing. There were the design temperature values used for equipment sizing and selection (i.e., 85°F and 95°F), the maximum calculated spray pond temperature (reported as 88.7°F in Section 9.2.5 and 88.6°F in Section 9.5.5), and the value used in containment heat removal analyses (e.g., 95°F Table 6.2-2).

The identified inconsistencies in SSW flow balance test acceptance criteria and the FSAR licensing bases values were additional examples of the licensee's failure to meet the requirements of 10 CFR 50.71(e) identified as Unresolved Item, (URI 96-201-02).

E2.3.1.3 Conclusions

The team concluded that the mechanical design of the SSW system was generally acceptable. However, the team identified several concerns regarding the failure by the licensee to routinely update and maintain design basis documentation. Incorrect or incomplete information was identified in the FSAR and the design review document (DRD). In addition, the team was concerned with the lack of formal documentation to verify system capability to perform the reactor vessel/containment flooding function and with the omission of the HPCS service water system from the wall thickness monitoring (corrosion monitoring) program.

E2.3.2 Electrical

E2.3.2.1 Scope of Review

The team reviewed Class IE electrical power sources for the SSW system and its components in accordance with GDC 17, "Electrical power system," of 10 CFR Part 50 Appendix A, and Regulatory Guide 1.93, "Availability of Electric Power Sources." These documents required that onsite electrical power supplies, including the batteries, have sufficient independence and redundancy to ensure the system safety function can be accomplished, assuming a single failure. The team also compared the drawings to the DRD, applicable sections of the FSAR, and TSs.

In addition, the team reviewed the documentation for the replacement of SSW pump motor SW-M-P/1B.

E2.3.2.2 Findings

Minor Design Change (MDC) 95-0097-0A for replacement of SSW pump motor SW-M-P/1B revised electrical design calculations, mechanical and electrical drawings, and databases. The replacement motor design characteristics were similar to those of the original motor, and complied with all original codes and standards as identified in FSAR Section 9.2.7 and WNP-2 design drawings. The pump motor kW load data in FSAR Table 8.3-2 reflected the load reduction associated with the new SW-M-P/1B for the DG2 loading. All applicable CMRs that affected electrical calculations and drawings have been verified and found acceptable. The team also reviewed the electrical protection coordination for SW-M-P/1B and found it acceptable.

The team determined that the electrical design requirements were appropriate and consistent in the reviewed documents.

E2.3.2.3 Conclusions

Electrical Power Sources

The remarks on electrical power source description in the RHR section of this report apply to the SSW. The observations are generic to the powering of all instruments and DC control devices. The remarks on the RHR battery sizing calculation also apply to the SSW design.

The team concluded that the electrical design requirements for the SSW system and its components were adequate and were operating within the design limits. No unacceptable conditions were identified during this review.

E2.3.3 Instrumentation and Control

E2.3.3.1 Scope of Review

The I&C assessment of the SSW system consisted of design documentation reviews, discussions with the responsible system engineer and discipline engineers, and walkdowns of the in-plant system. The assessment focused on FSAR commitments, operation within TS limits, and the ability of the SSW to perform its protective functions. The following design attributes were reviewed: instrumentation setpoints, instrument power and DC relay control power and remote and alternate shutdown provisions. Documents reviewed included applicable sections of FSAR Chapters 5-9, DRDs, applicable TSs, vendor documents, P&IDs, logic diagrams, EWDs, calculations, CMRs, PERs, TERs, PMRs, OERs, and EOPs.

E2.3.3.2 Findings

Setpoints

The remarks on setpoints in the RHR section of this report apply the SSW. The observations are generic to the setpoint program. The SSW instrument setpoints were developed and documented in the same manner as the RHR setpoints.

E2.3.3.3 Conclusions

The team concluded that the electrical design requirements for the SSW system and its components were adequate. however, the DRD lacked design detail.

