U.S. NUCLEAR REGULATORY COMMISSION

REGION I

Docket No:	50-311
License No:	DPR-75
Report No:	50-311/96-81
Licensee:	Public Service Electric & Gas Company
Facility:	Salem Nuclear Generating Station, Units 2
Location:	Hancocks Bridge, New Jersey 08038
Dates:	December 2-13, 1996
Inspectors:	J. Trapp, Team Leader, DRS S. Klein, Reactor Engineer, DRS G. Morris, Reactor Engineer, DRS L. Prividy, Sr. Reactor Engineer, DRS W. Sherbin, Contractor S. Stewart, Sr. Resident Inspector, DRP
Approved by:	James T. Wiggins, Director Division of Reactor Safety, Region I

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

Report Details

The objective of this inspection was to conduct an independent inspection to determine if the Salem Unit 2 component cooling (CC) system would perform its intended safety function. The scope of the inspection included verifying that the system had a technically sound design and licensing basis, system components were tested to demonstrate design requirements, and operating practices and procedures were consistent with the design. The team used the guidance provided in NRC Inspection Manual Chapter 93801, Safety System Functional Inspection (SSFI), to conduct this inspection activity.

The team noted that significant improvements were made to the CC system during the current outage. These improvements included the completion of a system flow balance, resolving instrument calibration errors, and the completion a significant number of corrective and preventive maintenance activities. The team found that the licensing basis CC description was, with a few exceptions, consistent with the actual CC system's design and operation. However, the team did identify two design issues regarding the CC pump room ventilation and the maximum acceptable flow limit for the CC pump, where operating practices were inconsistent with system design information. The resolution of these issues was ongoing at the conclusion of this inspection. The team concluded that contingent upon the satisfactory resolution of the SSFI findings and the licensee's already identified CC system restart issues, the Salem Unit 2 CC system would perform its intended safety function.

I. Operations

O3 Operations Procedures and Documentation

O3.1 Emergency Operations Procedures and Single Failures

a. Inspection Scope

The team reviewed the PSE&G contingencies for emergency operations to verify that plans and emergency operating procedures were consistent with the design bases for the CC system.

b. Findings and Observations

CC Pump Operability Requirements

The Salem Updated Final Safety Analysis Report (UFSAR), Section 9.2.2.3, states that "In the event of a loss-of-coolant accident (LOCA), one pump and one heat exchanger are capable of fulfilling system requirements." Salem Unit 2 Technical Specification 3.7.3 requires two independent CC loops to be operable in Modes 1, 2, 3, and 4.

In early 1995, PSE&G identified that certain emergency scenarios could place a single running CC pump in a runout (excessive flow) condition. Specifically, if a standby CC pump was out-of-service for any reason and a LOCA occurred coincident with a loss of offsite power and failure of a vital bus (which fails a second CC pump), two residual heat removal (RHR) heat exchangers would automatically be placed in service with only one operable component cooling pump. This alignment resulted in a single CC pump providing flow to two RHR heat exchangers. The licensee determined that this condition could be resolved by operating two CC pumps when two RHR heat exchangers were inservice. As an interim measure, in March 1995, PSE&G operations established an operating policy wherein if any one of the three CC pumps were not available, the technical specification action statement for an inoperable CC loop would be entered. The operating policy provided added assurance that two CC pumps would always be available.

The EOPs could have been revised to include contingencies for single CC pump operation; however, to reduce decisional steps and to allow for simplification of the EOPs for the LOCA, the initial availability of two CC pumps was assumed. Minimizing operator decision steps in the EOPs assured completion of the realignment of valves from the refueling water storage tank (RWST) injection phase to containment sump recirculation phase within an established time limit that assured adequate core cooling. Appropriate contingencies for loss of a vital bus and accompanying equipment were included in the EOPs.

<u>CC Pump Room Ventilation</u> (For additional information see Section E1.2)

The team reviewed the EOPs and the need for two operable CC pumps in the accident mitigation strategy. The EOPs were found consistent with the PSE&G operating policy. However, the team questioned PSE&G on the need for the CC pump room ventilation and whether the ventilation system controls were adequate to support three CC pump availability under normal and accident conditions.

The 21 CC pump room ventilation equipment (2VHE-33) and the 23 CC pump are provided power from electrical Train C. The 22/23 pump room ventilation equipment (2VHE-34) and the 22 CC pump are provided electrical power from Train B. The 22/23 CC pump room ventilation equipment (2VHE-34) is common for both the 22 and 23 CC pumps. Electrical Train A provided power to the 21 CC pump. A failure of Train C electrical power would prevent operation of the 21 CC pump ventilation equipment (2VHE-33) and the 23 CC pump. A failure of the 22/23 room ventilation equipment (2VHE-34) or electrical Train B would result in the failure of room cooling for both the 22 and 23 CC pumps. The failure of the room ventilation equipment may fail the associated CC pump. The team identified that, during certain accident scenarios and conditions, the EOPs require at least 2 operable CC pumps. If less than 2 CC pumps are operable, then the EOP instructions cannot be completed to ensure adequate CC will be available.

PSE&G reviewed the team's concerns and determined that plant operations prior to the decision to administratively require three CC pumps for technical specification operability could have resulted in operations outside of the plant's design bases. Specifically, for periods prior to 1995, when the 21 CC pump was out-of-service, the postulated single failure of the 22/23 CC pump room cooler could have resulted in a condition where no CC pumps would be available for accident mitigation. The postulated single failure of the 22/23 CC room cooler was a condition that had not been evaluated by PSE&G and was a condition that alone could have prevented the fulfillment of the safety function of the CC system. PSE&G made a notification of their determination to the NRC in accordance with 10 CFR 50.72(b)(2)(iii), on November 25, 1996.

The team was informed that PSE&G was considering a licensing bases change to revise the requirement for CC pump operability to capture the need to have three pumps operable during plant operations. Resolution of ventilation concerns would be required to support the change. PSE&G made resolution of the ventilation issue a Mode 6 (Refueling) prerequisite.

<u>CC Pump Runout</u> (For additional information see Section E1.1)

The team observed that, even if standby electrical power were available to the three CC pumps and to the room ventilation equipment, an EOP directed alignment allows one CC pump to be placed in an apparent runout condition for a short time during a postulated LOCA event coincident with a loss of offsite electric power. In the Salem EOPs, one CC pump is started in the initial steps following the reactor trip at the onset of the postulated event. During the change from the injection to the recirculation lineups, in Salem procedure EOP-LOCA-3, the CC valves from the two RHR heat exchangers are automatically opened prior to start of a second CC pump. The second pump was manually started following the valve alignment change. The entire change from injection lineup to the recirculation lineup is designed to be completed in less than 12.5 minutes following receipt of the RWST low level alarm at 15.2 feet. PSE&G operations had demonstrated that the second pump would be started in less than eight minutes from the onset of the runout condition. PSE&G personnel stated that single pump operations for a short period of time had been evaluated; however, the team questioned the flow rate limit that had been used in the evaluation.

The team was concerned that a single CC pump operating with both RHR heat exchangers in service would result in CC pump flows in excess of that previously evaluated and could result in pump damage. The team was also concerned that the overall electric loading of the emergency diesel generator supplying power to the CC pump, when in the runout alignment, may be higher than previously evaluated. In response to these issues, PSE&G initiated an action request (AR) and initiated both an engineering review of the issue and a root cause evaluation.

c. Conclusions

PSE&G had identified that emergency operations for some postulated events could result in operation beyond the design of the CC pumps. As an interim measure, in 1995, PSE&G operations initiated a policy to ensure that at least two CC pumps were operable during plant operation. The policy to ensure that at least 2 CC pumps would always be available failed to appropriately account for a single failure of CC pump room ventilation. The failure of the 22/23 CC pump room cooler, when the 21 CC pump was out of service, could have resulted in no available CC pumps during some postulated accident conditions. The failure to have considered this design deficiency remains unresolved pending NRC review of this issue for potential enforcement action **(URI 50-311/96-81-01)**.

The team identified that the operating policy of having three operable CC pumps failed to properly consider the affect of a loss of CC pump room ventilation on pump operability. The failure of the EOPs to account for a single failure of CC pump room ventilation is an NRC unresolved item pending the completion of the licensee's corrective actions and the review of this issue by the NRC for potential enforcement action **(URI 50-311/96-81-02)**.

The team identified that the EOPs allowed a CC pump to operate at flow rates beyond its documented design limits for a short period of time. The failure to provide a technically sound basis for operating a CC pump in this manner remains unresolved pending the completion of the licensee's corrective action and the review of this issue by the NRC for potential enforcement action **(URI 50-311/96-81-03)**.

O3.2 Operating and Abnormal Procedures

a. Inspection Scope

The team reviewed the CC system operating and abnormal procedures to verify the procedures instructions properly reflected the system design.

b. Observations and Findings

The team found that current revisions of operating procedures were in place to support CC system operations. The procedures had been recently revised and included enhancements such as basis sections for each procedure to describe commitments and reasons for various steps, and detailed sections for contingency actions when abnormal procedures were used.

The team identified a procedure discrepancy concerning when to trip reactor coolant pumps (RCPs) on loss of all component cooling. The discrepancy involved whether to immediately trip all RCPs on loss of CC, as stated in the CC abnormal procedure, or to allow five minutes for CC restoration as specified in the RCP abnormal procedure. PSE&G personnel stated that 10 minutes of RCP operations without CC was allowed by the technical manual for the pumps, however a previous commitment to the NRC stated that the pumps would be conservatively tripped immediately on total component cooling water loss. PSE&G prepared an action request to resolve the discrepancy.

c. <u>Conclusions</u>

Operating procedures related to normal and abnormal operations of the component cooling water system had been recently upgraded by PSE&G, and the team considered the improvements to be a good initiative. The team concluded that the CC procedures were generally of good quality and appropriately reflected the CC system design and licensing basis. However a discrepancy was identified on when to trip reactor coolant pumps on total loss of CC.

O5 Operator Training and Qualification

O5.1 <u>Training Material and Simulator Fidelity</u>

a. <u>Inspection Scope</u>

The team reviewed operator training for the component cooling system to verify that appropriate design information was provided to the operators. The review included an assessment of the technical completeness and accuracy of appropriate training materials and examination tools. The fidelity of the plant simulator regarding the CC system was also reviewed.

b. <u>Findings and Observations</u>

PSE&G performed a crew readiness assessment in January 1996 to evaluate the preparedness of the reactor operators for resumption of plant operations. The examination was conducted in three parts, a written examination, simulator scenarios, and a plant walkthrough evaluation. After a detailed evaluation of the examination results, PSE&G concluded that no specific weaknesses existed in operator knowledge regarding CC system operations and design. Therefore, no CC specific training was required before restart.

A CC lesson plan had been prepared and was awaiting final supervisory review and approval. The team reviewed the training plan and found that design information had been appropriately included. At the time of this inspection, the lesson plan had not been used. The requalification examination bank for written evaluation and job performance measures was reviewed by the team, and CC design and operations information was appropriately included.

The team reviewed simulator fidelity for full power CC operations, abnormal operations, and response to the loss of offsite power and loss of coolant combined with loss of offsite power events. In each case, the simulator appropriately modeled CC system performance and provided effective training for these events. The team was informed that extensive training on recently revised EOPs had been conducted and had included CC operations. Simulation of remote shutdown panel operations was not provided, and training on these operations was done by in-plant discussions and walkthroughs.

The team found that the operating, abnormal, and emergency operating procedures in use at the training facility were current and of high quality. Instructors were knowledgeable of CC specific operations and training provided to evaluate the operations.

c. Conclusions

The team found that PSE&G had translated appropriate CC design information into materials used for training and evaluating licensed operators. The simulator provided an effective tool for training and evaluating CC operations during normal and accident conditions. The procedures and lesson plans used for CC training were of high quality and appropriately complete for evaluation of operator knowledge and abilities on the CC system.

II. Maintenance

M1 Conduct of Maintenance

M1.1 System Flow Balance Test

a. Inspection Scope

The team reviewed a special flow balance test that was conducted to verify that the CC system would perform consistent with assumptions in the accident analysis. The test procedure was reviewed to verify that proper acceptance criteria were established for assuring adequate CC flow to safety-related equipment during postulated accident conditions.

b. Observations and Findings

On July 18, 1996, PSE&G initiated performance improvement request (PIR) 960709221 to identify and resolve a concern regarding whether the required component cooling flow through the residual heat removal heat exchanger (RHRHX) during a LOCA alignment would be obtained. PSE&G concluded that the best alternative to resolve the concern was to perform a special test in accordance with Procedure No. TS2.SE-SU.CC-0001(Q), CC System Flow Balance. In a 10 CFR 50.59 evaluation of this procedure, which was conducted in October 1996, PSE&G described the limiting LOCA alignment for the CC system as follows: one CC pump, one CC heat exchanger, one RHR heat exchanger, all the emergency core cooling system pumps, and the non-isolated, non-safety loads. The non-isolated, non-safety loads for Unit 2 include: the positive displacement charging pump, the seal water heat exchanger, the waste gas compressors, and radiation monitor system (RMS) heat exchangers.

The two main purposes of the flow balance test were:

- To ensure that the CC system safety-related components would receive design flow in the limiting LOCA alignment with one train of the CC system available.

- To benchmark a CC system hydraulic flow model that had been developed by a contractor and was being reviewed by PSE&G.

The CC system manager and the cognizant mechanical design engineer presented the results of the flow balance test to the Salem Unit 2 test review board during a November 21, 1996 meeting which was observed by the team. PSE&G identified the major test deficiencies as follows:

- The 21 and 22 RHR control room CC flow indicators read approximately 1000 gpm higher than the temporarily installed ultrasonic flow measuring instruments.

- The CC flows for the 21 and 22 centrifugal charging pumps mechanical seal heat exchangers were 9.5 and 10.8 gpm respectively compared to the required test acceptance value of 11.5 gpm. The team also noted that UFSAR Table 9.2-3 specified the CC flow to these components as 14 gpm (max). The cognizant mechanical design engineer indicated that the pump manufacturer had confirmed the minimum CC flow requirement to be 6 gpm. On this basis the test results were considered acceptable. PSE&G stated that UFSAR Table 9.2-3 and applicable plant procedures would be updated accordingly.

- During the latter portion of the flow balance test, lower than required flow readings were observed using the local flow indicator (2FIC643A) for the 21 safety injection (SI) pump seal water heat exchanger. PSE&G attributed the problem to a malfunction of 2FIC643A since initial flow readings from this instrument for a comparable system alignment resulted in flows greater than the required flow of 11.5 gpm. Work order (WO) 961031116 was issued to troubleshoot and repair 2FIC643A.

- During the initial flow balance of the system in accordance with Section 5.1 of Procedure No. TS2.SE-SU.CC-0001(Q), the CC flow to the 24 reactor coolant pump thermal barrier as read on local flow indicator (2FI620) was 38 gpm versus the required flow of 40-42 gpm. The cognizant design engineer stated that 38 gpm was acceptable with the pump manufacturer.

