U. S. NUCLEAR REGULATORY COMMISSION

REGION I

Report Nos. 50-272/87-18
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50-311

License Nos. DPR-70
DPR-75

Licensee: Public Service Electric and Gas Company

80 Park Plaza

Newark, New Jersey 07101

Facility Name: Salem Nuclear Generating Station - Units 1 and 2

Inspection At: Hancocks Bridge, New Jersey

Inspection Conducted: June 15, 1987 - June 19, 1987

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Inspection Summary:
Inspections on June 15, 1987 - June 19, 1987 (Combined Report Numbers 50-272/87-18 and 50-311/87-20)

Areas Inspected: Feedwater and condensate systems, including maintenance, surveillance, design changes, operations and management overview. The inspection involved 192 inspector hours by the NRC inspectors.

Results: The inspection team concluded that the licensee has successfully reduced the previously high number of Balance of Plant (BOP) related reactor trips. Management commitment in the form of manpower, expenditures, engineering, and preventive and corrective maintenance was evident. Strengths identified included significant, multi-disciplined review and implementation groups focused on reactor trip reduction. Weaknesses included minor procedure and system discrepancies identified by the team.

DETAILS

1. Persons Contacted

Within this report period, interviews were conducted with members of licensee management and staff as necessary to support the inspection activity. The personnel in attendance at the entrance and exit interview are listed in Appendix A.

2. History

Unit 1 came on line in December 1976 and Unit 2 came on line in May 1981. As can be seen by the table in Appendix "B", feedwater related reactor trips were numerous throughout the operating history of Salem station. The total reactor trips for both units at Salem is 260, with 118 trips being related to the feedwater system. According to the Westinghouse Owners Group (WOG) studies, this is an average ratio of trips that are feedwater related among Westinghouse plants. After an analysis of the types of reactor trips that are attributable to feedwater, two major, or above the average, subsets of this type of reactor trip can be identified; operator related, and feed pump related.

Operator related reactor trips, especially during the start up of the units, are directly attributable, for the most part, to the complex system design and operator inexperience at operating the system. The design of the steam dump system (described in section 5) did not lend itself to a smooth transition while placing the turbine on line. This coupled with manual control feedwater bypass valves led to the majority of operator induced feedwater trips.

Feed pump related reactor trips are due mainly to a low suction pressure condition (described in section 5) tripping the feed pumps. This problem has occurred partly due to the design of the condensate system and also as a result of cascading transients in the heater drain system.

With the correction of the aforementioned problems by an improved steam dump system, automatic feedwater regulating bypass valves, and the addition of higher capacity condensate pumps, feed system related trips have been reduced and the recent (since 1985) reactor trips appear to be caused mainly by random equipment failure. The reactor trips currently being experienced in the feedwater system are also more compound, in that they are multi-symptom related. For example, a feedwater or condensate system transient, brought about by an equipment failure, is compounded by an operator error while responding to the problem resulting in a reactor trip.

The team also identified that recently the operators, by appropriate and immediate response, have prevented plant trips following feed pump trips at high power levels. This action was not regularly achieved during earlier plant operations. Improved operator training and performance in the plant and feedwater system operation was noted after the start up of

the plant specific simulator. Modifications in operating procedures and lineups for the turbine control system have also enhanced the ability of the operators to recover from plant transients that in the past would have tripped the unit.

Other modifications to the instrumentation system, feed regulating valves, feedwater pumps and control oil system, have also contributed to an improved operation of the feed and condensate systems.

3.0 Operations

3.1 System (Valve) Lineups

The status and control of valves are maintained on the Tagging Request and Inquiry System (TRIS), a computer database system. This system was developed to avoid the inadvertent mispositioning of components (valve, breaker, disconnects, etc.) during component alignment for specific modes of operation and for safety tagging operations. The inspector reviewed a valve alignment report printout from the TRIS system for operation of Unit 2 feed and condensate systems in mode 1. The valve identification and positions were consistent with those listed on the Unit 2 steam generator feed and condensate drawing (DWG) 205302 (Revision 28). The inspector also reviewed the Unit 1 steam generator feed and condensate DWG, 205202 (Revision 32). The inspector noted a labeling error on sheet 3 of 3 for this drawing. Both feed pumps were labeled at the pump discharge as "No. 12 STM. GEN. FEED PUMP." One should have been identified as the No. 11 steam generator feed pump (SGFP). The inspector discussed this with a member of the QA organization, who indicated that it would be corrected. No other errors were detected on the drawings or valve lineups.

