

April 19, 2001

Mr. Harold W. Keiser  
Chief Nuclear Officer and President  
PSEG Nuclear LLC - X04  
P.O. Box 236  
Hancocks Bridge, NJ 08038

SUBJECT: SALEM GENERATING STATION UNIT 1 - NRC INSPECTION REPORT  
050000272/2001-005

Dear Mr. Keiser:

On March 23, 2001, the NRC completed a supplemental inspection at the Salem Generating Station Unit 1 facility. The enclosed report documents the results of the inspection, which were discussed on March 23, 2001, with you and Mr. D. Garchow and other members of his staff.

We conducted this inspection in accordance with NRC Inspection Procedure 95001, "Inspection for One or Two White Inputs in a Strategic Performance Area" as an examination of your activities associated with the unplanned reactor scram performance indicator (PI) crossing the White threshold during the fourth quarter of 2000.

You took appropriate actions in addressing the performance deficiencies contributing to this White PI and the discussion held at the exit meeting met the requirement for the regulatory performance meeting on this issue. As such, the NRC removed this issue from consideration of future agency actions, per the Action Matrix, in accordance with the guidance in Inspection Manual Chapter 0305, "Operating Reactor Assessment Program."

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Sincerely,

**/RA/**

David C. Lew, Chief  
Performance Evaluation Branch  
Division of Reactor Safety

Docket Nos.: 05000272  
License Nos.: DPR-70

Enclosure: Inspection Report 05000272/2001-05

Mr. Harold W. Keiser

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U. S. NUCLEAR REGULATORY COMMISSION

REGION I

Docket Nos.: 05000272

License Nos.: DPR-70

Report Numbers: 05000272/2001-05

Licensee: PSEG Nuclear LLC

Facility: Salem Generating Station, Unit 1

Location: P.O. Box 236  
Hancocks Bridge, NJ 08038

Dates: March 12 - 23, 2001

Inspector: Wayne L. Schmidt, Senior Reactor Inspector  
F. Jeff Laughlin, Resident Inspector

Approved By: David C. Lew, Chief  
Performance Evaluation Branch  
Division of Reactor Safety

## SUMMARY OF FINDINGS

IR 05000272-01-05 on 03/12 - 03/23/2001, PSEG Nuclear LLC, Salem Generating Station Unit 1. Initiating Events, White Performance Indicator (PI), Unplanned Reactor Trip, IP 95001.

This supplemental inspection was performed by the NRC to assess PSEG's evaluation associated with the unplanned reactor scram performance indicator (PI) crossing the White threshold during the fourth quarter of 2000. Salem Unit 1 experienced four reactor scrams (trips) during calendar year 2000 which caused this PI to exceed the licensee response band threshold and warrant this inspection. This inspection was conducted in accordance with NRC Inspection Procedure 95001.

### **Cornerstone: Initiating Events**

The identification, evaluation, and corrective actions for each of the individual trips were appropriate. The inspectors also determined that PSEG performed a comprehensive common cause analysis of the performance deficiencies which caused this PI to cross the White threshold. While the analysis did not identify a definitive common cause, several influencing factors were identified regarding the Salem Unit 1 reactor trips and associated white PI. These factors included human performance issues, equipment failure issues, procedure issues, and preventive maintenance program issues. These issues were documented in PSEG's corrective action program and addressed in a comprehensive corrective action plan.

PSEG took appropriate actions in addressing the performance deficiencies contributing to this White PI. The inspection exit meeting met the requirement of a regulatory performance meeting. As such, the NRC removed this issue from consideration of future agency actions, per the Action Matrix, in accordance with the guidance in IMC 0305, "Operating Reactor Assessment Program."

## Report Details

### 01 Inspection Scope

The NRC performed this supplemental inspection to assess PSEG's evaluation associated with the unplanned reactor scram (trip) performance indicator (PI) crossing the White threshold during the fourth quarter of 2000. This White PI is related to the initiating events cornerstone in the reactor safety strategic performance area.

Salem Unit 1 experienced four unplanned reactor scrams during calendar year 2000 which caused the plant to exceed the White threshold for the unplanned reactor scram PI. These scrams were as follows:

January 6, 2000	Manual Trip - Radio-frequency interference with feed water heater level controls caused all three intermediate feedwater heater trains to isolate. Operators manually initiated a reactor trip or shutdown.
April 12, 2000	Manual Trip - Personnel error during electro-hydraulic control (EHC) card replacement caused a 35% load reduction. Operators subsequently manually initiated a reactor shutdown.
August 9, 2000	Automatic Trip - Negative Rate - A failed circuit card in the rod control system (RCS) caused the "C" control bank rods to insert into the core, resulting in an automatic reactor shutdown due to a negative flux rate trip signal.
December 8, 2000	Automatic Trip - Steam Generator Low-Low Level - A failed circuit card in the solid state protection system (SSPS) caused a spurious feed water isolation. An automatic reactor shutdown followed due to a low level in one steam generator.