During discussions between the team and the cognizant mechanical design engineer, it was apparent that allowances for instrument error and CC pump degradation had been considered to establish reasonable acceptance criteria for the flow balance test. For example, the required CC flow to support operability of the 21 SI pump was 10 gpm (UFSAR Table 9.2-3). The cognizant mechanical design engineer indicated that 5% of full instrument range (±1 gpm) was required to account for instrument error and a 3-4% flow allowance was needed to account for a 10% degradation in pump head. Therefore, the acceptance criteria for the 21 SI pump CC flow was established as 11.5 gpm in the flow balance test procedure. PSE&G had discussed this general approach for establishing CC flow acceptance criteria in Action Request 961003083 which was issued to resolve the minimum required CC flow to the 21 and 22 centrifugal charging pumps mechanical seal heat exchangers. However, there were no documented calculations to support the CC flow acceptance criteria used in the flow balance test procedure. Pending PSE&G's completion and documentation of the calculations supporting the test acceptance criteria and review by the NRC for potential enforcement action, this issue is unresolved **(URI 50-311/96-81-04).**

The team also noted that documented calculations had not been completed for the required CC flow values to be incorporated into CC system procedures, such as the CC pump surveillance test procedures, S2.OP-ST.CC-0001(Q), -0002(Q), and -0003(Q). The team noted that an allowance for repeatability between surveillance tests should be considered in establishing the acceptance criteria. This consideration was illustrated by the following anomaly which could not be explained by the CC system manager or the cognizant mechanical design engineer. CC flow provided to the 21 RHR pump seals met the test acceptance criteria during the performance of the flow balance test (11.5-13.0 gpm measured in October 1996 with 21 CC pump) while the flow recorded during a later troubleshooting procedure did not (10.5 gpm measured in December 1996 with 23 CC pump). The team noted that this anomaly was exacerbated by the fact that the 23 CC pump was the strongest (i.e., highest developed head for a given flow) of the 3 CC pumps. Therefore, the 23 CC pump should have provided more flow than the 21 CC pump for the comparable CC system alignment.

c. <u>Conclusions</u>

It was apparent that PSE&G had attempted to include reasonable acceptance criteria into the flow balance test. However, final conclusions regarding the results of the flow balance test could not be made pending completion of the calculations required to properly document the CC flow acceptance criteria specified in Procedure No. TS2.SE-SU.CC-0001(Q).

M1.2 Pump and Valve Testing

a. Inspection Scope

Testing was reviewed to verify adequate pump and valve performance to support system operability. The review included PSE&G's implementation of the inservice test (IST) program and corrective actions taken to resolve deficiencies found during IST program Audit 95-012S.

b. Observations and Findings

Pumps

The team reviewed PSE&G's actions regarding periodic testing of CC pumps. Based on a review of test records, the team noted that PSE&G was adequately testing the CC pumps in accordance with the Salem IST program requirements. The team also noted that PSE&G had made a number of changes to improve pump testing in response to the findings of Audit 95-012S. For example, AR 9507221196 had been issued to resolve a significant pump testing problem. The CC pump test procedure had been written such that flow was not closely controlled which resulted in questionable repeatability of test results for trending pump performance. The team verified that the CC pump test procedures were corrected to ensure adequate test repeatability.

Notwithstanding the changes made to improve the pump testing at Salem, the team noted that several substantial CC pump testing activities, which the licensee had identified as needing to be addressed, were not done at the time of this inspection. The first activity involved elevated vibration readings for the three CC pumps which have recently been observed. PSE&G has issued a troubleshooting procedure per WO 960928055 to evaluate this problem. Also, after the documented pump acceptance criteria has been developed based on the flow balance test, the pump test procedures would need to be revised and pump baseline testing needed to be reperformed.

Relief Valves

The team reviewed PSE&G's program for testing relief valves in the CC system. The review included PSE&G's preliminary response to Generic Letter (GL) 96-06, Item 3, regarding potential overpressurization of piping caused by thermal expansion of trapped fluid between closed valves.

In the Salem IST program basis data sheets, PSE&G documented the basis for all CC relief valves concerning their inclusion or exclusion from the American Society of Mechanical Engineers (ASME) Section XI IST program. The team had the following comments upon reviewing these data sheets:

- PSE&G concluded that the CC excess letdown heat exchanger outlet relief valve (2CC112) did not provide a safety function. PSE&G considered that this thermal relief valve was not required to be in the scope of the IST program because inadvertent opening of this relief valve combined with subsequent failure to reclose would not prevent the excess letdown heat exchanger from performing its function. However, the team determined that 2CC112 does perform a safety function since it is relied upon to provide thermal relief protection for CC piping between containment isolation valves 2CC113 and 2CC115. Hence the relief valve should be periodically tested to provide ongoing assurance regarding its operational readiness. The team noted that the piping between 2CC113 and 2CC115 was identified by PSE&G in their preliminary response to GL 96-06 as requiring relief protection. PSE&G indicated that, even though relief valve 2CC112 was not currently in the IST program, it had been tested satisfactorily on September 27, 1996. PSE&G stated that 2CC112 would be included in a periodic surveillance test program.

- PSE&G had appropriately included in the IST program the relief valves (21, 22, 23, and 24CC129) which protect the CC piping associated with thermal barrier cooling for the reactor coolant pumps, and the vacuum breaker (2CC148) and relief valve (2CC147) for the CC surge tank. The team also verified satisfactory testing of these valves.

Manual Valves

The Salem EOPs included steps to isolate both the boric acid evaporator and the spent fuel pool heat exchangers from component cooling following certain postulated accidents. These steps were intended to prevent runout of the single CC pump started at the onset of the event. The team indicated that the manual isolation valves specified by the EOPs were not included in the inservice testing program and, therefore, could not be credited as operational. The team considered that operation of the valves could not be assured if periodic testing and monitoring was not accomplished. Further, for some interim period prior to shutting the valves but after a CC pump was started, the pump could be in a runout condition. PSE&G responded to the concern by demonstrating that in some scenarios, runout of the operating CC pump would result in the CC low header pressure alarm which could cause the reactor operator to isolate the non-safeguards CC header using valves CC-30 and CC-31, which were included in the IST program. This action could not be expected to be accomplished until some time after the CC pump had been operating in a runout condition. PSE&G had not evaluated this condition.

The team observed that no CC system manual valves were included in the scope of the Salem IST program. However, as stated above, the Salem EOPs included specific operating instructions regarding manual valves to isolate both the boric acid evaporator and the spent fuel pool heat exchangers from component cooling. PSE&G issued AR 961202179 to address the apparent inconsistency between the EOPs and the IST program regarding manual valves. PSE&G committed to resolve this inconsistency by establishing a periodic surveillance test for the applicable manual valves.

Power Operated Valves

The team reviewed testing of several power operated valves in the Salem IST program including MOVs and the CC surge tank vent which is a solenoid, air operated globe valve. The team also reviewed testing of the service water system solenoid air operated valves (21 and 22SW129) that supply cooling water to the CC pump room coolers. PSE&G had appropriately included power operated valves for the CC system in the IST program.

Valves 21 and 22SW129 were being adequately stroke time tested in accordance with Procedure S2.OP-ST.SW.0014(Q), Rev.3, Inservice Testing, Room Cooler Valves. In reviewing the testing of MOVs, the team noted that PSE&G recently reviewed the thrust limits for the RHR heat exchanger outlet valves (21 and 22CC16) to be consistent with their response to GL 95-07, Pressure Locking and Thermal Binding of Gate Valves. The team verified that the maximum thrust limits for these MOVs would be limited to minimize valve closure thrusts and thus prevent thermal binding upon opening. Maximum closure thrust values (28,611 lbs for 21CC16 and 26,566 lbs for 22CC16) not to be exceeded during testing were established in the Managed Maintenance Information System. Diagnostic test procedures required adherence to these limits while testing these MOVs.

Check Valves

The team reviewed the acceptance criteria that was included in Procedure S2.OP-ST.CC-0001(Q), 21 CC Pump Inservice Testing, for determining the acceptability of the backflow check function of the CC pump discharge check valve 21CC1. The procedure requires 2 of 3 of the following indications for an acceptable test: (1) an audible "clapping shut" when stopping the 21 CC pump; (2) decreased pressure observed at the pump discharge pressure gage; and (3) no reverse flow observed at the 21 CC pump. The team considered these criteria to be appropriate and noted no test failures for the CC pump check valves.

c. Conclusions

Although the licensee had identified that several substantial pump testing activities remained to be completed, the team concluded that PSE&G was adequately implementing pump and valve testing for CC as required by the IST program. The team identified instances where controls were not in place for periodically testing certain manual valves used in the EOP valves. PSE&G agreed to include these valves in a periodic surveillance test program.

M1.3 Maintenance and Testing of Heat Exchangers

a. Inspection Scope

The team reviewed CC heat exchanger maintenance and testing actions being taken regarding GL 89-13, Service Water System Problems Affecting Safety-Related Equipment, as described in PSE&G correspondence NLR-N90021, dated January 26, 1990, which was later revised in NLR-N90165, dated August 31, 1990.

PSE&G uses thermal performance testing to confirm that the component cooling heat exchangers (CCHX) can transfer required heat loads to the ultimate heat sink during a postulated accident. The results of this testing are used as input to a computerized model of the CCHX to confirm that the heat exchanger manufacturer's design data sheet performance can be achieved. The team sampled the results of CCHX thermal performance testing and the related computer model input and output.

b. Observations and Findings

CC Heat Exchangers

The CC heat exchangers are performance tested periodically in accordance with Procedures S2.OP-PT.SW-0026(Q) and -0027(Q), Revision 5, 21 and 22 Component Cooling Heat Exchanger Heat Transfer Performance Data Collection. Testing is performed while shutdown in Mode 4 with the last test having been performed in October 1994 for both CCHX. The Component Performance group is responsible for reviewing the test data, calculating the heat transfer capability of the heat exchanger, and providing the results to the system manager for review and approval.

The team reviewed the heat exchanger thermal performance test results obtained in October 1994. PSE&G calculated fouling factors based on test data to predict heat removal at design conditions. The predicted heat removal was multiplied by 0.95 to account for uncertainty (i.e., a 5% instrument measurement uncertainty value was assumed) and then compared to the heat removal requirements specified under service conditions in the heat exchanger vendor data sheet.

Based on the review of the thermal performance test results, PSE&G concluded that the CC heat exchangers would remove the required heat load under accident conditions. However, the team questioned the technical basis for the 5% assumption used to account for instrument measurement uncertainty. PSE&G stated that the 5% measurement uncertainty value was based on "equivalent" instrumentation, which was not identical to that used for the test. Hence, there was no specific documented technical basis for the assumed measurement uncertainty. The team determined that if the measurement uncertainty was greater than about 11%, the heat exchangers may not meet their required thermal performance under accident conditions.

Also, in light of clogged tubes reported from recent heat exchanger inspections, the team questioned how PSE&G calculated essentially clean heat exchangers with zero fouling factors on both tube and shell sides from the 1994 thermal performance testing results. For example, a review of the inspection and cleaning in March 1996 of the 21 CC heat exchanger performed under WO 960608023 indicated that "10% of the inlet tubes and 75% of the return tubes were clogged." Assuming similar heat exchanger condition during the 1994 performance test, it is not clear how the thermal performance tests for heat exchangers in service, prior to cleaning, would have zero fouling factors, when tube clogging was actually observed.

CCHX Thermal Performance Computer Model

The team found cases where computer model predicted near zero or negative fouling for the CC heat exchanger. For these cases, the heat exchanger performance calculated by the model was better than that predicted by the manufacturer's data sheet for a clean heat exchanger.

The team questioned the potential for non-conservative prediction of heat exchanger performance by the model. A non-conservative heat exchanger performance model would indicate less tube fouling than may actually be present in the heat exchanger. Therefore, an unacceptably fouled heat exchanger, that would be unable to perform its design function, may not be detected by conducting the performance test. In response to the team's questions, the licensee stated that the computer program was established to provide the most realistic assessment of cooler cleanliness and intentionally removes inherent conservatism in the theoretical calculations used in the model.

The licensee also ran an additional case using the model in which the manufacturer's design data sheet performance factors (temperatures, flows, and fouling) were input. Results showed that the model predicted approximately 12% better performance (overall heat transfer coefficient, U) than the data sheet performance. Although the model only predicts a 5% better heat load capability, the 12% over prediction in "U" is significant because this is the value used by Westinghouse in their accident analyses.

In response to the team's questions, the licensee contacted the manufacturer to obtain further information on whether the model's performance predictions were consistent with and applicable to the Salem Unit 2 CCHX.

CC Pump and Heat Exchanger Room Coolers

In a revised response to GL 89-13, dated August 31, 1990, PSE&G committed to periodically inspect and clean the two CC pump room coolers. PSE&G viewed this revised commitment as an acceptable alternative to the thermal performance testing option of GL 89-13. As a result of this revised commitment, PSE&G no longer committed to "trending important system parameters".

Based on a review of preventive maintenance WO 960528046 for inspection and cleaning of the 22 CC pump room cooler performed in April 1996, the team was concerned that the present method of inspecting and cleaning the room coolers may not demonstrate adequate thermal performance of the CC room coolers. The cooler inspection was performed in accordance with Procedure SC.MD.PM.SW-0006(Q), Revision 4, Service Water Room Coolers Internal Inspection. The specific concerns were:

- Comments in WO 960528046 indicated that silt, waterbox debris, and failed lining were present in the heat exchanger waterbox. However, acceptance criteria were not included for determining the as-found acceptability of the cooler regarding fouling factors and service water flow rates. This was inconsistent with PSE&G's response to GL 89-13 which stated in part that "Procedures will include acceptance criteria and recommended actions for acceptable results." Also, no technical justification for the inspection frequency of the room coolers existed.

- PSE&G did not periodically verify adequate service water or air flow through the room coolers. This concerned the team since silting was known to exist in service water lines and room cooler waterboxes and the manual damper (2-VHE-747) supplying air to the 22 CC pump room was found closed during a plant walkdown.

c. Conclusions

The team concluded that the computerized model used to predict CCHX performance, based on test data, may not be conservative. PSE&G is in contact with the heat exchanger manufacturer to resolve this issue. The team concluded that the lack of a specific documented technical basis for the 5% instrument measurement uncertainty assumption used in CC heat exchanger performance calculations was an unresolved item pending further evaluation of this issue by PSE&G and review by the NRC for potential enforcement action **(URI 50-311/96-81-05)**. The lack of acceptance criteria for assessing the as-found condition of the room coolers and for establishing adequate service water and air flow rates in CC room cooler maintenance procedures was considered to be an unresolved item pending PSE&G's evaluation and review by the NRC for potential enforcement action **(URI 50-311/96-81-06)**.

M1.4 Testing of Instrumentation and Controls (I&C)

a. Inspection Scope

The team witnessed testing that was performed to resolve a discrepancy with residual heat removal (RHR) heat exchanger CC flow measurement found during the system flow balance test.

b. Observations and Findings

CC RHR Heat Exchanger Outlet Flow Indication (2FI-601A and B) and Flow Element (2FE-601A and B)

CC flow is measured through each RHR heat exchanger by a transmitter which senses the differential pressure (DP) between the inner and outer radius taps that are located on a 12-inch, 90° elbow installed in the CC piping. The flow element was original plant equipment specified by Westinghouse to develop a DP of 137 inches of water which would correspond to a full scale flow of 10,000 gpm on the Control Room console indicators (2FI-601A and B). During the performance of the flow balance test, a discrepancy of CC flow to the RHR heat exchangers was observed. The Control Room console indicators read about 1000 gpm higher than temporarily installed ultrasonic flow meters (USFMs) which were used during the test to more accurately measure flow through both RHR heat exchangers. PSE&G reported this discrepancy to the NRC on November 29, 1996, in Licensee Event Report 96-028.

