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Facility: Salem Nuclear Generating Station, Units 1 and 2

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EXECUTIVE SUMMARY

Salem Inspection Report 50-311/96-19
October 22, 1996 - December 1, 1996

This inspection reviewed aspects of licensee engineering. The report covers a 6-week inspection related to the proposed testing for the Salem Unit 2 Integrated Test Program.

Based on their review of system test plans, test procedures, and Test Review Board activities, the inspectors concluded that:

- The Test Review Board was a good initiative in that it provided a forum for a multidisciplinary review of test results, and management interaction to guide testing personnel on appropriate actions to resolve test deficiencies.
- An unresolved item was opened regarding the Component Cooling Water Flow Balance Test results review. Specifically, issues regarding the correct cooling water flow to the safety injection pumps, the correct cooling water flow to the 24 reactor coolant pump thermal barrier, discrepancy with flow indication for cooling water flow to the residual heat removal heat exchangers, and status of the 21 component cooling pump with regard to IST requirements need resolution by PSE&G.
- The governing documents provide adequate controls for the conduct of the integrated test program.

Report Details

III. Engineering

E3 Engineering Procedures and Documentation

E3.1 Selection of System Test Plans for Review

a. Inspection Scope

The inspector reviewed the Salem Individual Plant Examination (IPE), submitted July 30, 1993, to determine the dominant contributors to the core damage frequency (CDF), and which systems were most important for risk reduction. In addition, the inspector reviewed NUREG-1150, "Severe Accident Risks, an Assessment for Five U.S. Nuclear Power Plants," to obtain further information related to risk at Westinghouse-designed pressurized water reactors (PWRs).

b. Observations and Findings

Public Service Electric and Gas Company (PSE&G) has developed system specific testing to assure the readiness of the systems to support unit restart and subsequent operation at full power. For the 46 critical systems in the System Readiness Review Program, these tests are delineated in the System Test Plans. The basis for the designation of the 46 critical systems was the combination of the safety related systems with those systems which had caused the majority of the plant transients during the past several years.

Table 3.4.7-8 of the Salem IPE contains the listing of basic events which contribute most to the CDF. The ranking of the individual events is based on reducing risk and the integrated plant model. The information is taken from Table 5.9-10 of the Salem Probabilistic Risk Assessment (PRA). These basic events identify systems and specific components within systems the failure of which leads to core damage.

The Zion plant is the Westinghouse design facility analyzed in NUREG-1150, "Severe Accident Risks, an Assessment for Five U.S. Nuclear Power Plants." Statements in the Salem IPE indicate that the Salem results are generally similar to the results for the Zion plant analyzed in the NUREG.

c. Conclusions

Based on the information in the Salem IPE and NUREG-1150, the inspector concluded that the most significant systems for risk reduction were: Emergency Diesel Generators, 4kV Distribution, Component Cooling Water, Service Water, and Safety Injection.

Eight systems were chosen for detailed reviews of the proposed testing. The selection of five of the systems was based on safety impact, and three more were added on the basis of the magnitude of the modifications made to the system during the extended outage.

The eight systems selected for detailed reviews are:

Diesel Generators	4kV Distribution
Service Water	Advanced Digital Feedwater Control System
Safety Injection	Control Room Area Ventilation
Component Cooling Water	Reactor Control and Protection System and Solid State Protection System (Hagan Modules)

E3.2 Integrated Test Program Controlling Documents

a. Inspection Scope

Governing documents for the Salem Unit 2 Integrated Test Program were reviewed to determine what requirements had been developed to control testing, and the handling of test discrepancies, during startup of the unit from the extended outage. Specific procedures reviewed included:

- SC.TE-TI.ZZ-0001(Q), Startup and Power Ascension Program
- SC.SE-DD.ZZ-0001(Z), System Readiness Review Program
- SC.SE-DD.ZZ-0002(Z), Support Systems Review Program
- NC.NA-AP.ZZ-0001(Q), Nuclear Procedure System
- NC.NA-AP.ZZ-0005(Q), Station Operating Practices
- NC.NA-AP.ZZ-0008(Q), Control of Design and Configuration Change, Tests and Experiments
- NC.NA-AP.ZZ-0009(Q), Work Control Process
- NC.NA-AP.ZZ-0059(Q), 10 CFR 50.59 Applicability Reviews and Safety Evaluations

b. Findings and Observations

Each of the procedures is discussed briefly below:

SC.TE-TI.ZZ-0001(Q), Revision 3, "Startup and Power Ascension Program"

This procedure implements the Startup and Power Ascension Program as required by the PSE&G Salem Restart Plan. This procedure defines the Startup and Power Ascension Program as consisting of component testing, system testing, integrated functional testing and power ascension testing to support the restart of the Salem Nuclear Generating Station. This procedure also provides guidance for the startup testing of critical systems as defined in SC.SE-DD.ZZ-0001(Z), System Readiness Review Program.

This procedure describes the functions of the Station Operations Review Committee (SORC) and the Test Review Board (TRB) in the startup process. The TRB performs technical reviews of system test plans and special test procedures (STPs), performs post test reviews of test results, and recommends approval of test plans, test procedures and test results to the SORC. The SORC approves testing described in design change packages (DCPs) and STPs, and recommends approval of System Test Plans to the General Manager.

Startup System Test Plans comprise a review of the PSE&G Salem Restart Plan work activities, with emphasis on the adequacy and completeness of testing required to ensure proper system function and performance. The system test plan also identifies the operational mode required for the performance of each planned test.

Hold points are established for Cold Shutdown, Hot shutdown, Hot Standby, Startup, and power operation. In addition, several power plateaus are defined for the power ascension phase of the testing. Plateaus are established at 25%, 47%, and 90% of rated thermal power to permit assessment of plant and personnel performance.

Test results will be evaluated for each system to determine the acceptability of deferring emergent or open work items. At the conclusion of the test program, the Startup Testing Manager will develop a report reviewing and summarizing the test results, and providing recommendations for incorporation into the startup plans for Unit 1.

SC.SE-DD.ZZ-0001(Z), Revision 5, "System Readiness Review Program"

This procedure provides overall guidance for PSE&G's efforts in determining system readiness for supporting the startup and subsequent operation of the Salem Station. The program consists of four phases culminating in the Startup and Power Ascension phase.

Phase I consists of a general review of system design documentation (UFSAR, Technical Specifications, configuration baseline documents (CBDs), License Commitment Documentation) was conducted during the Initial System Readiness Review (Phase I). The design basis review was expected to provide a complete and consistent understanding of the system functional requirements for readiness. A review was also conducted of the open corrective action program items, the preventive maintenance schedule, fluid system leaks, and labeling deficiencies. All items were evaluated and designated for accomplishment required prior to restart, recommended prior to restart, or deferral to post restart. Restart was defined as achieving criticality.

For systems considered to be within the scope of the program, the review was documented in system readiness review reports. These reports were submitted to the system readiness review board (SRRB) for evaluation and approval. After approval by the SRRB, the report is presented to the Management Review Committee (MRC) for final approval of work to be included in the outage scope.

Phase II consists of the system manager monitoring the status of ongoing work on the system during the extended outage.

Phase III consists of the final review of the readiness of the systems to support startup and subsequent power operation. It includes the deferral of outage scope work which did not get planned and scheduled, system walkdowns conducted by multidisciplinary teams, UFSAR/Tech. Spec. consistency review, evaluation of the effect of deferred work, and issuance of the final system readiness report.

Phase IV consists of the actual testing of the system during the plant startup and power ascension.

The procedure describes the methods to be used to evaluate and control emergent work during each phase of the program.

SC.SE-DD.ZZ-0002(Z), Revision 3, "Support Systems Review Program"

This procedure provides the process for the evaluation of the systems not covered by the System Readiness Review Program described above. This process ensures that the work to be performed on the system to make it ready to support restart is approved by management through the NAP-55 Outage Scope Control Process.

This process includes a review of the system design basis, outstanding work items, open corrective action program items, and a system walkdown. The evaluations performed for the support systems are similar to those performed for the safety related systems, although less rigorous. The final system readiness report is reviewed and approved by the SRRB.