The inspectors reviewed the individual corrective action program condition reports (CR) and licensee event reports (LERs) for each reactor trip (CR 70003702, LER 2000-001; CR 70006336, LER 2000-002; CR 70009253, LER 2000-003; and CR 70012945, LER 2000-005, respectively)

The inspectors also reviewed PSEG's Common Cause Analysis initially completed following the first three trips and then updated following the fourth trip (Analysis report dated October 12, 2000, and January 25, 2001, respectively).

### 02 Evaluation of Inspection Requirements

#### 02.01 Problem Identification

- a. Determine that the evaluation identifies who (i.e. licensee, self-revealing, or NRC), and under what conditions the issue was identified.

Each CR for the trips appropriately identified the method of identification. The reactor operators identified two of the four conditions and took actions to manually trip the reactor. The other two reactor trips were automatically actuated by the SSPS.

- b. Determine that the evaluation documents how long the issue existed, and prior opportunities for identification.

The CRs documented how long the conditions that led to the reactor trips existed and prior opportunities to identify the problems. In addition to the four reactor trips that resulted in the white PI, PSEG's Common Cause Analysis reviewed Salem Unit 1 and 2 and Hope Creek reactor trips and power decreases since August 1997 to identify potential precursors to the conditions resulting in the reactor trips.

- c. Determine that the evaluation documents the plant specific risk consequences (as applicable) and compliance concerns associated with the issue.

The CR for each trip and the associated LER appropriately documented the plant specific risk consequence. No specific compliance concerns were noted.

#### 02.02 Root Cause and Extent of Condition Evaluation

- a. Determine that the problem was evaluated using systematic methods to identify root causes and contributing causes.

For each trip, PSEG implemented their corrective action program and established a Transient Analysis and Response Plan (TARP) team to gather information and analyze the causes of the reactor trips. PSEG personnel used several methodologies to evaluate the four plant trips, including Equipment Failure Evaluation, Hazard-Barrier-Target Analysis, Change Analysis, and Event and Causal Factors Analyses. Since both Salem Units are of very similar design and subject to common programs, PSEG's common cause analysis compared the Salem Unit 1 performance relative to the superior Salem Unit 2 performance to identify potential causes of the Salem Unit 1 reactor trip conditions. The inspectors concluded these methodologies were well established, commonly used in nuclear facilities, and appropriate for the application.

- b. Determine that the root cause evaluation was conducted to a level of detail commensurate with the significance of the problem.

The inspectors determined that the common cause analysis was of appropriate detail commensurate with the significance of the white PI. PSEG formed a team of five people to determine the causes involved in the Salem Unit 1 reactor trips. The PSEG team reviewed the details of the Salem Unit 1 and 2, and Hope Creek plant derates since the Salem Unit 2 restart in August 1997, as well as Licensee Event Reports, TARP team reports, system health reports, and the July Materiel Condition Report. The team also reviewed the apparent causes for the RCS and EHC equipment failures. The inspectors determined that PSEG followed its procedural guidance for performing a level 1 root cause analysis.

The inspectors concluded PSEG's common cause evaluation was thorough and well-documented. While the analysis did not identify a definitive common cause, several influencing factors were identified regarding the Salem Unit 1 reactor trips and associated

white PI. These factors included human performance issues, equipment failure issues, procedure issues, and preventive maintenance program issues. The common cause analysis made recommendations to address these factors.

For each Salem derate since August 1997, the common cause analysis identified the equipment involved by system and whether the derates involved human performance issues. While there was no clear correspondence between the systems involved in derates and the systems involved in Salem Unit 1 reactor trips, the common cause analysis concluded that the Salem Unit 1 reactor trips generally involved an equipment failure followed by a human performance issue. The analysis concluded that improving equipment reliability improvements in key systems (heater drain system, RCS, feedwater heater system, EHC and SSPS) would reduce reactor trips at Salem Unit 1 and the potential for similar events at Salem Unit 2.

The common cause analysis similarly reviewed maintenance rule data by system. This comparison concluded that while there were not meaningful differences between the Salem Unit 1 and 2 equipment performance data, the overall equipment reliability process should be reviewed against industry standards to improve equipment performance. Additionally the common cause analysis recommended improving equipment monitoring of RCS and SSPS components at the circuit card component level. The common cause analysis review of LERs, material condition reports, work order backlogs and system health reports were of appropriate detail; however no additional recommendations were identified.