PSE&G performed a troubleshooting procedure authorized by WO961112091 to accomplish an insitu calibration of the elbow flow meters for the 21 and 22 trains. This procedure confirmed the problem was associated with the lack of initial field calibration of the elbow flow meters. The team witnessed portions of the troubleshooting procedure and verified the following:

- The test equipment for flow (Panametrics Transport PT868 Flowmeter) and DP had been calibrated to known standards prior to the test.
- Each transducer with mounting hardware was installed in accordance with the USFM vendor instruction manual and located at optimum locations (i.e., in straight run of pipe with more than 10 pipe diameters upstream and 5 pipe diameters downstream).

The team confirmed with the cognizant I&C engineer that Calculation No. SC-CC002-01, Revision 1, 1/2 Component Cooling RHR Outlet Flow Indication and Alarms, was the calculation of record and would be revised to include the correct design inputs for incorporation into the channel calibration procedures for CC flow through each RHR heat exchanger.

c. Conclusions

The team concluded that appropriate measures had been taken to control the collection of test data for the insitu calibration of the elbow flow meters. PSE&G was taking appropriate actions to correct the elbow flow meter design inputs and revise the CC RHR heat exchanger outlet flow indication and alarm channel calibration procedures.

M2 Maintenance and Material Condition of Facilities and Equipment

M2.1 CC Radiation Monitors

a. Inspection Scope

The team reviewed design and operations for containing radioactive contamination that could enter the CC system.

b. Observations and Findings

The Salem UFSAR, Section 9.2.2.3, states, "Since heat is transferred from the component cooling water to the service water, the component cooling system serves as an intermediate system between the reactor coolant and the service water systems and insures that any leakage of radioactive fluid from the components being cooled is contained within the plant." Further, in Section 11.4.2.2, the UFSAR states that "Component cooling liquid monitors (2R-17A,B), continuously monitor the component cooling water for radiation."

During system walkdowns, the team was informed by PSE&G that the CC radiation monitors had been out-of-service since some time in 1995 due to problems with the radiation monitoring computer. The CC radiation monitors are non safety-related and are not used to determine offsite radioactive releases. PSE&G returned the monitors to service on December 9, 1996. During the period that the monitors were out-of-service, the reactor had been defueled leaving the spent fuel pool heat exchanger as the only active CC load. No significant leakage of component cooling either into or out of the system had been suggested by surge tank level changes. Routine, weekly samples of component cooling water had been completed and had included evaluation of gross activity. During two periods when component cooling pumps were secured for maintenance, low levels of activity were detected in the CC system. The likely source of the leakage was the spent fuel pool heat exchanger. PSE&G informed the team that inspection of the heat exchanger did not identify leaking tubes and no activity was detected when the CC pumps were running. Also, no leakage of chromates into the spent fuel pool had been detected by chemistry sampling of the pool.

c. Conclusions

The team identified a discrepancy between the UFSAR requirement for CC radiation monitors to continuously monitor CC for radiation and station practice wherein the monitors had been out of service for over one year. The team was concerned that the licensee appeared to not repair these radiation monitors in a timely manner given the length of time the monitors were out-of-service and the function they provide (i.e. prompt identification of leakage into the system from radioactive systems served). These radiation monitor issues are unresolved pending further NRC review for potential enforcement action **(URI 50-311/96-81-07)**.

M2.2 Root Cause Evaluations and Corrective Actions for System Failures

a. Inspection Scope

The team reviewed corrective actions and root cause evaluations for CC equipment problems that had been identified by PSE&G.

b. Observations and Findings

The team reviewed 1994, 1995, and 1996 corrective maintenance work orders (WO) concerning pumps, various check valves, and several power operated valves in the CC system. Based on this review, the team observed the following:

- Increasing vibration levels had been noted for the CC pumps during inservice testing. PSE&G was taking appropriate actions to address this problem even though the vibration levels had not reached the alert level. WO 960928055 had been recently issued to perform a troubleshooting procedure for gathering and analyzing pump vibration levels while operating different pumps in parallel.

- Several check valves (2CC186 and 2CC119) had frequent local leak rate test failures. However, PSE&G took appropriate action to correct these failures. These valves were included in a comprehensive root cause analysis report issued by the check valve performance group in April 1996 in response to repeated failures of containment isolation valves identified in CR 960319147. Also, the CC pump discharge check valves had performed well with no corrective maintenance required during the last 3 years.

- WO 950924133 had been issued to correct a bent spring rod pipe support (2P-CCH-332) near the excess letdown heat exchanger containment isolation valve. The team verified that the cause of this problem was adequately assessed and not attributed to any hydraulic disturbance such as water hammer. PSE&G had determined the cause of the damaged support to be from an associated maintenance activity where the rod was bumped by a heavy load.

- High valve factors were determined for MOV 2CC117 during initial testing that was performed in response to GL 89-10. PSE&G attributed the problem to carbon steel wedge shoes without hard facing on the valve internal wear surfaces causing high frictional forces. PSE&G implemented design change 2EO-2340 to provide replacement wedge shoes with hard facing that improved the valve performance.

c. Conclusions

The team concluded that PSE&G was taking good corrective actions to identified CC equipment problems.

M3 Maintenance Procedures and Documentation

M3.1 Ventilation System Testing and Documentation

a. Inspection Scope

The team reviewed testing and documentation aspects of the ventilation system to determine its capability and readiness in supporting the operability of the CC system.

b. Observations and Findings

Separate room coolers are located in the motor driven auxiliary feedwater pump area for providing cooling for each of the two CC pump rooms. Air is cooled by a fan coil unit and independently ducted to each CC pump room. Return air from the pump rooms passes through a louvered fire damper mounted in the fire door of each CC pump room. The return air discharges through this louver to a hallway on the 84 foot elevation of the Auxiliary Building. When in standby, the room coolers are started on high temperature by individual room thermostats.

The team observed the following design and configuration deficiencies during plant walkdowns:

- The louvered fire damper in the fire door (Door C8-2) for 21 CC pump room was closed. The team noted that an analysis had not been performed regarding the impact on return air flow and room temperature with this louver closed. PSE&G also informed the team that two design information items concerning the room coolers were not available: (1) PSE&G could not determine design information concerning the louvered fire damper, such as free area with the louver open; and (2) no air flow calculation existed for the room cooler to determine if the louver in the fire door was adequately sized to pass design air flow. The team concluded that the closed louvered fire damper may have prevented the CC room coolers from performing their design basis function.

- In addition to the closed fire damper, the manual damper designated 2-VHE-747 located in the supply air duct of the room cooler designated 2VHE33 was closed. Also, manual damper designated 2-VHE-749 located in the supply air duct of room cooler designated 2VHE34 was closed. The team noted that these dampers and associated duct were shown on auxiliary building ventilation drawing 205337-A-8763-20 as supplying 600 cfm of air to the 22 CC pump room and 1350 cfm of air to the auxiliary feed pump area, respectively.

- PSE&G could not account for the position of the dampers described above. Therefore, the team questioned if PSE&G had administrative controls regarding ventilation damper positions to support equipment operability in safety-related systems. PSE&G indicated that there were no existing controls. AR 961121204 was issued for the Operations Manager to determine what controls should be implemented for ventilation system equipment to assure that the plant is operated consistent with design assumptions.

c. Conclusions

The team concluded that these deficiencies demonstrated inadequate configuration control of ventilation equipment needed to support CC system operability. This issue remains unresolved pending further NRC review for potential enforcement **(URI 50-311/96-81-08).**

M3.2 Test Procedure Acceptance Criteria

a. Inspection Scope

The team reviewed the maintenance and surveillance test procedures and results of selected electrical equipment required to support the CC system. The 125 Volt batteries are required to support control of the CC system pumps, the on-site power supply and power the pilot solenoid valves. The emergency diesel generators (EDGs) supply power for the CC system pumps and motor operated valves.

b. Observations and Findings

1. Salem UFSAR, Section 8.3.2.1 states that three 125 Volt batteries are provided for the control power for the vital buses and power for the 125 Volt dc distribution cabinets. Technical Specification 4.8.2.3.2g describes the requirements for a battery capacity discharge test to demonstrate at least 80% of the manufacturer's rating every 60 months. Technical Specification 4.8.2.3.2h further states that the test frequency shall be increased to 12 months if the battery shows signs of degradation including a drop of more than 10% capacity from the previous test.

Salem Nuclear Generating Station implements the requirements of these technical specifications by Procedure SC.MD-FT.125-0002(Q), Rev. 4, dated November 15, 1995, 125 Volt station Batteries Performance Discharge Test.

The team reviewed the latest battery capacity test data for the safety-related 125 Volt batteries. The team noted that procedure SC.MD-FT.125.0001(Q), Rev. 0, dated November 5, 1992, 125 Volt Station Batteries Performance Discharge Test, was the controlling procedure at the time of those tests. The team confirmed both procedures referenced Institute of Electrical and Electronics Engineers (IEEE) Standard 450-1987, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries. Attachment 11 to procedure SC.MD-FT.125.0001(Q), required that the capacity of the battery be calculated at the completion of the test in accordance with procedure steps 5.4.37 or 5.5.18. The team noted that the required calculation of battery capacity was defined in the body of the procedure (steps 5.4.37 and 5.5.18) as the ratio of the time to reach low battery voltage to two hours (the time used to establish the discharge rate.) The team confirmed this method of calculating battery capacity was in agreement with the method contained in IEEE-450-1987, Section 6.5, Determining Battery Capacity. The team found that the tests for batteries 2A and 2B (performed in May 1993 and April 1993 respectively) were stopped at two hours instead of proceeding to the low battery voltage point as implied by procedure steps 5.4.37 and 5.5.18. The licensee indicated the tests were stopped at two hours because that duration was required by other steps in the test procedure (5.4.33 and 5.5.17.) The team noted that since the test was not properly completed, no calculation could be performed in accordance with procedure steps 5.4.37 or 5.5.18. However, the data sheets indicated the batteries had 100% capacity.

The team confirmed the batteries had at least 100% capacity as stated by reviewing the recorded test data. However, the team was concerned that there was no documented true battery capacity established in the 1993 tests, there was no value to compare with the next battery capacity test for degradation.

In response, the licensee had the battery manufacturer estimate the probable capacity from the 1993 test data. The results showed the battery capacities were 115% for battery 2A and 112.5% for battery 2B.

The team noted the latest revision to the battery test procedure (SC.MD-FT.125.0002(Q), Rev. 4, dated November 15, 1995), was changed, in part, to incorporate a change to the Technical Specification Surveillance Requirement 4.8.2.3.2 (approved by the NRC on September 19, 1995.) Part of the Technical Specification change incorporated a requirement to increase the frequency of the battery performance tests from 60 months to 12 months if degradation in battery capacity of more than 10% was found from the previous test. The team found that the revised procedure failed to incorporate an acceptance criteria for battery degradation. The team also found that the discussion in the body of the procedure on degradation in the form of notes (Procedure pages 21 and 48) indicated a frequency change to every 18 months was appropriate for a greater than 10% capacity drop from the previous test.

In response to these concerns, the licensee issued AR 961206169 to review this item and revise the procedure.

2. The team reviewed the battery charger maintenance procedure S2.MD-ST.125-0001(Q), Rev. 0, dated July 27, 1996, 125 Volt Battery Chargers. The 125 Volt battery chargers had been replaced under change 2EC-3332/1 because of maintenance problems with the original chargers. The original chargers were rated for 250 Amps and the new chargers were rated for 300 Amps. Because of ampacity concerns of the ac power input cables, both the original and the new chargers required the current limit to be set at a maximum of 210 Amps. The team found that the current battery charger current limit as-found test contained a caution and required the electrician to adjust the controls to ensure the current drawn by the charger would not exceed 210 Amps. This instruction would inhibit recording the true as-found current limit if it had drifted above 210 Amps because the test would not permit loading the battery charger above 210 Amps. In response to the team's observation, the licensee initiated an AR to review this item.

3. The team reviewed the Diesel Generator Speed/Load Control System Alignment procedure, SC.MD-CM.DG-0006 (Q), Rev. 8, dated June 12, 1996, to determine the setpoint for the EDG governor motor operated potentiometer (MOP) allowable frequency range. This setpoint was critical because the EDG loading calculation (ES-9.0002) is based on the EDG frequency not increasing above 60.5 Hertz. This restriction was further emphasized in a recent request to change the Technical Specification 4.8.1.1.2 from 61.2 to 60.5 Hertz max. License Change Request S95-36 was sent to the NRC on November 25, 1996. However this was a re-write of license change request (LCR) 94-40 which was initiated in response to Incident Report 94-301, dated October 13, 1994, which first documented the potential for EDG overloading because EDG frequency in excess of 60.5 Hertz conditions. The team found that even though the new procedure had an acceptable as-left criteria of 59.80-60.20, there were no acceptance criteria for the as-found condition (procedure step 5.5.1.) The team observed that the as found condition of EDG 2C was recorded at 60.22 Hz. when tested on May 11, 1996, following the installation of a new MOP. The setting was returned to 60.03 Hz. The team confirmed the settings for EDGs 2A and 2B were found and left within the allowable as-left tolerance during their last preventive maintenance.

The licensee indicated that an AR would be initiated to revise that section of the procedure addressing as-found frequency of installed MOPs.

c. Conclusions

The team concluded that the failure to incorporate the latest technical specification surveillance criteria in the battery surveillance performance test procedure was a procedure weakness. The licensee stated that the procedure would be revised to properly reflect the technical specification requirement.

The team concluded that the licensee had failed to follow their battery performance test procedure for calculating the capacity of batteries 2A and 2B in 1993 because of an inadequate test procedure.

The team also concluded that the errors found in the battery charger test procedure and the EDG speed control alignment procedures had minor safety significance. The licensee has initiated actions to correct these procedure deficiencies.

The above issues are unresolved pending the completion of the licensee's corrective action and the NRC review of this issue for potential enforcement action **(URI 50-311/96-81-09)**.

III Engineering

E1 Conduct of Engineering

E1.1 Component Cooling Pump Runout and NPSH

a. Inspection Scope

The team reviewed several design calculations, engineering evaluations, and other design documents to assess the design basis and supporting analysis for the CC system.

b. Observations and Findings

Calculations

Calculation S-C-CC-MDC-0879, Revision 1, dated June 28, 1992, Maximum and Minimum CC Pump Flow Requirements and NPSH, established the CC pump minimum permissible flow, runout flow, and evaluated required and available NPSH during runout conditions. The team reviewed this calculation in detail and identified the following weaknesses:

1. The calculation (Sheet 1) refers to an attached pump curve to establish the recommended minimum flow rate of 1000 gpm for the CC pumps. However, the pump curve is a generic Goulds pump "catalog cut" without any specific customer designation. It was not clear that this curve is applicable to the Salem CC pumps.

2. Using the accident alignment for the CC system provided in TS2.SE-SU.CC-0001(Q), Revision 0, CC System Flow Balance, with the minimum flow requirements provided in UFSAR Table 9.2-3, and assuming isolation of CC flow to the spent fuel pool heat exchanger and boric acid evaporator early in the injection phase (in accordance with the EOPs) of a postulated large break LOCA, the team determined that total CC pump flow may be as low as 771 gpm. Consequently, the 1100 gpm minimum CC pump flow requirement established in the calculation may not be satisfied during the injection phase of a postulated LOCA.