NC.NA-AP.ZZ-0001(Q), Revision 8, "Nuclear Procedure System"

This procedure establishes the requirements for preparing, reviewing, issuing, and revising procedures for use at the Salem and Hope Creek stations. It also establishes the policies for the Nuclear Business Unit (NBU) relating to procedure use and adherence. The process applies to all NBU personnel, contractors (except those working under their own approved quality assurance program), and other PSE&G departments performing activities at the Salem and Hope Creek stations.

The policy statement on procedure use states that procedure users are expected to think about procedure activities before performing them, rather than blindly following the procedures. Procedure users are expected to report all problems with procedures, and submit revision requests to resolve those problems. If a procedure cannot be followed as written, the activity is to be stopped and the supervisor consulted. The supervisor will determine if an on the spot change (OTSC) is required. OTSCs are not required for typographical or editorial changes. The process allows for the use of computer-generated forms or attachments in lieu of a photocopy of the actual procedure form so long as the content is not changed.

OTSCs are used only when the normal revision process will not satisfy the time constraints necessary to implement the change, and the intent of the procedure is not changed. Approval is granted by the job supervisor and the Senior Nuclear Shift Supervisor (SNSS) or Nuclear Shift Supervisor (NSS).

NC.NA-AP.ZZ-0005(Q), Revision 6, "Station Operating Practices"

This procedure defines the operating practices for station and non- station personnel to follow to ensure the safe operation of the Salem and Hope Creek stations. Section 5.12, "Shift Briefings/Special Tests, Infrequently Performed Tests or Evolution Briefings" is of particular note since a number of the tests in the power Ascension phase will fall under the category of Special Tests.

The procedure requires that a test engineer be assigned for special tests, infrequently performed tests, or infrequently performed evolutions. In addition, a briefing by the supervisor is required prior to performing the test. Individuals who will be performing the activity are expected to ask questions at the briefing, and to be fully cognizant of the precautions, limitations, and conditions requiring test termination.

Special tests or infrequently performed evolutions are considered to be those which are not covered by existing station procedures, are performed less frequently than once every 18 months, use combinations of existing procedures such that the plant is placed in an unusual configuration, one time tests that have the potential to significantly impact plant conditions, or which require responses from multiple work groups. An additional category consists of plant startups after extended outages or following major modifications to reactivity control, power production, or power transmission systems.

NC.NA-AP.ZZ-0008(Q), Revision 10, "Control of Design and Configuration Change, Tests and Experiments"

This procedure establishes a uniform method for controlling design changes, configuration changes, tests and experiments at the Salem and Hope Creek stations. This procedure defines a test as a controlled set of plant operations intended to verify that a system or component conforms to predetermined specifications. An experiment is defined as a controlled set of plant operations intended to determine system or component characteristics which were not previously known. Tests and experiments which change the plant configuration, including long-term installation of temporary equipment, are required to be controlled and documented. This procedure provides that control through the change package process.

NC.NA-AP.ZZ-0009(Q), Revision 10, "Work Control Process"

This procedure provides the method for identifying, planning, scheduling, reviewing, performing, testing and post completion review of work on structures, systems, and components at the Salem and Hope Creek Stations. The definition of work includes corrective and preventive maintenance, modifications, testing, experiments, inservice testing, nondestructive examination, refueling, and tech. spec. surveillances with a periodicity greater than one week. Use of the process is mandatory on safety related, seismically qualified and fire protection equipment at the stations. Its use is strongly urged for balance of plant equipment.

Work is identified, planned, and scheduled on-line in the Maintenance Management Information System (MMIS). Material requirements are designated in MMIS, which initiates the procurement process. MMIS generates schedules, based on plant operating conditions, which drive the work accomplishment. MMIS is used to track the status of work, document the completion of work, and maintain equipment histories.

The MMIS automatically generates post-work test activities when the retest field is marked "Y". Separate work documents are generated for retest when testing is to be performed by another work group, when release of safety tagging is required for retest, or when system conditions need to be established prior to the post work testing.

NC.NA-AP.ZZ-0059(Q), Revision 5, "10 CFR 50.59 Applicability Reviews and Safety Evaluations"

This procedure provides the guidance for to perform applicability reviews for procedure revisions, changes, tests or experiments, and to perform safety evaluations when required by Title 10 of the Code of Federal Regulations, Section 50.59 (10 CFR 50.59).