E2.4 Ultimate Heat Sink (UHS)

The UHS consisted of two water-filled concrete basins connected by a 30-inch diameter siphon line. The UHS is the source of cooling water to the SSW system for long-term reactor decay heat removal and essential cooling system heat load dissipation after a normal reactor shutdown or a shutdown following an accident, including a LOCA. FSAR Section 9.2.5.1 credited the UHS with the capability to provide cooling for 30 days without makeup. This safety function capability would be available following the occurrence of the most severe site-related natural events, including earthquakes, tornados, floods, and drought.

E2.4.1 Mechanical

E2.4.1.1 Scope of Review

Primary design and licensing bases documents for the UHS were FSAR Chapters 9.2.5 and 9.2.7 and the DRD (Division 300 Section 309 "Standby Service Water System," Revision 0). Supporting documents included drawings, calculations, modification packages, safety evaluations, operating procedures, and operator training material.

E2.4.1.2 Findings

a. Regulatory Guide 1.27 - UHS Tornado Protection

FSAR Section 9.2.5.1 specifies that the UHS design satisfy the guidelines of Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants" (Rev. 1). The guide indicated that to be found acceptable a proposed single water source must be demonstrated to be able to withstand defined events without loss of safety function. These defined events included the most severe natural phenomena, taken individually. SSW system DRD Section 2.4.8.7 identified the requirements of Regulatory Guide 1.27 Position C.2 as applicable to the UHS.

The inspection team reviewed the licensee's Nonconformance Report NCR 288-340, which stated the "continuous makeup" mode, with the spray ponds allowed to over flow, was the operating mode following tornado damage. The NCR also stated that long-term overflow of the spray ponds could erode the Category I fill which support the walls. As a corrective measure the licensee referenced Plant Procedure Manual (PPM) 4.12.8, "Tornado/High Winds," an abnormal condition procedure with instructions for general actions required after an earthquake. The required actions include defeating a discharge valve closed/pump trip interlock and manually manipulating valves to redirect flow to the circulating water system.

The inspection team noted that the FSAR did not adequately describe the complete flow path for the "continuous makeup" mode with the spray ponds allowed to overflow (the design basis when the NCR was written). Additionally, the NCR disposition introduced an alternate design configuration, imposing new design requirements on interfacing systems. The FSAR was not updated to describe where the effluent water would be directed. The licensee initiated RFTS 97-01-006 to clarify the FSAR in this regard. FSAR changes will be implemented via LDCN 97-007.

The inspection team reviewed PPM 4.12.8 "Tornado/High Winds," to identify what actions were required and what parts of the system were used to realign the system to a once-through cooling mode. The inspection team questioned the adequacy of the piping system used to redirect the SSW system flow for tornado protection.

The licensee stated that the required cover for tornado missile protection was 5 ft in accordance with FSAR Section 3.5.3.3. The licensee stated that two sections of the circulating water system piping had actual soil cover of 1 ft or less. No calculations analyzed the acceptability of this piping for tornado impact loads. The licensee issued Problem Evaluation Request (PER) 297-0031 to document this deficiency. The licensee issued Calculation Modification Record (CMR) 97-0009 to evaluate a direct impact of design basis tornado missiles using revised tornado design criteria recently approved by the NRC. The CMR demonstrated that the revised design basis missiles will not perforate the piping and that the piping will not collapse as a result of postulated missile loads.

b. Regulatory Guide 1.27 30 Day Water Inventory

FSAR Section 9.2.5.1 stated that the UHS was designed to satisfy the requirements of Regulatory Guide 1.27 (Rev. 1). Regulatory position C.1 requires that the UHS be capable of sufficient cooling for at least 30 days unless it can be demonstrated that replenishment or use of alternate sources can be effected to assure continuous capability of the sink.

The inspection team reviewed FSAR Table 9.2-3, "Total Spray Pond Water Losses and Content 30 Days After Design Basis LOCA Event," to verify that the design documents were consistent with the licensing documents and that the regulatory requirement for 30 days onsite water inventory without makeup was met. Specifically, the team compared the FSAR water consumption losses to the DRD values and the calculations.