3. The calculation assumes (Sheet 2) that "CC pump runout flow is 20% higher than the flow corresponding to its best efficiency point (BEP)." The calculation states that this assumption is consistent with "normal industry practice." In addition, the required pump NPSH at runout (5700 gpm) is extrapolated (Sheet 7) from the manufacturer's design pump curve. However, the pump curve only shows required NPSH for flows up to 5000 gpm. It is not obvious from the curve that required NPSH could be limited to the 23 feet value determined in the calculation.

4. No documented basis was provided for the minimum surge tank water level (El. 126'-0") used in the calculation to determine NPSH available to the pump. Although a setpoint calculation exists for the surge tank levels, PSE&G was unable to correlate the levels in the setpoint calculation (SC-CC003-01, Revision 0) to the low level elevation specified in the calculation.

Licensee Identified Pump Runout Issue

The calculation states (Sheet 1) that "None of the operating modes of the CC system require flow in excess of the design flow," and "...there is no expected scenario that would lead to pump runout condition..." However, in 1994 PSE&G identified the potential for CC pump runout during a postulated LOCA and failure of a vital bus (PR 940805141). Consequently, PSE&G contracted an external engineering organization to perform an additional analysis of the CC pump capability to operate under runout conditions (Evaluation of Component Cooling Pump at Runout Condition, dated November 7, 1994). That analysis also used extrapolations of the manufacturer's pump curves to conclude that the pump could operate "reliably at runout flow conditions for an indefinitely long period." The report also stated that the CC pump will operate at runout until another CC pump is restored to service or until an RHRHX can be isolated. Subsequently, PSE&G developed administrative guidance to require three CC pumps to be operable assuring the availability of two CC pumps assuming the single active failure of one CC pump.

SSFI Identified Pump Runout Issue

The team identified other cases where the potential exists for the CC pump to operate at or near runout conditions which had not been adequately evaluated to assure the pump manufacturer's NPSH requirements would be satisfied. For example:

- In the event of a postulated LOCA, (using current EOPs) one CC pump is started during the injection phase, and the RHRHX outlet valves (21CC16&22CC16) automatically open during recirculation on low level in the RWST, running out the pump for approximately 10 minutes.

- When a CC pump is started in EOP-TRIP-1, the spent fuel pool heat exchanger and boric acid evaporator may still be aligned for service. Recent flow balance test results indicate that CC pump flow may be near runout (5500-5600 gpm) until flow to these loads is isolated.

- A Westinghouse analysis (PSEBO-96-040, Revision 1, dated September 3, 1996, Single Train Cooldown Analysis Report) indicates that CC flow rates through the CCHX and RHRHX are based on one CC pump operating near runout.

In response to these issues, the licensee contacted the pump manufacturer to obtain further information related to CC pump performance under runout conditions. In a letter to PSE&G, dated December 11, 1996, the manufacturer stated that:

- The minimum flow for this pump is 600 gpm for a maximum of 60 minutes.

- Maximum continuous flow is 5600 gpm. Based on testing done on same size pumps, a maximum flow rate of 6370 gpm may be tolerated for up to 10 minutes. However, NPSH required is 26 pounds per square inch absolute (psia) and brake horsepower is 362 hp.

At the time of the inspection, PSE&G did not have a formally documented hydraulic analysis or a field benchmarked and issued flow model that establishes the maximum possible CC pump flow that could be achieved for all worst case system alignments. Except for the estimates and extrapolations reflected in this calculation and the independent analysis, there was no documented hydraulic analysis to establish the maximum possible CC pump flow that could be achieved, or to confirm that the manufacturer's NPSH requirements would be satisfied.

CC Flow Diversion

The team also noted that when the outlet valves open on both RHRHXs (on low RWST level) and the CC pump is at runout, CC flow may be diverted from safety-related components (e.g., SI, charging, and RHR pumps) to the RHRHXs. There was no documented analysis or testing to assure that adequate CC flow would be supplied to the safeguards pumps during these conditions. In addition, with two RHRHXs operating, more heat may be rejected to the CC system. There was no documented analysis to establish what flow would be supplied to the RHRHXs, and that the CCHXs could maintain CC supply temperatures below the design limit (126°F).

EDG Loading

The pump manufacturer determined that the CC pump motor would be required to produce approximately 362 brake horsepower at pump runout conditions. This is an increase of approximately 62 brake horsepower above that assumed in the EDG loading calculation for a CC pump motor. The team noted that the impact of the increased horsepower requirement on the EDG loading had not been evaluated.

Summary

In summary, the team found that there was no documented analysis to confirm that:

- Minimum CC pump flow will be greater than 600 gpm in all cases, e.g., during injection.
- The maximum flow will not be exceeded in any mode of operation or system alignment.
- Sufficient NPSH is available to support operation at the maximum permissible runout flow rate. It is not clear that operation at this flow rate, even for a short duration, will not result in cavitation that could compromise the capability of the CC pump to continue performing its safety function.
- The emergency diesel generator has adequate capability to accommodate the increased loading from a CC pump operating at the specified runout flow.
- Adequate CC flow is supplied to safeguards pumps when the outlet valves on both RHRHXs are open at low RWST level; or, that sufficient flow would be supplied to both RHRHXs to maintain CC supply temperatures at or below 126°F.

The licensee has issued AR 961212085 to evaluate CC pump operation at the maximum flow rate of 6370 gpm.

c. Conclusions

The team identified a condition where the operation of the CC pumps appeared inconsistent with documented design limits. The team concluded that the CC pumps would probably be at or near runout conditions when the RHRHX outlet valves are automatically opened during a postulated LOCA. CC pump operation at runout during these conditions had not been adequately analyzed by PSE&G. Consequently, the CC pumps may be adversely affected if sufficient NPSH is not available, and the pumps are subjected to the effects of cavitation. An unresolved item for this issue is described in Section O3.1 of this inspection report.

E1.2 CC Pump Room Ventilation

a. Inspection Scope

At the completion of the inspection, PSE&G had not issued a verified analyses of CC room temperatures under design basis conditions with postulated single failures of the auxiliary building ventilation room coolers. The team was informed of preliminary room temperature results by PSE&G. The team reviewed an interim design calculation completed to establish the maximum outside air temperature that would permit simultaneous operation of the 22 and 23 CC pumps assuming failure of the 22/23 pump room cooler during Mode 6 (refueling operations).

b. Observations and Findings

There was no documented analysis to demonstrate that sufficient cooling would be provided to the 22/23 CC pumps to permit satisfactory pump operation with the 22/23 CC pump room cooler (2VHE34) out-of-service. In response to the team's concerns, PSE&G performed a preliminary analysis to determine CC room temperatures under design basis accident conditions assuming the single failure of these room coolers. The analysis assumed the door to the pump room with the failed room cooler is open. Preliminary results indicated temperatures as high as 138°F in the room with the failed room cooler, which was in excess of current room temperature design limits. PSE&G is evaluating the permanent removal of the 22/23 CC pump room door, and is developing analyses of room temperatures for these accident conditions.

The team also reviewed interim design calculation S-2-ABV-MDC-1666, Revision 0, Maximum Outside Air Temperature for Mode 6 Entry. The calculation was developed in response to the team's concern with the single failure of CC room ventilation equipment. This calculation was performed using a GOTHIC computer model. Since the room coolers are thermostatically controlled to start at 100°F, and calculated temperatures in the areas never reached 100°F, without modeling the coolers, no room cooler operation was assumed in the analysis. The doors of the 22/23 CC pump room were removed in the model. The calculation determined that the maximum permissible outside air temperature for operation under these conditions is 67°F. The interim analysis was performed to allow refueling activities to proceed prior to the final resolution of this issue.

c. Conclusions

Since the analyses of cooling available to the 22/23 CC pump room for design basis accident conditions had not been completed, the team was unable to assess the licensee's evaluation. PSE&G is continuing efforts to complete and verify these calculations and to resolve the issues related to the single failure of the room coolers and its impact on CC system performance. The team found the interim design calculation on 22/23 CC pump room temperatures was acceptable in that it adequately represented the scenario described for Mode 6 operation. An unresolved item for the ventilation system issues is described in Section O3.1 of this inspection report.

E1.3 Pump Seal Water Cooling

a. Inspection Scope

The team reviewed the technical basis for assuring that adequate CC water flow will be provided to emergency core cooling pump seal water coolers following the initiation of an accident.

b. Observations and Findings

A Westinghouse letter BURL-3824, dated May 14, 1980, ESF Pump Operation Without CC indicates that the centrifugal charging, safety injection, and RHR pumps can be operated without CC being supplied to the seal water heat exchangers for 15-20 minutes following an accident or blackout provided that lube oil cooling (service water) is automatically started within 50 seconds. A memorandum attached to the letter recommended that procedures should be changed to start a CC pump in the event of a small break LOCA that could result in extended RWST drawdown time beyond the 15-20 minute criterion. The team questioned whether this issue had been addressed to assure that adequate cooling water is supplied to the safety-related pump seal coolers within the prescribed 20 minutes. The licensee had issued PIR 950814345, dated February 1996, which raised similar questions on this issue. However, resolution of this PIR was not completed and the licensee was not viewing closure of the PIR as a restart issue.

PSE&G engineers stated that, a CC pump will be started within 20 minutes after the initiation of any accident event, including any size LOCA. PSE&G is further evaluating the time required to start a CC pump using the current EOPs to confirm that a CC pump can be started within the required 20 minute time frame.

c. Conclusions

The licensee's operations staff indicated that the EOPs would direct the operators to manually start a CC pump in less than 20 minutes after the initiation of any accident event. However, PSE&G was unable to provide documentation to support this assessment. Consequently this item remains unresolved pending the completion of the PSE&G evaluation and NRC review for enforcement action **(URI 50-311/96-81-10)**.

E1.4 Electrical Protective Devices

a. Inspection Scope

The team reviewed the electrical protective devices selected for CC system pumps and MOVs to ensure that the components were adequately protected and the device setpoints were appropriate. The team also reviewed the calculations, single line drawings and MCC pan descriptions and performed walkdowns of associated MCC pans to verify the as-built CC system MOV power supplies and protective devices.

b. Observations and Findings

1. CC MOV Thermal Overload (TOL) Heaters

Heater Selection

The team reviewed calculation ES-18.006, Rev. 0, dated June 16, 1994, Selection of TOL Heater Elements for Safety Related MOVs, to confirm the design was in conformance with the licensee's commitments to Regulatory Guide 1.106. The calculation indicated a change from using option 1a of the Regulatory Guide, continuously bypassed except during testing, to option 2, trip setpoints established with all uncertainties in favor of completing the safety-related function.

The team identified that the calculation incorrectly used the manufacturer's data for the trip characteristics for the TOL relays. The manufacturer's information that was included as a reference was incomplete in that it did not include the current range tables required for proper selection of the heater elements. The calculation did correctly include information that indicated the trip point was 125% of the heater element minimum current, but never defined minimum current. The licensee incorrectly used digits included as part of the heater model number as the trip point. The team noted that the licensee's technical standard for TOL sizing was issued one month after the calculation had been issued and correctly addressed the manufacturer's heater selection criteria for trip point determination.

The team questioned the source of the MOV motor data because the referenced motor curves listed in the calculation spreadsheet were not included in the referenced motor data packages. PSE&G was able to find motor data sheets for the CC system valves in question under another vendor document not referenced in the calculation.

The team noted that the calculation methodology adjusted the thermal withstand data for the MOV motors based on applied voltage. Motor thermal withstand is not directly affected by applied voltage. In addition, the calculation also adjusted the motor time current characteristic curves for voltage. This unrealistic double compensation for voltage was a conservative error. However, the team did find that the calculation failed to address the ambient temperature of the MOVs which could affect their thermal withstand capability. The motor data that the licensee found indicated the motors were rated for 40 degrees centigrade (°C). The calculation indicated some of the MOV motor ambient could be as high as 50°C.

The team observed that the time current characteristic curves for the heater elements selected for 6 of the 14 CC valves would not provide locked rotor protection. This failure to meet one of the goals of the calculation was not addressed.

The team observed that the calculation did not address the position of the TOL adjustment knob, located on the face of the TOL relay. This adjustment could affect the trip point by +/-10%. This was also was not addressed in the assumptions. The team walked down several CC system motor control center (MCC) compartments and confirmed the adjustment knobs were set at 100%. Therefore, this did not affect the results of the calculation.

The calculation was based on un-compensated TOL relays and adjusted the trip curves for a 50 °C ambient. The team's walkdown confirmed that there was a mix of un-compensated and ambient compensated TOL relays.

The licensee documented the calculational weaknesses identified by the team in AR 961212226. The AR was designated as requiring completion prior to Mode 4, hot shutdown.

<u>Heater Design Control</u>

The team observed that design change DCP 2EC-3249, approved July 9, 1994, was initiated to provide adequate protection for the power conductors feeding the safety-related valves. This was to be accomplished by resizing the thermal overload relay heaters, breaker sizes and removing the jumpers around the TOL contacts. Calculation ES-18-006 was the base design document for the TOL heater selection.

The team identified inconsistencies between the calculated TOL heater size, the heater size listed on the 230 Volt MCC one line diagrams and the heater size listed in the Maintenance Management Information System (MMIS) data base. These inconsistencies affected 3 of the 14 CC system MOVs. In addition, the team identified an additional MOV which did not have any TOL data listed in MMIS and two MOVs that had two different TOL heater sizes listed for the same valve.

The team identified the following examples where the TOL calculation and the TOL heaters installed in the plant did not agree:

Valve	Calc	Installed
CC118	C2.68A	C3.01
CC136	C2.60A	C3.56A
CC190	C5.92A	C6.30A

In response to the difference between the calculation and the installed heaters, the licensee performed an extent of condition evaluation and found 28 other discrepancies in safety-related systems. The licensee identified that a change document (CD) No. 509/0 had been written against calculation ES-18.006, as a result of design change 2EC-3249. The CD was issued to revise the calculation for 30 heaters, including 2 of the 3 CC system MOVs identified above. The CD did not address one of the CC system MOVs identified as having a discrepancy. In addition, the team noted that for one CC system MOV, discrepancies in heater size existed between the installed heater, calculation, and the CD.

The CD failed to provide a technical justification for the change in TOL heater size. The team found that 10 of the 30 TOL heater changes involved reducing the size of the heaters without any design calculation. Smaller size heaters could result in premature tripping of the safety-related MOVs. This was in direct conflict with the one of the stated goals of modification 2EC-3249 to remain in conformance with Regulatory Guide 1.106 by selecting heaters based on the conservative methodology.

2. <u>CC MOV Molded Case Circuit Breaker (MCCB) Magnetic Setting</u>

The team noted that the time current curves developed as part of calculation ES-18.006 to demonstrate adequate protection for the MOV and the connected power cables did not include the MCCB that forms part of the combination motor starter with the TOL and the contactor. The TOL manufacturer's information included as a reference to the calculation stated that short circuit protection must be provided for the TOL and its associated controller [contactor]. Selected MCCB curves were included in Calculation ES-13.006(Q), Rev. 2, dated October 18, 1995, Breaker and Relay Coordination. The team noted that the MCC one line diagrams indicated a variety of MCCBs had been used in the MCC compartments supplying the CC system valves. These included thermal-magnetic (T/M) breakers that respond to both overload and fault conditions and adjustable magnetic-only (MAG) MCCBs that respond only to fault (instantaneous) conditions. The team found examples where four CC valves with the same size MOV motors and TOL heaters (C5.92A) were protected by 15 Amp T/M MCCB (2CCV117, 2CCV131), a MAG set at 42 Amps (2CCV17) and a MAG set at 128 Amps (2CCV18). The team identified the 128 Amp setting was excessive because the ratio of protection of the MCCB to the TOL was greater than 20 and should normally be in the range of 7 to 10. This high setting provided insufficient protection for the combination starter. The team also found that Calculation ES-13.006, Attachment E2, page 109, plotted this breaker at 42 Amps, not 128 Amps.