The procedure requires that if a Tech. Spec. change is required, NRC approval be obtained before implementing the proposed revision, change, test or experiment.

c. Conclusions

Based on the information summarized above, the inspector concluded that the governing documents provide adequate controls for the conduct of the integrated test program.

E3.3 System Test Plan Organization and Contents

a. Inspection Scope

The inspector reviewed a sampling of system test plans, including those for the target systems, to determine what information they contained and how the information was organized and presented.

b. Observations and Findings

The system test plans are generated, reviewed and approved in accordance with SC.SE-TI.ZZ-0001(Q), Startup and Power Ascension Program. The system test plans are made up of a set of four tables, and a synopsis of the testing activities. The test plan is developed by the system manager, and reviewed by the TRB and the SORC. Final approval is by the General Manager. The test plans are revised, rereviewed, and reapproved as necessary due to changes in the outage work scope.

Table 1 of the system test plan contains a listing of the DCPs which were within the outage work scope. Entries in the table include the DCP identification, a brief description of the work to be accomplished, and the testing to be performed to ensure satisfactory completion of the work.

Table 2 of the system test plan contains a printout from the MMIS which lists the work orders which had been issued against the system during the outage. This printout was customized for the system managers to show the work order number, the work activities, and the retest requirements if appropriate. Each entry in the printout was coded for the integrated test program hold point for which the retest was required to be complete.

Table 3 of the system test plan contains a listing of testing which was deemed appropriate as a result of industry experience.

Table 4 of the system test plan consists of a listing of other testing the system manager deemed appropriate, along with a justification for each test. For those cases where no other testing was considered necessary, that also required justification.

The synopsis of testing consists of a narrative description of the testing planned and the general rationale. If special test procedures or major surveillance test procedures are to be used for testing, they are listed in the synopsis.

c. Conclusions

The inspector determined that the system test plans reviewed conformed to the requirements of the governing procedure and were appropriately reviewed and approved. The inspector concluded that the system test plans provide an excellent method of consolidating the testing requirements for a system into a single controlled document. This provides for easy identification of required testing.

E3.4 Reactor Control and Protection System (RCP) & Solid State Protection System (SSPS) Restart Testing

a. Inspection Scope

The inspector reviewed procedures and documents related to the licensee's efforts in establishing and implementing the Startup and Power Ascension Program and its effectiveness in demonstrating that the RCP and the SSPS would be subjected to testing that satisfactorily validates the new design bases.

Upon initial examination of the Startup System Test Plans for both the RCP and SSPS, the inspector concluded that both systems had undergone extensive design changes and modifications. For example, the RCP was substantially modified as a result of Hagan module replacements and upgrades, and the SSPS was modified to incorporate new design features (Advanced Digital Feedwater Control System) not present when the facility was originally licensed. The following subsections provide a brief description of documents reviewed and examined during the inspection, and the inspector's preliminary conclusions.

b. Observations and Findings

System Readiness Review Report - Reactor Control and Protection System (RCP) & Solid State Protection System (SSPS), dated September 28, 1996.

This report established the licensee's conclusions as to the scope of work needed to ensure readiness of the Salem Unit 2 RCP and SSPS systems for restart in accordance with SC.SE-DD.ZZ-0001(Z). In the "Design Basis and Licensing Basis Concerns" section of the report, the licensee concluded that "No evidence was found during the System Readiness Review that would indicate that the Reactor Protection and Control System deviates from its Licensing and Design Basis." However, the inspector noted, under "Summary of Evaluation of Work Scope," for the RCP that the licensee also identified three "major restart areas of concern" which included: (1) additional DCPs that will be required to support the Hagan Refurbishment & Replacement Project, (2) approximately 140 procedural changes needed to support existing DCPs such as Digital Feedwater System installations, (3) several outstanding workorders. Since the Hagan Refurbishment & Replacement Project, representing the replacement of approximately 75% of the RCP, had not been implemented by the readiness review report time-frame and was considered to be outside of the review scope, the inspector could not determine the overall status of the program. Additionally, the inspector identified the following concerns related to the report:

- (a) it is not clear that the affected systems were evaluated to identify known significant or recurring maintenance and operations problems;
- (b) it is not clear that affected surveillance test procedures were evaluated to identify what, if any, additional testing will be required to assure that the modified systems will perform their design basis functions;
- (c) it is not clear that any attempt was made to identify testing requirements necessary to verify the adequacy of new design modifications.