The team found that some of the values in the FSAR could not be readily supported by calculations. The calculated values for drift loss, spray evaporation loss, and surface evaporation loss were not available. The team also noted that the calculation input pond minimum volume was 935,100 gallons, whereas the FSAR and the DRD had 2,100,000 gallons.

Calculation ME-92-02-41, "Room Temperatures During Design Basis Accidents," provides the basis for FSAR values for drift and evaporative losses. This code prints out the pond volume as a function of time but not the individual loss components. The licensee issued CMR-97-0004 to identify the individual drift and evaporative loss outputs in the calculation output. The values determined by the model and documented within the CMR are consistent with the FSAR values.

The licensee indicated that the pond minimum volume of 2,100,000 gallons is based on the design and performance characteristics of the siphon connecting the two ponds. It is not calculated within the computer simulation. The 935,100 gallon input is only used in deactivated subroutines, which have no effect on the output. The original purpose of the pond minimum input was to determine when the siphon would break if pond inventory was depleted. The licensee issued CMR-97-0011 in conjunction with CMR-97-0004 to properly document the basis for the pond minimum volume and to revise the computer simulation to be consistent with the as-built siphon performance.

The team determined that compliance with the 30 day water inventory requirements as presented in the FSAR was supported by design documentation.

c. UHS Cleanliness

TS 3.7.1.3 for the UHS gives limits for minimum water levels, maximum water temperature, and maximum average sediment depth for an operable UHS. The TS maximum average sediment depth allowable was less than or equal to 0.5 ft on the floors of the spray ponds.

The team verified the maximum allowable sediment depth was consistent with the interconnecting siphon design and with the minimum volume value used in the 30-day water-inventory for SSW system operation. These design features were documented in calculations 10.07.74, "Standby Service Water System Siphon Between Spray Ponds" and ME-02-83-21, "Spray Pond Water Level Range," respectively.

The team reviewed procedure 7.4.7.1.3 "Surveillance Procedure for Spray Pond Average Sediment Depth Measurement." Sediment was measured at 23 locations around the pond perimeter and at 4 locations around the ring spray header. The 27 measurements were averaged to determine the measurement. The team noted that measurement locations would give representative results for the interconnecting siphon areas; however, the locations sampled may not be representative for the depressed sumps at the SSW pumphouse.

The inspection team reviewed drawings M780, "Composite Piping Standby Service Water Pump House 1B," S513, "Spray Pond Plan, Section and Details," and Byron Jackson SSW Pump Outline Drawing 2C-5173. The drawings provided details of the intake screens and weir wall and the location of the pump suction for SSW pumps 1A and 1B. The pump suction was identified at 1 ft above the floor of the pumphouse sump.

The licensee indicated that intake screen inspections used remote video cameras to examine the pond side for the presence of debris and clams at the bottom of the screens. Sediment was not found during the remote video inspection. Accumulated debris consisted of tumble weeds and small pieces of plastic. Cleaning the screens was planned using divers to remove accumulated debris during the next outage. The licensee stated that, based on the remote video inspections, silt would not get past the weir wall about 20 ft away from the intake screens.

E2.4.1.3 Conclusions

The inspection team concluded that the design of the UHS was in conformance with the operational description in FSAR Section 9.2.5.

E2.5 Emergency Electrical Power Supplies

The emergency diesel generator system was designed to provide emergency power to safety-related loads following a LOOP or a LOCA coincidental with a LOOP. Three independent emergency diesel generators (EDGs), DG1 dedicated to Division 1, DG2 dedicated to Division 2, and DG3 dedicated to Division 3 (HPCS), were installed.