In addition, the team found two pairs of valves (21CC3, 22CC3 and 2CC30, 2CC31) with TOL size C10.4B heaters and 52 Amp RMS inrush currents that had instantaneous MAG settings of 68 and 75 Amps, respectively. Standard industry practice (e.g., ANSI C37.96-1976, AC Motor Protection) would maintain a ratio between inrush and MAG breaker setpoint of 175 -200%. These low settings below 150% could result in premature tripping of the MCCB resulting in failure of the valve to perform its intended safety function. The licensee responded that they had never experienced a trip of the MCCB during valve testing. Nevertheless, the licensee agreed that setpoint to locked rotor ratios of less than 150% was not prudent and initiated a change to these four MCCB setpoints to reduce the risk of premature failure.

3. <u>CC Pump Overcurrent Relay</u>

The team reviewed the CC pump overcurrent relay setpoints as documented in the maintenance department's relay test orders and compared those values with the relay settings depicted in calculation ES-13.006(Q), Breaker and Relay Coordination, Rev. 2, dated October 18, 1995, and Drawing 203117, Rev. 24, dated March 11, 1996. The team observed that the relay settings were consistent between the two documents. However, the team noted the CC pump motor data (full load and locked rotor amps) contained on the drawing differed slightly from the motor outline drawing 209C219, Rev. 6, and the motor nameplate data. The team noted that the coordination curves used generic motor data for motor acceleration, and the time current plots failed to contain any motor thermal capability information. The team reviewed the assumed motor acceleration data to verify the use of generic curves was acceptable. The calculation assumed all pumps accelerated in one second, but the overcurrent relays for all the safety-related 4160 Volt motors (except 21AFW) were set to allow locked rotor current for approximately 15 seconds. The team reviewed traces of the January 23, 1996, loss of offsite power loading test of EDG 2A and confirmed the CC pump accelerated to full speed within one second with an average voltage of 4200 Volts applied. The team also estimated the acceleration of the CC pump with a minimum specified 70% voltage would be less than four seconds. Therefore the use of generic motor accelerating curves was acceptable for the CC pump motor.

The calculation did not include motor thermal damage capability curves. Therefore, it was not possible to determine if the relays provided sufficient running or locked rotor protection. The team reviewed the motor specification 78-1303, dated July 26, 1978, and specification 85001, dated December 13, 1985, and confirmed that motor thermal capability information should have been available. The licensee was not able to find motor thermal damage criteria in its document files. The motor manufacture was also unable to find Salem specific CC pump motor information. However, the motor manufacturer was able to find motor data for a motor similar to the CC pump motor supplied to another nuclear facility. The team found the thermal damage curve for the similar motor was not fully protected in the locked rotor condition by the settings used for the Salem CC pump motor overcurrent relays. However, as noted above, the relay setting would allow greater than 15 seconds locked rotor condition prior to tripping. This discrepancy would only affect the CC pump motor if it had failed to start and was not considered an operability concern by the team because in order for the relay to malfunction the CC pump would have already failed to start for another unrelated reason. The licensee considered the existing relay setting provided adequate motor protection during normal operation. The team noted that the long time overcurrent setting would permit a 200% overload and would not inhibit operation of the CC pumps. The licensee considered some potential motor damage under a locked rotor condition to be acceptable.

c. Conclusions

The team concluded that there were significant weaknesses in the calculation for the selection of the thermal overload relays for the CC system MOVs. The selection of the new TOL heaters involved a lack of design and calculation control. The lack of quality in the calculation indicated that the calculation preparer and the reviewer failed to fully understand the operation of the equipment or the referenced manufacturer's information.

The design change to place the TOL heaters in service resulted in the installation of TOL heaters without a documented design basis. The team concluded that the licensee had not maintained document control of the TOL relay heaters associated with the CC system and other safety-related systems because heater sizes existed in MOV circuits that were not based on the existing calculated basis. The team also concluded the change document to the design calculation did not provide any documented basis to accept the installed TOL heaters for 30 safety-related MOVs.

The team found inappropriate design control in the selection of the molded case circuit breakers associated with the CC system valves. The team identified four magnetic trip MCCBs that had the potential for a premature trip (Valves 21CC3, 22CC3, 2CC30 & 2CC31). The licensee completed corrective actions to reset these breakers prior to the conclusion of this inspection with minor modifications to S-96-025 and S-96-026.

The team also identified some minor weaknesses in the documentation and assumptions made in the calculation for the selection of the CC pump motor overcurrent relays.

The team concluded that these issues remain unresolved pending the completion of the licensee's corrective actions and the review of these issues by the NRC for potential enforcement action **(URI 50-311/96-81-11)**.

E1.5 Setpoint Control

a. Inspection Scope

The team reviewed selected instrument setpoint calculations to ensure that the setpoints had a technically sound basis.

b. Observations and Findings

1. 2RM17 - Surge Tank Vent Isolation Radiation Monitors

The UFSAR, Section 9.2.2.4.3, indicates that the CC surge tank is open to the atmosphere, but if high radiation is detected in the recirculation system, the vent line is automatically closed. The inspectors questioned the setpoint basis for the radiation monitor alarm and safety function and were informed that the setpoint was established to detect when the concentration of radioactive material in the component cooling system was approximately that of primary coolant. The basis for the setpoint was to ensure that gaseous releases via the waste gas header were low. In response to the team's questions, the licensee's engineers stated that the radiation monitors associated with the CC surge tank vent line appear to be set substantially above the setpoints documented in either the Westinghouse Precautions Limitation and Setpoint Document, Table 4.5, (Rev. 7, August 1979) (VTD-304209) or the CC system configuration baseline document, DE-CB.CC-0023(Q), Rev. 1, Table T-1. Both of these documents indicated a setpoint was 0.5 decade above minimum sensitivity. UFSAR Section 11.4 describes these process radiation monitors, and UFSAR Table 11.4.2 indicated the setpoint for 2-R17A and 2-R17B was 1.0 E(-)7 micro curies per cubic centimeter. Maintenance Procedure S2.IC-CC.RM-0027(Q), Rev. 3, December 11, 1996, which indicated a trip setpoint of 1.8E4 counts per minute. PSE&G informed the team that an evaluation of the radiation monitors setpoints and their bases would be conducted.

2. 2LI-628A,C Cooling Component Cooling Surge Tank Level Alarms

The team reviewed Calculation SC-CC003-01, Rev. 1, Setpoint Relationships - CC Surge Tank Level, dated April 23, 1996, which established the uncertainties associated with the high and low level alarms for the CC system surge tank. The range for the alarms were established by the Westinghouse Precautions Limitations and Setpoints document (Rev. 7, August 1979) (VTD-304209) for the prime purpose of detecting leakage into or out of the CC system. The team noted that the calculation concluded that the process limits were not defined and required future configuration to assure the existing setpoints were adequate for the alarm limits. The team found that no action had been established to resolve this (or other) open items from the setpoint calculations.

c. <u>Conclusions</u>

The team concluded that the design basis documentation for the CC system radiation monitors were inconsistent. The team also determined that the CC radiation monitor setpoints may be inappropriately set to high. These radiation monitors are not safety-related and are not used to calculate offsite radioactive releases.

The team also identified that the design basis setpoint calculation for the surge tank level alarms contained missing information that was identified in the body of the calculation, but had not been included in a system to track its resolution.

The calculation deficiencies are an unresolved item pending the completion of the licensee's corrective action, including an evaluation to determine if the radiation monitor setpoint was consistent with the UFSAR, and the review of these deficiencies by the NRC for potential enforcement action **(URI 50-311/96-81-12).**

E1.6 <u>Equipment Power Supplies</u>

a. <u>Inspection Scope</u>

The team reviewed the power supplies for selected CC system and supporting system components to confirm proper electrical train separation.

b. <u>Observations and Findings</u>

1. <u>CC Pumps</u>

The team reviewed the 4160 Volt and 230 Volt MCC one line diagrams. The team confirmed the three CC pumps were powered from individual safety-related 4160 Volt ac busses. These busses are fed from the preferred offsite power supply and can be fed from the onsite emergency diesel generators if required. The pumps are automatically loaded on the EDGs following a LOOP and are manually loaded on the EDGs following a LOCA and appropriate load shedding. The team questioned the emergency operating procedure (EOP) guidance for the restoration of the CC system. The team noted that procedure 2-EOP-APPX-1, Rev.20, dated October 14, 1996, Step 5, required load shedding the 21 cooler and three fans (21 switchgear supply fan, 21 auxiliary building exhaust fan and the 21 containment fan cooling unit) prior to starting the 21 CC pump. The team noted the corresponding section in the EDG loading calculation (ES-9.002) did not account for these load changes at the 600-second mark, but instead load shed the containment spray pump (317 kW) at the time 21 CC pump was added at 59 minutes. The team therefore questioned the availability of the onsite power supply for CC pump 21 at the assumed 10-minute switchover point.

The licensee agreed that the EDG loading calculation failed to address this scenario and issued an AR (961223215) to resolve this issue. This will remain an unresolved item pending the licensee's incorporation of this scenario into the EDG loading analysis and the review of this issue by the NRC for potential enforcement action **(URI 50-311/96-81-13).**

2. CC Motor Operated Valves

The team confirmed the motor operated valves were powered from 230 Volt ac vital motor control centers (MCCs) powered from the A and C safety divisions. The one exception found by the team was the flow control valve for the number 22 RHR heat exchanger (22CC16), which was powered from the B safety division. This arrangement of power supplies permits isolation of the two CC flow headers and allows CC flow to both safety divisions of the CC system on loss of any one power supply.

3. CC Instruments

The team reviewed selected CC system instruments powered from the 115 Volt instrument buses and confirmed that those instruments were powered from redundant vital instrument buses.

4. Supporting Systems Power Supplies

The team reviewed the power supply for the fan units cooling the CC pump rooms 21 and 22 and confirmed they were powered from safety related 230 Volt ac MCCs. The team noted that the number 22 pump (Train B) room also contains the number 23 CC pump (Train C) and was cooled by fan unit 2VHE34 powered from Train B. However, the team found that the number 21 CC pump (Train A) was cooled by fan unit 2VHE33 powered from Train C. Therefore loss of Train C could result in loss of both the number 21 and 23 CC pumps. The effect of single failures on multiple CC pumps are also discussed in section O3.1, E1.1, E1.2 of this inspection report.

c. Conclusions

The team concluded that proper train separation had been provided for the CC system components. However, the team concluded that the emergency power supply for the 21 CC pump to support EOP APPX-1, step 5, had not been included in the EDG loading analysis. Also, the team concluded that the association of two fan units for the three CC pumps provided the opportunity for an additional single failure not previously analyzed by the licensee.

E3 Engineering Procedures and Documentation

E3.1 Electrical Calculations

a. Inspection Scope

The team reviewed selected design basis calculations and analyses for the ac and dc electrical systems that support CC system operation. The dc system is required for pump control, pilot solenoid valve power and control, control center low voltage control, and EDG control and loading. The ac system is required for CC pump power and MOV power and control.

b. Observations and Findings

1. CC Control Circuit Voltage Drop

The team observed that calculation ES-15.006(Q), Rev. 2, dated January 23, 1995, 230 Volt Vital AC Bus Control Power Circuit Voltage Drop Study, did not address the MOV control circuit voltage drop for all circuits including 7 of the 14 CC system MOV circuits. The licensee responded that the calculation was based on the "worst case" circuits. The team noted that the calculation failed to document and verify this assumption. In response to the SSFI team finding, the licensee reviewed the circuit lengths of the missing circuits and confirmed that these circuits were enveloped by other analyzed circuits with similar size one motor starters. Therefore the voltage drop assumptions for the CC system MOVs were acceptable.

2. Load Flow CC Pump Starting Capability

The team observed that calculation ES-15.004(Q), Rev. 2, dated October 7, 1996, Load Flow and Motor Starting, was based on a degraded voltage condition of 0.932 Per Unit (PU). This value was less than the present degraded voltage setpoint and adds conservatism to the analysis. However, the team noted that the CC pump motor was not included in the analysis which included other safety-related 4160 Volt motors. The licensee responded that the 300 horsepower (hp) CC pump motor would be enveloped by the larger motors (400 and 600 hp) on the 4160 Volt buses. Therefore the calculation was also acceptable for the CC pump motor. The calculation had not documented this engineering judgement.

3. Battery Charger Recharge Load on the EDG

The CC pumps are automatically loaded onto the EDG following a loss of offsite power (LOOP) and manually loaded onto the EDGs following a safety injection signal coincident with a LOOP. The team observed that calculation ES 9.002(Q), Rev. 2, dated October 14, 1994, Emergency Diesel Generator Loading, indicated very little margin between the required load and the 2 hour EDG rating.

The team observed that the calculation included detailed loading analysis for all three EDGs for several different cases including LOOP, LOOP/LOCA with all EDGs available, and LOOP/LOCA with one EDG not available. The loading analysis for the 2B EDG was the most limiting because the calculated margin below the 2 hour EDG rating was 68 kilowatts (kW) at a nominal frequency of 60 hertz (Hz).

The team reviewed the calculation of the battery charger contribution to the EDG loading. This calculation was based on measured battery charger output during normal plant operation. The team observed the calculation incorrectly adjusted the measured output of the battery charger resulting in an incorrect conclusion that the input power was less than the output power. The licensee had previously acknowledged this error and had appropriately issued a change against the calculation prior to this inspection.

In addition, the team noted that the calculation was based on a 250 Amp charger and the chargers had been replaced with 300 Amp chargers under design change (DCP) 2EC-03332, approved April 1, 1996. The EDG loading calculation had been identified as a document that required change as part of that modification and included a change document (CD E511/0) against the calculation identifying the change details.

Following a loss of offsite power and prior to the diesel generators supplying power to the battery chargers, the batteries begin to discharge to supply the dc loads. Calculation ES-4.006(Q), Rev. 0, 125 Volt dc Component Study and Voltage Drop, indicates the initial battery voltage could drop to 113.16 volts and the battery cable resistance is less than .0007 ohm. When voltage is returned to the battery charger, its output voltage will attempt to return to 132 Volts direct current (Vdc), resulting in the charger going into current limit. The team found that the calculated battery charger load on the EDGs neglected any battery recharging current, following a partial battery discharge, that could result in the battery chargers going into a current limit mode. This additional load was not included in either the original calculation or in the two changes that were outstanding against the calculation.

The team considered the lack of adequate justification for not including the battery recharging current in the battery charger load in the diesel generator load calculation to be an unresolved item pending the licensee's evaluation of this issue and the NRC review for potential enforcement action. **(URI 50-311/96-81-14).**

4. DC System Time Constant

The team observed that calculation ES-4.003(Q), Rev. 1, dated January 18, 1996, 125 Volt DC Short Circuit and System Voltage Drop, included as an attachment a letter from the manufacturer of the battery main fuses. This letter provided confirmation for the dc interrupting rating for the fuses. The team noted the letter included a statement that the rating was only applicable if the dc system time constant was within the requirements of the Underwriters Laboratory (UL) standard (UL-198L, DC Fuses for Industrial Use) used to test the fuses. The licensee could not produce any evidence that the circuit time constant was ever reviewed to address the fuse manufacturer's caution. The fuses in question were the main fuses from the battery. They would only be called on to operate for a major fault on the dc bus. While the team does not consider this to be an operability concern, the team did considered this to be an undocumented engineering judgement. The licensee initiated an action request (AR 961130114) against the calculation to document the time constant of the dc system.

c. Conclusions

The team concluded that the licensee failed to document a number of engineering judgements and assumptions. The calculation review and approval process also failed to identify and correct the lack of rigor in documenting assumptions and engineering judgements. While the missing engineering judgements and unsubstantiated assumptions did not invalidate the results of these calculations, other unsubstantiated assumptions, used in the CC NPSH and TOL heater calculations, did invalidate the calculation results.