Startup System Test Plans for RCP (Rev. 0) and SSPS (Rev. 1)

This document identifies the affected system testing planned for the Salem Unit 2 Restart. This plan includes testing required following implementation of restart scope design changes, performance of system corrective and planned maintenance work activities as well as system surveillances required for restart/power ascension and any additional test requirements identified during the System Readiness Review process. Table 4 of the procedure is intended to provide justification for any additional testing needed beyond that identified by each DCP and/or workorder.

While the license acknowledged that the RCP "has gone through a total upgrade, which consisted of a combination of Refurbishment or Replacement," the conclusion reached in Table 4 is that "The requested additional testing is focused on the Process Control loops" and that "No additional testing is required on the Protection side of the Hagan system since the protection loops will undergo channel calibration and time response testing required by Tech. Spec." The inspector found no documented bases for the licensee's deviation from the requirements of SC.TE-TI.ZZ-0001(Q), "Startup and Power Ascension Program."

Specifically, it appeared that the Startup Test Plans for both RCP and the SSPS would not subject either system to Integrated Functional Testing (Section 5.1.3, Phase III) or to Power Ascension Testing (Section 5.1.4, Phase IV). It is not clear how the Salem Startup Group determined that existing Surveillance Test procedures would adequately verify the functionality of new or modified RCP and SSPS equipment.

c. Conclusions

The extent of testing of RCP and SSPS will require additional inspector review during subsequent inspections. (IFI 50-311/96-19-01)

E3.5 Component Cooling Water System Test Plan

a. Inspection Scope

The inspector reviewed the System Test Plan for the Component Cooling Water (CCW) System, Revision 0, approved August 22, 1996, and portions of the referenced DCPs which describe the change made and specify the post work testing. In addition, the inspector attended the TRB review of the CCW Flow Balance Test results which was conducted November 21, 1996.

b. Observations and Findings

Several of the DCPs involved the replacement of gate valve wedge guide shoes with Stellite® surfaced shoes. The description of the change stated that the valve factor would be reduced (reducing valve thrust on opening). The evaluation of other programs affected specifically stated that the motor-operated valve (MOV) program was not affected. When this matter was discussed with the engineer in charge of

the MOV program, he informed the inspector that the problem had been identified in August 1996, and an Action Request (AR) generated for evaluation and corrective action determination.

The inspector attended the TRB review of the results of the CCW Flow Balance Test. During the presentation of the results, the system manager indicated that there were discrepancies between the acceptance criteria and actual results. The discrepancies were: 1) Differences between indications of the ultrasonic flow meters used during the test, and the permanently-installed flow instruments for CCW flow to the residual heat removal system (RHR) heat exchangers. The discrepancy amounted to approximately 1,000 gallons per minute (gpm) at the design flow of 4,000 gpm. Personnel from the design engineering group stated that this could easily be resolved by changing the calibration range of the transmitter; 2) Only 38 gpm cooling water flow to the 24 reactor coolant pump thermal barrier heat exchanger could be achieved, rather than the required 40-42 gpm. Design engineering representatives stated that this was acceptable, since an analysis had been performed and 36 gpm would provide adequate cooling at normal system temperatures; 3) The required flow to the charging pump seal coolers could not be achieved. Design engineering representatives stated that the manufacturer had been contacted on this issue, and 5-7 gpm were needed for each seal cooler. As the Salem seal coolers are in series, rather than parallel as assumed in the design calculations, the flows achieved were adequate; 4) The test data show the 21 CCW pump at the low end of the inservice test (IST) range, and the data will need further scrutiny by the IST program personnel to evaluate its acceptability. These issues are unresolved, pending resolution by PSE&G and subsequent NRC review. (UNR 50-311/96-19-02)

During the TRB review of the CCW Flow Balance Test results, system engineering and operations representatives reminded the other members that the acceptance criteria were derived, in some cases, from design bases numbers, and that revisions to the test procedure which affected acceptance criteria would require full engineering evaluations and reviews for applicability of 10 CFR 50.59.