The stationary batteries and their associated battery chargers were designed to provide backup power supply to distribution equipment and other direct current (DC) loads. The equipment and loads connected to the DC system were designed to operate over a specified range of voltage above and below the system nominal voltage. The system minimum voltage was restricted by the allowable minimum battery cell discharge voltage in accordance with battery capacity sizing calculations. The system maximum voltage was determined by the battery charger setting required to maintain the battery fully charged.

E2.5.1 Scope of Review

a. Emergency Diesel Generator System

The team reviewed FSAR Diesel Generator Loading Tables 8.3-1(DG1), 8.3-2(DG2), and 8.3-3(DG3) against Diesel Generator Loading Calculation E/I-02-91-03, Revision 5, including 12 CMRs.

b. Direct Current (DC) System

The team reviewed calculation 02.05.01 Revision 9, "Direct Current Power System 24v, 125v and 250v Batteries and Battery Chargers," and all applicable CMRs.

E2.5.2 Findings

The team found discrepancies between the FSAR description and the calculations for both electrical systems. While these discrepancies did not affect system operability and reliability, they showed examples of the licensee's not meeting requirements for FSAR update. The following are examples of such discrepancies.

Emergency Diesel Generator System

Control room emergency chiller was listed as a load in FSAR Table 8.3.1, "Division 1 Diesel Generator Loading, Automatic Loading of Engineered Safety Systems Bus." These chillers start and stop automatically. Diesel Generator Loading Calculation E/I-02-91-03, Revision 5, Table 1A, "Standby Diesel Generator (DG-1) Load Calculation Automatically Applied Loads for Shutdown With LOOP," and Table 1B, "Standby Diesel Generator (DG-1) Load Calculation

Automatically Applied Loads for LOCA With LOOP," identified the load as manual start and manual stop.

The standby liquid control pump and heater in Calculation E/I-02-91-03 Table 2C are listed as 68 kW. FSAR Table 8.3-2 separately listed the pump as 33 kW and the heater as 50 kW.

Calculation E/I-02-91-03 did not specify when the hydrogen recombiner fans and heaters would be manually initiated during a LOCA, whereas FSAR Table 8.3-2 identified recombiner initiation at 60 minutes after a LOCA.

Direct Current (DC) System

After reviewing existing calculation 02.05.01 Revision 9, and all outstanding CMRs, the team concluded that batteries B1-1, B1-2 and B2-1 were adequately sized to complete their respective safety functions. However, the team noted the following discrepancies:

DC panel schedule drawing E509, revision 19, dated October 21, 1983, deleted five loads from distribution panel E-DP-S1/1D and added them to distribution panel E-DP-S1/1F. FSAR Table 8.3-18, "Plant switchgear and MCC DC control power summary," did not reflect this change. The licensee has initiated a corrective action (Item 15 of PER 296-0777) to incorporate the change in the next FSAR amendment. The licensee will track this issue under PTL Item A-137076.

FSAR Table 8.3-4a, "Division 1 125 VDC Battery/System Loads," Table 8.3-4b "Division 2 125 VDC Battery/System Loads," and Table 8.3-5, "Division 1 250 VDC Battery/System Loads," provided battery system loads during 0-6 sec, 6-60 sec, 1-119 min, and 119-120 min. FSAR Table 8.3-7, "Battery Load Profiles Utilized To Verify Operability Per Tech Spec Surveillance Requirement 4.8.2.1.d.2," gave TS criteria for 18 month battery surveillance. Review of Calculation 02.05.01, "Direct Current Power System 24v, 125v and 250v Batteries and Battery Chargers," and Surveillance Procedure 7.4.8.2.1.17, "18 Month Battery Surveillance Tests," confirmed the values listed in the FSAR and in the calculation. However, CMR 94-1122, which used "Battpro," provided a more detailed battery loading profile than the FSAR and the calculation. The revised profile provided higher margin and less inrush current for the installed batteries. Licensee stated that the FSAR table would be revised to reflect the battery loading profile in the next FSAR amendment.