E3.2 Technical Standards

a. Inspection Scope

As part of the team's review of issues identified during this inspection, the team reviewed the guidance available to the engineering staff in the form of technical standards.

b. Observations and Findings

1. Low Voltage Circuit Breakers and Combination Starters

The team reviewed technical standard ND.DE-TS.ZZ-2012(Q), Rev. 0, dated July 7, 1994, Low Voltage Circuit Breakers and Combination Starters during the review of the selection of thermal overload relays and molded case circuit breakers for the CC system motor operated valves. The team noted the technical standard was generally consistent with present engineering practice endorsed by recent IEEE standards (IEEE-741-1990). However, the section on MCCB selection recommended an instantaneous setting range of 185% to 235% of the motor's locked rotor current. While this range of settings would have avoided the risk for premature tripping of CC system MOVs, it did not address the TOL manufacturer's requirement for short circuit protection for the combination starter components. This requirement, contained in the licensee's vendor technical data (VTD) number 317235-01 (GE instruction GEH-5091), and included as a reference to Calculation ES-18.006, Rev. 0, June 6, 1994, indicated the importance of providing short circuit protection for the thermal overload relay.

The team also noted that Attachment 4 to the standard listed a number of TOL heaters as non-safety related. Two of those heaters were used in the CC system and included in the ES-18.006 calculation. The licensee could not identify the bases for the non-safety related label, but did confirm that the TOL heaters of concern in the CC system were listed in the Salem Unit 2 Bill of Material as safety-related.

2. Medium Voltage Motor Protection

The team reviewed technical standard ND.DE-TS.ZZ-2014(Q) , Protective Relaying for 4.16 kilo Volts (kV) and 7.2 kV Busses, Rev. 1, dated December 13, 1995, as part of the review of the protection for the CC pump motors. The team noted that the standard's recommendations for the long term and instantaneous relay settings agreed with industry recommendations (ANSI C37.96) and the actual settings on the CC pump motor overcurrent relays generally agreed with the standard. The team noted that the standard's recommendation for the time dial selection correctly stated that it should be picked to lie between the motor acceleration curve and the motor thermal damage curve. This information was missing from the Salem calculation ES-13.006, Rev. 2, dated October 18, 1996, and contributed to the discrepancy noted in Section E1.4 of this report. The standard did not address selection guidelines for using generic motor data. The Salem calculation assumed the same one second motor acceleration curve for all 4.16 kV motors without any basis. The team confirmed this was a good value for a 100% voltage start of the CC pump required by the Salem motor specifications number 78-1303, Rev. 0, dated July 26, 1978, and number

85001, Rev. 0, dated December 13, 1985, from a review of the EDG loading test data but also noted that the service water pump required two seconds to come up to speed. This did not address minimum voltage starting at 70% voltage with the potential for a longer acceleration time.

3. Electrical Installation

The team reviewed technical standard SC.DE-TS.ZZ-2034(Q), Rev. 3, dated July 30, 1996, following a walkdown of the electrical distribution equipment associated with the CC system. The team observed numerous examples of power cables, in the 84 foot elevation dc equipment area, that were unsupported for distances of six feet or more, including the ac power feeds to the new 300-amp battery chargers recently installed under DCP-2EC-3332, Rev. 0, dated April 1, 1996. The team noted that the standard, paragraph 5.2.27, specified that the maximum free air length [of cable] should be nominally 3'-0" or twice the minimum bend radius, whichever is greater and that this paragraph had not been changed in the latest revision.

The licensee responded to these discrepancies between the recently issued technical standards and the existing plant conditions by stating that the intent of the standards was for new work. Although the new battery charger did not change the ac power cables, the team felt the cables should have been supported between the raceway and the new chargers to the recent guideline. The licensee prepared an Action Request (961212228) to address the generic concern of these discrepancies.

c. Conclusions

The team concluded that the development of the technical standards program was a positive initiative by the licensee. However, the team noted that the standards did not include a technical justification for the acceptability of existing conditions in the plant. The team considered this to be a program weakness. In addition, the team identified one case where work in progress, during the development of the technical standards, was not coordinated with the technical standard the licensee was developing at the same time. The licensee issued an Action Request to address the practice of not evaluating existing conditions.

E3.3 Drawing Control

a. Inspection Scope

The team conducted walkdowns of the CC system to verify that plant drawings were consistent with the installed plant equipment.

b. Observations and Findings

The team noted several minor discrepancies with component description on the labels attached to CC components. For example, the team noted that the label on the steam generator blowdown cooler inlet valve was incorrectly labeled as the outlet valve. The licensee appropriately issued ARs to track the resolution of these deficiencies.

The piping and instrument diagrams (P&ID) for CC were generally accurate. The team noted that the labels on the steam generator blowdown cooler heat exchangers were not consistent with the P&ID. The licensee revised the P&ID (Sheet 2, Rev. 33) to properly document the component identification numbers. The team also noted that the P&IDs did not indicate identification numbers for instrumentation located on the post accident sample coolers. The licensee issued an AR to track and resolve this discrepancy.

The team identified that DCP 2SC-2154 did not update the P&ID to remove FM 601A&B and DCP 2EE-0248 did not update the instrument loop diagram for FIC 642A&B. In response, the licensee issued ARs 961130118 and 961206159 to address these and related drawing errors.

Section E1.4 of this report also addresses discrepancies between the 230 Volt vital MCC bus one line diagram and the installed TOL heater and related design documents.

c. Conclusions

The team concluded that the CC system drawings were generally accurate. The licensee initiated actions to correct the minor discrepancies identified by the team for both the drawings and plant equipment labels.

E3.4 Configuration Baseline Document

a. Inspection Scope

The team reviewed selected sections of the Configuration Baseline Document (CBD) for the component cooling system. The team also sampled several design calculations, engineering evaluations, and other design documents to assess the accuracy of the CBD and its supporting design inputs.

b. Observations and Findings

The CBDs were developed and issued final for use during the 1988 to 1992 time frame. However, in some cases CBDs were found to be impacted by processes outside of the design change process (e.g., revisions to calculations and engineering evaluations). These types of changes to the CBD were incorporated without design verification. In a memorandum, dated July 1, 1996, all licensing and engineering personnel were directed to use qualified source documents (calculations, engineering evaluations, etc.) in CBDs rather than the CBDs themselves to make engineering decisions. The CBDs were to be used as a "Road Map" to identify these source documents. The CBD validation effort is in process to fully validate the design basis information contained in those documents.

The CBD provided a comprehensive index of CC design basis calculations. In general the team found that calculations were readily available and, in the case of those maintained on the Document Management System (DMS), easily retrieved.

c. Conclusions

The team concluded that the CBD was a good source of design information and was properly controlled by the licensee. The team found that CC design calculations were referenced in the CBD. Calculations on the DMS were readily available.

E8 Miscellaneous Engineering Issues

E8.1 Post Accident Sampling System Heat Exchangers

a. Inspection Scope

The team reviewed the interface between CC and the PASS to verify that operating practices were consistent with the licensing basis.

b. Observations and Findings

The UFSAR, Section 9.3.6.1, states that, "The PASS provides the capability to obtain, under accident conditions, a containment air grab sample, liquid and stripped gas reactor coolant grab samples..." Section 9.3.6.2 states that, "Ten gallons per minute of component cooling water is supplied to the sample cooler rack to cool reactor coolant samples."

Emergency Operating Procedure, 2-EOP-TRIP-1, Reactor Trip or Safety Injection, Step 17, provides instructions requiring the closure of the boric acid evaporator CC outlet valve (2CC48). Isolating the boric acid evaporator also isolates CC water from the PASS heat exchangers. The boric acid evaporator CC outlet valve remains closed throughout the duration of an accident. Therefore, in accordance with the current EOPs, CC is not available to provide PASS heat exchanger cooling flow during an accident.

In response to this concern, the licensee provided procedure SC.CH-AB.CC1155(Q), Revision 0, Temporary Cooling of PASS Cooler Rack 811, which is used to restore cooling to the PASS cooling rack (Panel 811). The team reviewed this procedure and found that it provides for installation of temporary hoses to supply cooling water (demineralized water) to the PASS when component cooling water is not available. However, this temporary installation is not consistent with the description of the cooling water supply provided in the UFSAR or with NUREG 0737 evaluations for the PASS. The licensee issued AR 00961212177 to track the resolution of this discrepancy.

c. Conclusions

The team concluded that providing PASS heat exchanger cooling water from the demineralized water system is inconsistent with the UFSAR. This issue remains unresolved pending: (1) the completion of the licensee's evaluation, including an assessment to determine if the operating procedure change for using deminerlized water instead of CC was conducted in a manner consistent with 10CFR 50.59 and 50.71(e); and, (2) review by the NRC for potential enforcement action **(URI 50-311/96-81-15).**

E8.2 Licensing Basis Verification

a. Inspection Scope

The team compared the UFSAR description of the CC (Section 9.2.2, Component Cooling System) and support systems with the design basis information to verify that the UFSAR descriptions were accurate. The team also reviewed the licensee's UFSAR Project Macro review of the CC system to verify that the licensee had adequately reviewed the UFSAR.

b. Observations and Findings

The team identified examples where the description material in the UFSAR did not clearly reflect the CC system design. For example:

- Section 9.2.2.8.1, states in part that "The reactor coolant pump bearing temperature alarm is set at 175 degrees Fahrenheit." The next paragraph which also discusses the reactor coolant pump bearing temperature alarm states that "The maximum test temperature of 185 °F is also the suggested alarm setpoint...". The team found that these two statements were not consistent.

- Section 9.2.2.3, states in part that "The operation of the system is monitored with the following instrumentation: 3. A temperature indicator in the outlet line from each heat exchanger". The team noted that the steam generator blowdown sample heat exchangers did not have a temperature indicator in the outlet line.

- Section 11.4.2.2, states in part that "These channels (CC radiation monitors 2-R17A,B) continuously monitor the component cooling water for radiation." The team noted that plant procedures do not require one or both CC radiation monitors to be continuously inservice when the CC system is in operation. The team also noted that both CC radiation monitors had been out-of-service for an extended duration at the start of this inspection (See Section M2.1).

The team reviewed the UFSAR Macro-Review for the CC system. The Macro-Review was one part of the licensee initiative to validate the information provided in the UFSAR. The CC Macro-Review was conducted by one engineer during a one week duration. The CC Macro-Review verified 57 UFSAR attributes and identified 6 discrepancies. The identified discrepancies were generally descriptive errors that did not adversely affect the CC system function. For example, the Macro-Review identified that the UFSAR incorrectly stated that CC provides makeup water for the waste gas compressor seals. The Macro-Review correctly identified that the CC system is not capable of performing this function. The identified discrepancies for the CC system were all appropriately placed in the corrective action program.

The attributes were verified by identifying a document which substantiated the statement in the UFSAR. It was not the intent of the Macro-Review to conduct an in-depth validation of the supporting documentation. For example, if the attribute was each CC heat exchanger is designed to remove 1/2 the decay heat 20 hours after plant shutdown, then the calculation validating this information would be referenced in the Macro-Review. The engineer conducting the Macro-Review would not necessarily review the calculation to verify that the assumptions were valid and the calculation was based on sound engineering principles.

The team compared the administrative guidance provided in procedure S2.SE-DD.ZZ-0008(Z), System Engineering Final System Readiness Review UFSAR Macro-Review Desk Guide, with the CC Macro-Review. The team noted a few examples where the attributes recommended for selection by the desk guide, such as setpoints, were not selected for verification during the CC Macro-Review. For example, the RCP bearing alarm setpoint was not selected. The team also noted one example, regarding the absence of the outlet temperature indicator on the steam generator blowdown sample heat exchanger, where the attribute was selected; however, the Macro-Review did not identify the discrepancy between the plant and UFSAR description.

The team reviewed the auxiliary building UFSAR project Vertical Slice to determine if the single failure of the CC room ventilation issue identified during this inspection was identified during the Vertical Slice. The team concluded that this issue was not explicitly identified during the Vertical Slice review. However, the licensee had initiated a single failure evaluation to review ventilation systems for single failures. The licensee's ventilation engineers stated that the preliminary evaluation had identified that a single ventilation failure would affect multiple CC pumps.

c. <u>Conclusions</u>

The team concluded that the CC licensing basis descriptions (UFSAR) were, with a few minor exceptions, consistent with the actual plant design. The team concluded that the CC UFSAR Macro-Review was a good initiative and identified and corrected several UFSAR discrepancies. However, the team noted that there are significant scope and methodology differences between the Vertical Slice/Macro-Review and an SSFI. Therefore, it was not the primary purpose of the Vertical Slice/Macro-Reviews, to identify design issues, such as, the ventilation and pump runout issues that were identified during this inspection.

E8.3 Licensing Basis Updates

a. Inspection Scope

The team reviewed the timeliness for two licensing basis changes.

b. Observations and Findings

During the team's review of the EDG loading Calculation ES-9.002, the team noted the analysis concluded that the load margin must be maintained by restricting the frequency of the EDG to no greater than 60.5 Hz. A maximum frequency would limit the maximum pump and fan speeds and limit their driven load. This then would limit the increase in load to below the EDG's 2 hour limit. The calculation referenced an incident report (94-301, dated October 13, 1994) and a licensing change request (LCR) 94-40 which addressed the change in the EDG technical specification. Technical Specification 4.8.1.1 presently limits the acceptable frequency range to 58.8 - 61.2 and the proposed change would set the allowable range to 58.8 - 60.5 Hz. The LCR 94-301 had not been issued but had been replaced by LCR S95-36. LCR S95-36 had been sent to the NRC for approval on September 26, 1996. The team was concerned with the delay in issuing the LCR which supports the EDG operability. In response to the team's concern, the licensee indicated the delay was due to combining the original LCR 94-40 with another LCR into the new LCR S95-36. There was no explanation why this new LCR was not released until September 1996.

The team reviewed the licensee's EDG governor test and setup procedure SC.MD-CM-DG-0006(Q), Rev. 8, dated June 12, 1996, and noted that the allowable frequency range of the latest governor setup procedure would have supported the proposed technical specification. (Refer to Section M3.2 of this report for a discussion on the as-found acceptance criteria.)

The team also noted that a proposed 1995 LCR S95-31, Component Cooling - Add Third Pump, has not been submitted to the NRC. In addition, actions had not been initiated to reflect this administrative control requirements in the UFSAR or technical specification bases. The licensee's system readiness review indicated that the resolution of this item was scheduled for prior to plant restart.

c. Conclusions

The team concluded that PSE&G was untimely in submitting their licensing change request for the EDG frequency limit requirement. In addition, incorporation of the 3 operable CC pumps administrative requirement into the licensing basis was also untimely.