PSEG's common cause analysis reviewed specific EHC and RCS equipment issues at the appropriate level of detail to identify differences in the Salem Unit 1 and 2 RCS preventive maintenance (PM) history. PSEG determined that a PM task to evaluate and functionally test RCS circuit cards had been approved for discontinuance through applicable programmatic controls. The PM task was last performed on the Salem Unit 1 RCS in 1992 and last performed on the Salem Unit 2 RCS in 1996. The recommended frequency of the PM task had been every two refueling cycles. The common cause analysis concluded that performance of this PM may have prevented the Salem Unit 1 August 2000 reactor trip and other RCS related performance issues. The common cause analysis recommended the RCS PM be re-established and modifications to upgrade the RCS be considered. A similar recommendation was made to consider the adequacy of PM tasks and equipment reliability for the SSPS and EHC circuit cards.

- c. Determine that the root cause evaluation included a consideration of prior occurrences of the problem and knowledge of prior operating experience.

PSEG's assessment included a Common Cause Analysis of the Salem Unit 1 reactor trips. This analysis considered the systems involved in the reactor trips since 1997 and additionally considered systems involved in all Salem Unit 1 and 2 and Hope Creek derates since the Salem plants restarted in 1997. This review considered previous similar equipment problems were identified. Three of the four Salem Unit 1 reactor trips involved performance issues with electronic circuit cards; however the circuit cards failed in different systems. The licensee's evaluation of each of these reactor trips, as documented



in the associated LER, did not identify prior occurrences of these failures within the last two years. There was no prior occurrence of the reactor trips which would have aided in preventing subsequent reactor trips.

- d. Determine that the root cause evaluation included consideration of potential common causes and extent of condition of the problem.

The licensee's common cause analysis was thorough and appropriately considered the extent of the problems by evaluating all plant derates since the Salem Units were restarted, maintenance rule data, system health reports, maintenance backlogs and Licensee Event Reports. While PSEG did not determine a definitive common cause for the Salem Unit 1 reactor trips that led to the white PI, influencing factors were identified concerning the need to improve the overall equipment reliability process, equipment performance of five specific systems, and performance monitoring and PM tasks for RCS circuit card components. The inspectors concurred with the assessment.

#### 02.03 Corrective Actions

- a. Determine that appropriate corrective actions are specified for each root/contributing cause or that there is an evaluation that no actions are necessary.

Root cause evaluations for each of the four Unit 1 reactor trips in calendar year 2000 were timely, thorough, and specified reasonable corrective actions. The evaluations were presented to the corrective action review board within the time limits specified by station procedures. PSEG has also specified corrective actions from the common cause analysis. These include the re-establishment of the Westinghouse preventive maintenance program for RCS circuit card functional testing and the refurbishment/replacement of SSPS circuit cards which contain components that could cause a reactor trip.

- b. Determine that the corrective actions have been prioritized with consideration of the risk significance and regulatory compliance.

The preventive maintenance of RCS electronic components was planned for refueling outage 14, scheduled to begin in April 2001, while the refurbishment of SSPS circuit cards was planned between May and August 2001. The inspectors concluded that PSEG's prioritization of corrective actions based on plant risk was reasonable.

- c. Determine that a schedule has been established for implementing and completing the corrective actions.

The inspectors reviewed PSEG's documented schedule of corrective actions and determined that the scope and timeliness was reasonable with appropriate emphasis on plant risk. SSPS was the only risk-significant system involved in a reactor trip and PSEG plans to refurbish the SSPS circuit cards between May and August 2001.

- d. Determine that quantitative or qualitative measures of success have been developed for determining the effectiveness of corrective actions to prevent recurrence.

PSEG has scheduled a self-assessment to determine if corrective actions taken to improve equipment deficiencies have been effective in reducing plant derates.

03. Management Meetings

Exit Meeting Summary

On March 23, 2001, the inspectors met with Mr. David Garchow and other members of the site management and presented the inspection results. Mr. David Lew, Chief, Performance Evaluation Branch, Region I attended this exit meeting.

The exit meeting met the requirement of a regulatory performance meeting, per the Action Matrix, in accordance with the guidance in IMC 0305, "Operating Reactor Assessment Program."

**Persons Contacted**

Eugene Nagy, Plant Engineering Manager  
Steve Mannon, Performance Engineering Manager  
Mark Fowler, Performance Engineer  
Ron Heaton, Component Engineer

**Documents Reviewed**

January 6, 2000, Trip - Order 70003702, LER 2000-001  
April 12, 2000, Trip - Order 70006336, LER 2000-002  
August 9, 2000, Trip - Order 70009253, LER 2000-003  
December 8, 2000, Trip - Order 70012945, LER 2000-005  
Common Cause Analysis, Salem Unit 1 Reactor Trips, Revisions 2 & 3 - Order 70009498  
Electronic Equipment Refurbishment Level 1 Action Plan  
Electrical/Control Systems Refurbishment/Upgrade Worksheet

**Acronyms Used**

EHC	Electro-hydraulic Control
IMC	Inspection Manual Chapter
PSEG	Public Service Electric & Gas
RCS	Rod Control System
RFO	Refueling Outage
SSPS	Solid State Protection System
TARP	Transient Analysis and Response