FSAR Table 8.3-15, "Class IE Auxiliary AC Distribution System (230 kv Grid Supply) Expected Voltage Over Grid Voltage Range," incorrectly showed the maximum 230 kv grid voltage as 240 kv instead of 242 kv. Administrative LDCN 97-000 will revise the value to 242 kv during the next FSAR amendment.

The identified FSAR and calculation discrepancies were additional examples of the licensee's failure to meet the requirements of 10 CFR 50.71(e) identified as Unresolved Item, (URI 96-201-02).

The team noted that maintenance and operations field personnel relied on the FSAR table to set the battery profile for load test. The licensee stated that the FSAR was updated whenever the DC load calculation was revised. However, the review of output documents listed in Calculation 02.05.01 did not list FSAR as an output document. At the time of inspection, the licensee had issued a Reference Cross Index RMCS input sheet to include FSAR tables as output interface documents.

The inspectors identified use of the FSAR instead of source calculations to set the battery profile for the load test as an Inspection Followup Item. (IFI-96-201-15)

The team reviewed licensee procedure, Engineering Directorate Manual 2.15, that recommended that calculations be revised if five or more change modification requests (CMRs) are outstanding against a calculation. The team found repeated evidence that calculations with as many as 29 outstanding CMRs were not being revised, with one calculation having 77 outstanding CMRs. For example:

Calculation E/I-02-90-01, "Low Voltage Systems Loading" - 77 CMRs
Calculation E/I-02-87-02, "480V Motor Control Centers Load Data For LOCA Operation" - 23 CMRs
Calculation E/I-02-85-07, "Steady State Loads Supplied From 480V Motor Control Center" - 29 CMRs

The licensee stated that controls would be established to meet the intent of the procedure. The team identified the inconsistencies in following the recommendation of Engineering Directorate Manual EDP 2.15 regarding outstanding CMRs as an Unresolved Item. (URI-96-201-16)

The team did not find any significant problem with calculations that had a large number of outstanding CMRs. The licensee has agreed to prioritize the calculations with a large number of outstanding CMRs and to revise or update first those where the modifications may have functional impact.

E2.5.3 Conclusion

Discrepancies between the FSAR values and corresponding data used in the calculations did not appear to affect the results of the calculations. However, the licensee's failure to routinely update FSAR values continues to be a concern. Failure to adhere to an engineering procedure appeared to be an isolated event, but it could result in reliance by engineers on calculations which are not up to date.

APPENDIX A

Open Items

This report categorizes the inspection findings as Unresolved Items (URIs) and Inspection Followup Items (IFI) in accordance with the NRC Inspection Manual, Manual Chapter 610. An unresolved item is a matter about which more information is required to determine whether the issue in question is an acceptable item, a deviation, a nonconformance, or a violation. The NRC will issue any enforcement action resulting from its review of the identified unresolved items. An inspection followup item is a matter that requires further inspection because of a potential problem, because specific licensee or NRC action is pending, or because additional information is needed that was not available at the time of the inspection.

Report Number	Finding Type	Title
50-397-/96-201-01	URI	Discrepancies between the heat exchanger test analysis source data and the FSAR licensing basis. (Section E2.1.1.2)
50-397/96-201-02	URI	Failure to periodically update the FSAR as required by 10 CFR 50.71(e). (Section E2.1.1.2)
50-397-/96-201-03	IFI	DRD did not identify the RHR backup source of power. (Section E2.1.2.2)
50-397-/96-201-04	IFI	Plant procedure PPM 4.7.1.9 did not reflect the plant response to an under-voltage condition, SM-8. (Section E2.1.2.2)
50-397-/96-201-05	IFI	RHR DRD did not discuss I&C requirements and their implementation. (Section E2.1.3.2)
50-397-/96-201-06	IFI	NRC to verify that Appendix R alternate shutdown activities for RHR valves are accomplished from the remote shutdown panel and not the alternate remote shutdown panel.
50-397-/96-201-07	URI	The differential design pressure for the ADS actuator was not adequatly analysed for low containment pressure. (Section E2.2.1.2)