E8.4 Probabilistic Safety Assessment

a. Inspection Scope

The team reviewed the Salem Probabilistic Safety Assessment (PSA) fault trees to verify that the CC system design was properly modeled in the PSA fault trees. The team also verified that dependencies between CC and other safety-related systems were consistent with the design information.

b. Observations and Findings

The team noted that the PSA description of the CC system operation and fault tree was not consistent was the system design basis. The licensee's PSA engineers made the following changes to address the team's findings:

- Separate CC fault trees were developed for CC normal operation and CC operation when entering cold leg recirculation following a loss of coolant accident. The cold leg recirculation fault trees included separating the two CC headers as required by the emergency operating procedures.

- The Human Error Probability for the operator action to transfer to cold leg recirculation was recalculated to reflect the train separation.

- A new operator action was created to represent restarting a CC pump and un-isolating the CC heat exchanger service water after a loss of offsite power and a safety injection signal both occur.

The team also noted that the PSA model incorrectly assumed that the CC to the charging pump seals was not required for pump operation. In response to this finding, the licensee's PSA group created a new event tree to model the response to a loss of all CC as an initiating event. This had previously been excluded as an initiating event because of the incorrect assumption that the charging pumps were not dependant on CC. There is a potential that the loss of CC will result in a loss of the charging pumps and reactor coolant pump thermal barrier cooling. Under certain conditions, this could result in a RCP seal LOCA.

The preliminary CC model update resulted in a core damage frequency (CDF) change from approximately 4.4E-5/year to 8.13E-5/year. The new model assumed that a loss of the 22/23 CC pump room cooler would result in both CC pumps failing to function. The licensee's engineering staff was conducting an analysis to determine what actions could be implemented to break the dependency between the CC pump room coolers and CC pumps. A decrease in CDF will be achieved if corrective actions eliminate this dependency.

The PSA group with the assistance of operations staff reviewed the PSA descriptions for several safety-related systems to determine if the modeling errors identified were prevalent throughout the PSA. The operations staff review did not identify any other significant discrepancies.

c. Conclusion

The team concluded that there were CC modeling errors that adversely affected the calculated plant CDF. The licensee corrected the identified errors and performed a review to identify similar errors in the individual plant evaluation (IPE). The team determined that the licensee's actions to resolve this issue were appropriate.

V. Management Meetings

X1 Exit Meeting Summary

The team discussed the team findings with the licensee staff and management before leaving the site on December 13, 1996. The team presented the inspection results to members of licensee management at the conclusion of the inspection on January 8, 1997. The exit meeting was open for public observation. The slides used at the exit meeting are provided as Enclosure 1 to this report. The licensee acknowledged the findings presented.

No proprietary material was knowingly retained by the team or disclosed in this inspection report. The SSFI team question data base that was developed by the licensee will be maintained onsite as a quality controlled record.

PARTIAL LIST OF PERSONS CONTACTED

V.J. Chandra, Engineering
T. DelGaizo, Contractor
D. Dodson, Licensing
J. Dunn, Westinghouse
L. Ford, System Manager
M. Hoskins, Engineering
K. King, Engineering
D. Lounsbury, Operations
W. Maher, Engineering
D. McHugh, Senior Engineer
G. Overbeck, Director System Engineering
D. Powell, Licensing
J. Raymond, Westinghouse

DOCUMENTS REVIEWED

Drawings

205331 A8763-46, Rev. 46, dated 7/3/96, No. 2 Unit Component Cooling, Sheet 1 of 3
205331 A8763-32, Rev. 32, dated 6/21/96, No. 2 Unit Component Cooling, Sheet 2 of 3
205331 A8763-35, Rev. 35, dated 6/27/96, No. 2 Unit Component Cooling, Sheet 3 of 3
205337 A8763-19, Rev. 35, dated 12/5/96, No. 2 Unit Auxiliary Building Ventilation, Sheet 2
205337 A8763-21, Rev. 21, dated 12/29/96, No. 2 Unit Auxiliary Building Ventilation, Sheet 3
207491 A8803-24, Rev. 24, No. 1 Unit-Auxiliary Building Component Cooling Piping, Plans Elev. 45', 55', 64', 100', & 122'
205328-SH1, Rev. 46, Chemical & Volume Control System P&ID
205328-SH2, Rev. 53, Chemical & Volume Control System P&ID
205328-SH3, Rev. 39, Chemical & Volume Control System P&ID
205342-SH3, Rev. 62, Service Water Nuclear Area P&ID
205342-SH4, Rev. 51, Service Water Nuclear Area P&ID
209C219, Rev. 6, CC Pump Motor Outline Drawing
203828, Rev. 20, SWP 21 125V DC Schematic
203834, Rev. 17, SWP 22 125V DC Schematic
220942, Rev. 16, SW Inlet Control Valves to CC HT EX 21 & 22
322509, Rev. 21, 2B Ventilation 230 V Vital CC One Line
322510, Rev. 20, 2C Ventilation 230 V Vital CC One Line
211517, Rev. 9, 21 CC Pump 125V Schematic
211518, Rev. 4, 22 CC Pump 125V Schematic
211520, Rev. 4, 23 CC Pump 125V Schematic
211516, Rev. 4, 21 CC Pump 28V Schematic
211519, Rev. 9, 22 CC Pump 28V Schematic
211521, Rev. 7, 23 CC Pump 28V Schematic
601685, Rev. 4, 2CC17, 21CC3, 2CC30 MOV 230/115V Schematic
601683, Rev. 5, 22CC3, 2CC18, 2CC31 MOV Schematic
211527, Rev. 16, 2CC117, 2CC136 MOV Schematic
211528, Rev. 24, 2CC118, 2CC113, MOV & SOV Schematic
216911, Rev. 14, 2CC131 MOV Schematic
218846, Rev. 15, 2CC187 MOV Schematic
218847, Rev. 16, 2CC190 MOV Schematic
224384, Rev. 9, 2CC215 SOV Schematic
211526, Rev. 4, 2CC117, 2CC136 28V Control
211530, Rev. 14, 22CC16 MOV Schematic
211529, Rev. 15, 21CC16 MOV Schematic
601686, Rev. 1, 22CC3, 2CC18, 2CC31 28V Control
601684, Rev. 0, 2CC17, 21CC3, 2CC30 28V Control
211524, Rev. 10, 2CC149 28V Control
242625, Rev. 4, RM System Alarms - Sheet 1
242626, Rev. 3, RM System Alarms - Sheet 2
211522, Rev. 11, 21 Surge Tank and Header Pressure Alarms
211523, Rev. 10, 22 Surge Tank and Header Pressure Alarms

220178, Rev. 18, Interface Racks 41 & 126
236256, Rev. 7, Safeguard Equipment Control System
236259, Rev. 8, Safeguard Equipment Control System
236262, Rev. 8, Safeguard Equipment Control System
211357, Rev. 9, 28V DC Oneline
220804, Rev. 8, 2ADE 28V Distribution Cabinet Oneline
220805, Rev. 9, 2BDE 28V Distribution Cabinet Oneline
220806, Rev. 7, 2CDE 28V Distribution Cabinet Oneline
223720, Rev. 22, 125V DC Oneline
220812, Rev. 21, 2A 115V AC Vital Instrument Bus Oneline
220813, Rev. 20, 2B 115V AC Vital Instrument Bus Oneline
220814, Rev. 18, 2C 115V AC Vital Instrument Bus Oneline
222483, Rev. 29, 2A West Valve 230V Control Center Oneline
222484, Rev. 30, 2B West Valve 230V Control Center Oneline
222485, Rev. 37, 2C West Valve 230V Control Center Oneline
222505, Rev. 23, 2A East Valve 230V Control Center Oneline
222507, Rev. 24, 2C East Valve 230V Control Center Oneline
203063, Rev. 31, 460V & 230V Vital and Non-Vital Oneline
601400, Rev. 13, 2A-230V AC Vital Bus Oneline
601401, Rev. 13, 2B-230V AC Vital Bus Oneline
601402, Rev. 11, 2C-230V AC Vital Bus Oneline
203061, Rev. 30, 4160V Vital Buses Oneline
601701, Rev. 13, Salem-Hope Creek 500kV, 138kV, 4.16kV One Line
203117, Rev. 24, 4160V Vital Buses Relay Settings
EDG 2A, 11/23/96, Loading Test Visicorder Plot
203666, Rev. 9, Safeguards Emergency Loading Sequence SH1
203667, Rev. 7, Safeguards Emergency Loading Sequence SH2
203668, Rev. 6, Safeguards Emergency Loading Sequence SH3
203669, Rev. 7, Safeguards Emergency Loading Sequence SH4
203670, Rev. 11, Safeguards Emergency Loading Sequence SH5
203673, Rev. 6, Safeguards Emergency Loading Sequence SH6
228477, Rev. 14, Control Console Component Coding Water
622031D, Rev. 0, Loop Diagram Vent Valve 2CC149
622029D, Rev. 1, Loop Diagram Excess Letdown Ht Ex Outlet 2CC113 (3 sheets)
622030D, Rev. 1, Loop Diagram Excess Letdown Hx Ex Inlet 2CC215 (3 sheets)
622013, Rev. 2, Loop Diagram, 2FT601A (3 sheets)
622014, Rev. 2, Loop Diagram, 2FT601B (3 sheets)
622017, Rev. 1, Loop Diagram, 2F1C613
622020, Rev. 1, Loop Diagram, 2F1C622
622019, Rev. 1, Loop Diagram, 2FIC619
622018, Rev. 1, Loop Diagram, 2FIC616
622021, Rev. 0, Loop Diagram, 2FIC645
622022, Rev. 0, Loop Diagram, 2FIC646
622027, Rev. 0, Loop Diagram, 2FIC643A
622028, Rev. 0, Loop Diagram, 2FIC643B
622032, Rev. 0, Loop Diagram, 2FIC642A
622033, Rev. 0, Loop Diagram, 2FIC642B
622034, Rev. 0, Loop Diagram, 2FIC625

622015, Rev. 1, Loop Diagram, 2LT628A (2 sheets)
622016, Rev. 0, Loop Diagram, 2LT628B (2 sheets)
622023, Rev. 1, Loop Diagram, 2PC600A
622024, Rev. 1, Loop Diagram, 2PC600B
622000, Rev. 0, Loop Diagram, 2TE672P
622001, Rev. 0, Loop Diagram, 2TE672Q
622006, Rev. 0, Loop Diagram, 2TA8463
622002, Rev. 0, Loop Diagram, 2TE672U
622003, Rev. 0, Loop Diagram, 2TE672V
622007, Rev. 0, Loop Diagram, 2TA8464
622004, Rev. 0, Loop Diagram, 2TE672L
622005, Rev. 0, Loop Diagram, 2TE672M
622008, Rev. 0, Loop Diagram, 2TA8465
622035, Rev. 1, Loop Diagram, 2TIC627A
622010, Rev. 0, Loop Diagram, 2TE602C
622011, Rev. 3, Loop Diagram, 2TE602A (2 sheets)
622026, Rev. 1, Loop Diagram, 2TA9286Z
622036, Rev. 1, Loop Diagram, 2TIC627B
622009, Rev. 0, Loop Diagram, 2TE602D
622012, Rev. 2, Loop Diagram, 2TE602B (2 sheets)
622025, Rev. 2, Loop Diagram, 2TA9264Z
622037, Rev. 1, Loop Diagram, 2TIC623
622038, Rev. 1, Loop Diagram, 2TIC624
21839-A-8902, Rev. 19, Salem Unit 2 Auxiliary Building Component Cooling Piping, Mechanical Arrangement, Plans and Elevations
21839-S-8902, Rev. 20, Salem Unit 2 Auxiliary Building Component Cooling Piping, Mechanical Arrangement, Plans and Elevations

Calculations and Engineering Evaluations

S-C-CC-MDC-0879, Revision 1, 6/23/92, Maximum and Minimum CC Pump Flow Requirements and NPSH
S-C-CC-MDC-0860, Revision 0, 3/5/92, CC System Design Temperatures
S-C-CC-MDC-0575, Revision 0, 7/16/90, 11 and 21 CCW Heat Exchanger Data Sheet Revision for Titanium Tubes
S-2-CC-MDC-0559, Revision 0, 6/28/90, 22 CCW Heat Exchanger Performance Evaluation
S-2-ABV-MDC-1622, Revision 0 IR1, 10/24/96, Auxiliary Building Pump Room Temperatures
S-2-ABV-MDC-1666, Revision 0, 12/9/96, Interim Design Calculation-Maximum Outside Air Temperature for Mode 6 Entry
S-C-VAR-MEE-1146, Revision 0, 11/1/96, Review Component Cooling & Service Water System Piping Classifications - Salem
S-C-CC-MEE-0606-0, 7/29/91, Service Water Pipe Cracks in Component Cooling (CC) Heat Exchanger 12/22 Cubicle
S-C-CC-MEE-0596-0, 7/15/91, Containment Isolation Valves for Component Cooling System
S-C-CC-MEE-0880-0, 2/25/94, Evaluation of Component Cooling System Operability with Valves CC125 & CC146 Open

S-C-CC-ME-0605, 7/29/91, Component Cooling (CC) System Surge Tank Relief Valve CC147 Set Pressure
S-C-CC-ME-0602-0, 7/29/91, Component Cooling System Isolation Following Thermal Barrier Rupture
S-C-N210-MSE-269, 7/31/84, Potential Overpressurization of the Component Cooling Water System
Westinghouse Calculation 3/10/67, Relief Valves for IPP#2, ACS (applicable to PSE&G)
S-C-4kV-JDC-959, Rev. 4, 6/18/93, Degraded Vital Bus UV Setpoint
ES-4.003(Q), Rev. 1, 1/18/96, 125 Vdc Circuit and System Voltage Drop
ES-4.004(Q), Rev. 3, 5/29/96, 125 Vdc Battery and Battery Charger Sizing
ES-4.006(Q), Rev. 0, 1/18/96, 125 Vdc Component Study and Voltage Drop
ES-9.002(Q), Rev. 2, 10/14/94, Emergency Diesel Generator Loading
ES-13.005(Q), Rev. 5, 3/27/96, Penetration Overcurrent Protection
ES-13.006(Q), Rev. 2, 10/18/95, Breaker & Relay Coordination Study
ES-15.004(Q), Rev. 1, 10/7/96, Load Flow & Motor Starting
ES-15.006(Q), Rev. 2, 1/23/95, 230V Vital MCC Power Circuit Voltage Drop
ES-15.008(Q), Rev. 2, 12/22/95, Degraded Grid Study
ES-18.006(Q), Rev. 0, 6/6/94, Selection of TOL Heater Elements
SC-CC001, Rev. 1, 6/14/94, CC Ht Ex Outlet Temp Setpoint
SC-CC002, Rev. 1, 4/27/96, CC RHR Outlet Flow Setpoint
SC-CC003, Rev. 1, 4/23/96, CC Surge Tank Level Setpoint
S-2-CC-MDC-0898(003) and (004), MOV Capability Assessments for 21 and 22 CC16

<u>Correspondence and Other Documents</u>

DE-CB.CC-0023(Q), Revision 2, 1/5/94, Configuration Baseline Documentation for Component Cooling Water
NLR-I90194, 5/17/90, B. A. Preston to V. Polizzi, Licensing Position on Passive Failures Associated with the Salem Service Water System
NLR-I94224, 6/14/94, D. A. Smith to H.G. Berrick, Service Water and Component Cooling Water Design Bases Accident Conditions
LR-I96102, 7/25/96, Updated Licensing Position on Passive Failures Associated with the Salem Generating Station Service Water System
Westinghouse PSE-89-744, 11/8/89, Salem CCW Calculation Summaries
TS2.SE-SU.CC-0001(Q), Revision 0, 10CFR50.59 Applicability Review, CC System Flow Balance
Westinghouse PSE-84-802 (Re-ISSUED), 7/26/84, Component Cooling Water System Potential Overpressurization Notification
Westinghouse BURL-4031, 10/21/81, Reactor Coolant Pump CC & Seal Injection Water Loss
Westinghouse PSEBO-96-040, 9/3/96, Single Train Cooldown Analysis Report, Revision 1
Westinghouse PSE-94-605, 5/25/94, Revision 1 of Salem CCWHX SWS Flow Margin Report (Post-LOCA Mode)
Westinghouse 2Q223, 5/26/89, Type 93A Reactor Coolant Pump for Surry Units 1 and 2 Estimated Flow Through Thermal Barrier Cooling Water Outlet Caused by Rupture of One Heat Exchanger Tube
VTD No. 322553, dated 11/21/96, Evaluation of Component Cooling Pump at Runout Condition, Revision 1, November 7, 1994 (MPR Associates, Inc.)