The review of the adequacy of post modification and startup testing will continue in subsequent inspections.

c. Conclusions

At the end of the inspection period, the review was still in progress. As a result, no final conclusions could be reached regarding the adequacy of the CCW testing.

Based on the CCW flow balance test results review, the inspectors could not rule out that the technical staff may be too willing to justify test results rather than correct inconsistencies. This will be further reviewed as the test program progresses and additional test results reviews are conducted.

E3.6 Service Water System Testing

a. Inspection Scope

The inspector reviewed the Service Water System Test Plan, Revision 1, dated July 12, 1996, and those portions of referenced DCPs which described the change and the post modification testing.

b. Observations and Findings

The inspector noted that a large portion of the modifications to the system consisted of replacing the carbon steel piping and components in the system with molybdenum bearing austenitic stainless steel. This change is intended to alleviate the corrosion problems which have been experienced with the cement and asphalt lined carbon steel piping which has been in use. Other changes involved replacing the service water pumps with a new design pump which is more suitable to the silt-laden brackish water at the plant.

The reviews of the adequacy of post-modification and startup testing will continue in subsequent inspections.

c. Conclusions

At the end of the inspection period, the reviews were still in progress, and no meaningful conclusions could be drawn.

E3.7 Safety Injection System Testing

a. Inspection Scope

The inspector reviewed the Safety Injection System Test Plan, Revision 1, dated October 17, 1996, and those portions of the referenced DCPs which described the changes made and the required post modification testing.

b. Observations and Findings

The inspector identified that the modifications being made to the Safety Injection System were primarily to mitigate potential problems which had been identified with the system. Examples included pump runout during long term recirculation (after an accident) due to cavitation-induced throttle valve trim erosion, and potential plugging of throttle valve ports by post-accident debris from the containment sump.

The reviews of the adequacy of post modification and startup testing will continue in subsequent inspections.

c. Conclusions

At the close of the inspection period, the reviews of the adequacy of post modification testing were still in progress and no substantive conclusions could be reached.

E8 Miscellaneous Engineering Activities

E8.1 Conformance to Updated Final Safety Analysis Report (UFSAR)

The inspector reviewed the following sections of the Salem UFSAR to identify the licensing basis for several of the systems selected for test plan review:

- 9.4.1, Control Area Air Conditioning
- 7.3, Engineered Safety Features Instrumentation
- 9.2.2, Component Cooling Water System

At a meeting held at One White Flint on November 18, 1996, a decision was made by senior agency management that the reviews of the startup testing should be conducted against the design calculations for the facility, not the UFSAR or Technical Specifications. As a result of this directive from senior agency managers, the conformance of the facility to the UFSAR was not evaluated. Rather, the extent to which the proposed testing will demonstrate the facility's conformance to its design basis is being evaluated.

V. Management Meetings

X1. Exit Meeting Summary

The inspectors presented the inspection results to members of licensee management on December 12, 1996. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

PARTIAL LIST OF PERSONS CONTACTED

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LIST OF ACRONYMS USED

AR	Action Request
CBD	Configuration Baseline Document
CCW	Component Cooling Water System
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
DCP	Design Change Package
GPM	Gallons Per Minute
IPE	Individual Plant Evaluation
IST	Inservice Testing
MMIS	Maintenance Management Information System
MOV	Motor Operated Valve
MRC	Management Review Committee
NAP	Nuclear Administrative Procedure
NBU	Nuclear Business Unit
NRC	Nuclear Regulatory Commission
NSS	Nuclear Shift Supervisor
OTSC	On-The-Spot Change
PRA	Probabilistic Risk Assessment
PSE&G	Public Service Electric and Gas
PWR	Pressurized Water Reactor
RCP	Reactor Control and Protection System
RHR	Residual Heat Removal
SNSS	Senior Nuclear Shift Supervisor
SORC	Station Operations Review Committee
SRRB	System Readiness Review Board
SSPS	Solid State Protection System
STP	Special Test Procedure
Tech. Spec.	Technical Specifications
TRB	Test Review Board
UFSAR	Updated Final Safety Analyses Report