50-397-/96-201-08	IFI	Incomplete documentation for quencher support and tail pipe support design. (Section E2.2.1.2)
50-397-/96-201-09	IFI	DRD discrepancy in identifying ADS valves. (Section E2.2.3.2)
50-397-/96-201-10	URI	Failure to implement the requirements of RG 1.62 requirements for ADS manual initiate. (Section E2.2.3.2)
50-397-/96-201-02	URI	Failure to update the FSAR to reflect a plant design change.
50-397-/96-201-11	IFI	Inadequate design documentation to demonstrate containment flooding capability. (Section E2.3.1.2)
50-397-/96-201-12	URI	Inadequate corrective action to implement corrosion monitoring of HPCS service water. (Section E2.3.1.2)
50-397-/96-201-13	IFI	Licensee will redevelop calculation to identify potential cavitation areas in the SSW system. (Section E2.3.1.2)
50-397-/96-201-14	IFI	Exclusion of the fuel pool heat exchanger and the control room emergency chiller from the SSW test lineup. (Section E2.3.1.2)
50-397-/96-201-02	URI	Failure to update the FSAR, regarding SSW keepfull pumps. (Section E2.3.1.2)
50-397-/96-201-03	IFI	Documentation inconsistencies, regarding SSW keepfull pumps. (Section E2.3.1.2)
50-397-/96-201-02	URI	Inconsistencies between the SSW flow balance test acceptance criteria and the FSAR licensing basis values. (Section E2.3.1.2)

50-397-/96-201-02	URI	Inconsistencies between FSAR electrical distribution loads and associated calculations. (Section E2.5.1.2)
50-397-/96-201-15	IFI	Use of the FSAR instead of source calculations to set the battery profile for load test. (Section E2.5.1.2)
50-397-/96-201-16	URI	Did not meet the guidance of Engineering Directorate Manual 2.15 concerning outstanding CMRs. (Section E2.5.1.2)

APPENDIX B

Acronyms & Abbreviations

ADS	automatic depressurization system
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ATWS	anticipated transients without scram
BTU	British thermal unit
BWROG	Boiling Water Reactor Owners Group
I&C	instrumentation and control
CDCR	configuration document change request
CIA	containment instrument air
BDC	basic design change
CMR	calculation modification record
DC	direct current
DSA	design safety analysis
DRD	design requirements document
ECCS	emergency core cooling systems
EWD	electrical wiring diagram
EDG	emergency diesel generator
EOP	emergency operating procedures
EPG	emergency procedures guidelines
FPC	fuel pool cooling
FSAR	final safety analysis report
FCD	functional control diagram
GDC	general design criteria
GE	general electric
gpm	gallons per minute
HPCS	high pressure core spray
hr	hour
IFI	Inspection Followup Item
ISCR	instrument setpoint change request
MDS	master data sheet
IP	inspection procedure
ITS	Improved Technical Specifications
kw	kilowatt
LDCN	licensing document change notice
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LPCS	low pressure core spray
LPCI	low pressure coolant injection
MG	motor generator
MDC	minor design change
MOV	motor-operated valve
MWt	megawatts thermal
NCR	nonConformance report
NDE	Nondestructive Examination
NPSH	net positive suction head
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation

OER	operating experience review
P&ID	Process and instrumentation diagram
PER	problem evaluation request
PMR	plant modification record
PTL	Plant Tracking Log
RHR	residual heat removal
RPS	reactor protection system
RPV	reactor pressure vessel
RFTS	Request for Technical Services
SRV	safety relief valve
SRSS	square root of the sum of the squares
SSFI	safety system functional inspections
SSW	standby service water
SWEC	Stone & Webster Engineering Corporation
TEMA	Tubular Heat Exchanger Manufacturers Association
TER	technical evaluation request
TS	Technical Specification
UHS	ultimate heat sink
UPS	uninterruptable power supply

APPENDIX C

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