Bechtel Letter GSA-3679, 2/14/91, SWS Heat Exchanger Performance Evaluation - Computer Runs with Dummy Values
DES-93-0300, 12/30/93
PIR 00950814345 CR
PIR 00960216322
PIR CR 00960925135
Letter LR-N96228, 9/25/96, PSEG to NRC LCRS95-36
Letter LR-N95042, 4/4/95, PSEG to NRC LCR 93-27
Letter NLR-N94169, 9/13/94, PSEG to NRC LCR 93-27
Letter NLR-N94108, 6/28/94, PSEG to NRC LCR 93-27
Letter NLR-N93196, 1/21/94, PSEG to NRC LCR 93-27
Letter 95-1158, 9/19/95, NRC to PSEG 125V DC TS 3.8.2.3
Letter, 12/6/96, C&D to PSEG 1993 Performance Test Evaluation
Performance Improvement Request 960709221, Concern with Setting CC Flow through RHRHX, issued July 18, 1996
PSE&G Audit No. 95-0125 of Inservice Testing Program
Nuclear Training Center Lesson Plan 0299-095.04H-PANFLO-00, Panametrics Ultrasonic Portable Flowmter
Panametrics Letter, dated November 22, 1996, forwarding Certificate of Calibration for PT 868 Instruments - Serial Numbers 702, 157 and 158
Performance Improvement Request 961026073, Discrepancy with RHR HX CC Flow Measurement
PSE&G Letters NLR-N90021, dated January 26, 1990, and NLR-N90165, dated August 31, 1990, regarding Commitments to Generic Letter 89-13
Action Request 960319147 Regarding Repeat Failures of Containment Isolation Valves
Action Request 961121204 Regarding Corrective Actions to Control Configuration of Ventilation System Equipment
Action Request 961202179 Regarding Corrective Actions to Address the Manual Valves Inconsistency between EOPs and the IST Program

Configuration Baseline Documentation

DE-CB-CC-0023(Q), Rev. 0, 1/15/94, CC System Configuration Baseline Document

Vendor Technical Document

304209, Rev. 7, August 1979, Westinghouse Precautions Limitations & Setpoints
317235, Rev. 1, 4/4/95, General Electric Thermal Overload Relay Data
317227, Rev. 1, 4/4/95, Reliance Motor Data 10 HP
317229, Rev. 1, 4/4/95, Electric Apparatus Motor Data 10 HP
317233, Rev. 1, 4/4/95, Limitorque Motor Data 0.2 HP
175421, Rev. 1, 9/12/94, Westinghouse CC Pump and Motor Data
910-142A-2, Two Channel Transport Model 2 PT868 Portable Flowmeter

Technical Standards

ND.DE-TS-ZZ-2012(Q), 7/13/94, Low Voltage Circuit Breakers & Combination Starters
ND.DE-TS.ZZ-2014(Q), 12/13/95, Protective Relaying for 4.16kV & 7.2kV Buses
SC.DE-TS.ZZ-2034(Q), 7/30/96, Construction of Electrical Installation

OPS Procedure

Emergency Operating Procedures
CC Abnormal and Normal Operation Procedures
2-EOP-APPX-1, Rev. 20, Component Cooling Water Restoration

Miscellaneous

SWEC TOL Walkdown, 11/95 - 3/96, Fuse & breaker Verification Data Sheets
MMIS Component Data, CC system 230V MCC Pan Data Records

Specification

S-C-1978-DSP-1303, Rev. 0, 7/26/78, Spare Motors (78-1303)
S-C-1970-EGS-0048, Rev. 0, 6/25/70, Alternating Current Motors (70001-A)
S-C-E000-EGS-0115, Rev. 0, 12/13/85, Alternating Current Motors (85001)

Work Order

960214251, 6/25/96, 2C EDG MOP Replacement
960805170, 8/8/96, 2A EDG Governor Corrective Maintenance
960214210, 7/9/96, 2B EDG MOP Replacement
931124002, 5/11/93, 2A 125V Station Battery Performance Test
950521003, 11/14/94, 2C 125V Station Battery Performance Test
931124004, 5/12/93, 2B 125V Station Battery Performance Test
880412133, 10/18/88, 2A 125V Station Battery Replacement
880412134, 9/17/88, 2B 125V Station Battery Replacement
950725034, Rebaseline 21 CC Pump per Procedure S2.0P-ST.CC-0001(Q)
960202028, Rebaseline 22 CC Pump per Procedure S2.0P-ST.CC-0002(Q)
950622037, Rebaseline 23 CC Pump per Procedure S2.0P-ST.CC-0003(Q)
960928055, Authorizing Troubleshooting Procedure to Collect Data for Evaluating Electrical Vibration Levels for 21, 22, 23 CC Pump
961112091, Authorizing Troubleshooting Procedure to Collect Data for Calibrating RHR HX CC Flow Elbow Meters
960608023, Regarding Inspection and Cleaning of 21 CC Heat Exchanger
960528046, Regarding Inspection and Cleaning of 22 CC Pump Room Cooler
950924133, Correct Bent Spring Rod Pipe Support 2P-CCH-332
960919250, Replace CC Surge Tank Vacuum Breaker Valve 2CC148
960422158, Perform Set Pressure Test on Relief Valve 2CC112

Modifications

2EC-3585/Pkg 1, 10CFR50.59 Safety Evaluation for CCW Letdown Temperature Control Valve (CC71)
2EC-3249, 7/8/94, Cable Protection (TOL Replacements)
2EC-3332, 4/1/96, 125V Battery Charger Replacement
2EZ-1478, 7/13/93, Valve 2CC71 Temperature Interlock
2EC-1015, 10/20/82, Addition of motor operators to CC Valves
2EC-0348, 8/3/83, Addition of motor operators to CC Valves
2EC-1014, 10/12/82, Addition of motor operators to CC Valves
Design Change 2EO-2340, Regarding Replacement Wedte Shoes for MOV 2CC117
Design Change 2EO-2425, Regarding Replacement of 1-inch Globe Valves 2CC281 and 282

Evaluations

S-C-230-EEE-0753, 5/18/93, 230V Motor Operation During Degraded Grid
S-C-230-EEE-0790-2, 7/20/93, Motor Starting & Running During LOCA Block Start

UFSAR

8.3, Onsite Power System
9.2.2, Component Cooling System
11.4.2.2, Process Radiation Monitor
Chapter 15, Accident Analysis

Technical Specification

2/4.8.1, AC Sources
3/4.8.2, Onsite Power Distribution

Procedures

S2.IC-CC.RM-0027(Q), Rev. 3, 12/11/96, 2R17B CCW Process Radiation Monitor
SC.MD-ST.ZZ-0005(Q), Rev. 2, 5/2/96, MCCB Maintenance
SC.MD-PT.230-0001(Q), Rev. 1, 5/22/96, TOL Overcurrent Trip Testing
SC.MD-CM-DG-0006(Q), Rev. 8, 6/12/96, DG Speed/Load Control System Alignment
SC.MD-ST.125-0004(Q), Rev. 8, 5/16/96, 125V Station Batteries 18-Month Service Test
SC.MD-FT.125-0002(Q), Rev. 4, 11/15/95, 125V Station Batteries Performance Discharge Test
S2.MD-ST.125-0001(Q), 7/27/96, 125V Battery Charger Maintenance
TS2.SE-SU.CC-0001(Q), CC System Flow Balance
S2.OP-ST.CC-0001(Q), -0002(Q), -0003(Q), Inservice Testing - 21, 22, 23 Component Cooling Pumps
S2.OP-ST.SW.0014(Q), Inservice Testing, Room Cooler Valves
S2.OP-PT.SW-0026(Q) and -0027(Q), 21 and 22 CC Heat Exchanger Heat Transfer Performance Data Collection

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-311/96-81-01	CC pump room ventilation deficiency prior to 1995
50-311/96-81-02	Current EOPs are inconsistent with single CC pump room ventilation failure
50-311/96-81-03	Current EOPs allow CC pump to runout which is not supported by pump design documentation
50-311/96-81-04	No documented basis for CC flow balance acceptance criteria
50-311/96-81-05	No documented basis for CC heat exchanger performance test assumptions and analysis
50-311/96-81-06	Lack of acceptance criteria for CC room ventilation coolers
50-311/96-81-07	CC radiation monitors not restored in a timely manner
50-311/96-81-08	CC pump room ventilation damper position is not controlled
50-311/96-81-09	Battery surveillance test inadequacies
50-311/96-81-10	CC supply to pump seal water cooling heat exchangers
50-311/96-81-11	Inadequacy in TOL heater calculation and control
50-311/96-81-12	Inadequacy in setpoint calculations for radiation monitors and surge tank level alarm
50-311/96-81-13	EDG loading study discrepancy with loading CC pump
50-311/96-81-14	EDG loading study discrepancy with battery charger
50-311/96-81-15	PASS operation inconsistent with UFSAR

LIST OF ACRONYMS USED

BEP	best efficiency point
CBD	Configuration Baseline Documentation
CC	Component Cooling Water System
CCHX	Component Cooling Heat Exchanger
EOPs	Emergency Operating Procedures
ESQ	Emergency Safeguards
ft	feet
gpm	gallons per minute
hp	horsepower
LOCA	Loss of Coolant Accident
NPSH	Net Positive Suction Head
NRC	United States Nuclear Regulatory Commission
PASS	Post Accident Sampling System
PSE&G	Public Service Electric & Gas
psia	pounds per square inch absolute
RHR	Residual Heat Removal System
RHRHX	Residual Heat Removal Heat Exchanger
RWST	Refueling Water Storage Tank
SFP HX	Spent Fuel Pool Heat Exchanger
SGS	Salem Generating Station
SI	Safety Injection
UFSAR	Updated Final Safety Analysis Report
°F	degrees Fahrenheit
MCCB	molded case circuit breaker
TOL	thermal overload relay
°C	degrees Centigrade
MAG	magnetic only (instantaneous) MCCB
CV	chemical and volume control system
SW	service water system
A	ampere
V	volt
kV	kiloVolt
kW	kiloWatt
W	Westinghouse
C&D	C&D Charter Power Systems
RM	radiation monitoring system
CBD	Configuration Baseline Document
ac	alternating current
dc	direct current
O/L	one line
EDG	emergency diesel generator
MCC	motor control center
LCR	Licensing Change Request
VTD	Vendor Technical Document
MOP	motor operated potentiometer
PU	per unit
LOOP	loss of offsite power

ENCLOSURE 1

EXIT MEETING SLIDES

SALEM UNIT 2

SAFETY SYSTEM FUNCTIONAL INSPECTION

COMPONENT COOLING WATER

NRC INSPECTION 50-311/96-81

DECEMBER 2-13, 1996

OBJECTIVE

Determine if the system will perform its intended safety function

SCOPE

- Verify the system has a technically sound design and licensing basis
- Verify that system components are tested to demonstrate design requirements
- Verify that system operating practices are consistent with the design
- Review licensee's efforts to validate licensing basis

OVERALL CONCLUSIONS

- Significant CC system improvements were made during the current outage
- The licensing basis descriptions (FSAR) were, with some exceptions, consistent with actual plant conditions
- Design issues were identified by the team that raise questions regarding CC system capabilities
- Contingent upon the satisfactory resolution of the SSFI findings,
- The SSFI team has concluded that the Unit 2 CC system can perform its intended safety function

CC PUMP ROOM VENTILATION

<u>Operating Practice Are Inconsistent with Design</u>

- Historically, the single failure of CC room ventilation was not properly addressed
- Current EOPs do not support CC system operation with a single ventilation component failure
- No CC ventilation design analysis to support current EOPs
- This issue should have been identified in 1995 when administrative requirements were changed
- Based on the SSFI finding, an AR was issued to track the resolution of this issue

Ventilation Configuration Control is Inadequate

- No ventilation damper administrative controls

- Dampers found mis-positioned

Ventilation Testing

- The CC pump room ventilation testing does not measure design parameters necessary to demonstrate function

CC PUMP OPERATION

Operating Practices Inconsistent With Design

- EOPs allow a CC pump to operate beyond its measured pump curve
- The calculation for CC pump runout/NPSH included some unsubstantiated assumptions
- An adequate analysis was not completed to support the runout of the CC pump
- Based on the SSFI finding, an AR was issued to track the resolution of this issue

ENGINEERING DESIGN EVALUATIONS

Calculations

- Calculations were generally easily retrievable and available
- The breaker overcurrent relay setting for 4 MOVs were not conservative and required resetting
- Multiple inconsistencies were noted in the MOV thermal overload calculation
- The setpoint calculation and actual CC radiation monitor setting were not appropriate
- The setpoint calculation for the surge tank level alarm was not complete

ENGINEERING QUALITY VERIFICATION

Licensing Basis Validation

- The PASS system is not operated in accordance with the FSAR description
- Several other minor descriptive FSAR discrepancies were identified
- Minor discrepancies were noted between the implementation of the FSAR project CC Macro Review and the administrative guidelines
- The CC Macro review fulfilled its intended function
- Two changes to the TS were not submitted in a timely manner

Probabilistic Safety Assessment

- Dependencies between the CC pumps/charging pumps and ventilation were not modelled correctly

- These errors impacted the calculated core damage frequency

SURVEILLANCE AND TESTING

Test Program Scope

- In general, CC system components were included in the test program
- One exception was the Spent Fuel Pool and Boric Acid Evaporator manual isolation valves

Procedures

- In general, the surveillance test procedures reviewed were appropriate
- One exception was the battery performance test procedure acceptance criteria were not consistent with the TS

Acceptance Criteria

- The basis for the CC flow balance test acceptance criteria was not documented

- The basis for the CC heat exchanger performance test acceptance criteria was not documented

Test Program Implementation

- In general, the test program implementation was good

- The 1993 battery surveillance test data were not properly evaluated

OPERATIONS

Procedures

- Operating procedures were generally of high quality and consistent with the CC system design

- Exception noted were the EOPs related to ventilation failures or CC pump runout and the RCP trip criteria was inconsistent between Abnormal Procedures

Training

- The CC training material was of high quality

- The simulator properly reflected the CC design with the exception of the CC radiation monitor setpoints

Equipment Configuration Control

- The CC radiation monitors have been out-of-service for nearly 1 year
- CC system drawings are generally accurate
- Corrective actions reviewed for CC system component failures were appropriate