The inspector also reviewed operating procedures for the feedwater and condensate systems. Interviews with the operators indicated a good knowledge of systems and operating procedures on the part of the operators. However, the inspector observed that certain plant changes (condensate pump upgrades) were not reflected in operating procedures. Condensate pump parameters, in the current procedure while conservative, do not reflect the actual parameters of the new pumps. This problem was identified to the licensee for corrective action. Further discussion with licensee management indicated other minor BOP procedure discrepancies for which licensee review and corrective action was appropriate.

3.2 Walkdown

The inspector conducted a walkdown of the feed and condensate systems (partial) for Unit 2 with particular attention paid to the following items:

- valve positions
- maintenance activities
- cleanliness and preservation
- component conditions
- labels and tags

The inspector noted the following observations: The valves were in their expected condition for a plant operating at power and although no valve maintenance was observed, there were indications that an active program was ongoing relative to steam leak repairs. Only one steam leak was observed on a heater drain valve near the condensate pumps. There were some valves with lagging removed which indicated that steam leaks had recently been repaired.

All of the feed and condensate valves examined by the inspector were labeled. The main steam, feed, condensate and other system piping in the turbine building had been labeled with colored tape to indicate the system, line number, and direction of flow. Metal identification tags were attached to all of the feed and condensate valves which the inspector examined. Most of the system labeling had been completed in the last year.

On several Limitorque valves, stem covers were missing. One pressure gage on No. 2 lube oil purifier was broken. With the exception of these deficiencies, the feed and condensate systems for Unit 2 appeared to be in good condition. These items were discussed with the licensee. There was also cleaning and preservation (painting) in progress. The results of the walkdown indicated that increased management attention to the balance of plant was evident.

3.3 Operator Information

The inspector reviewed several Operation Department's "Newsletters." They provided pertinent information to the operators on a daily basis. The newsletters generally contained the following general types of information:

- Unit 1 Standing Orders
- Unit 2 Standing Orders
- Standing Orders common to both units
- Unit 1 Status
- Unit 2 Status
- Notices
- Review of Past Notices
- Procedural Changes
- Safety Concerns
- General Interest

Notices usually described recent incidents which have occurred in the industry and were of interest to the operating staff. Past notices contain similar information of interest.

The Operations Department has also established "Information Directives" (IDs) to disseminate operating information to designated personnel. They are used to transmit items of information, significant LERs, NRC Bulletins, introduce new or revised procedures, inform the shift of temporary or permanent changes to operating parameters or practices or any other functions deemed necessary by the Operations Manager. The NRC inspector reviewed several IDs to ensure that information was being disseminated in a timely manner.

Another system established to provide information to the operators is the Technical Department Engineering Memo (TDEM). These are used primarily to convey to various departments information regarding operation, maintenance, or other site activities derived from engineering studies or vendor field instructions. The TDEMs were originated based on engineering review of the following types of documents:

- Operational history review (pump flow, pump vibration data, etc.)
- System (component) failures
- Vendor manual review, updates
- Technical specification/license changes
- NRC/regulatory bulletins
- Industry related experience (INPO)

TDEMs also include any action that is required as a result of an engineering review. The inspector reviewed several TDEMs to confirm that the information provided or requested was sufficiently clear to communicate the appropriate information or initiate the desired action. Distribution verification for both IDs and TDEMs is accomplished by an initialed distribution sign-off sheet.

During refueling outages, summaries were prepared for those design changes which are planned for that outage. These summaries listed the system, the design change number, and the drawings affected. A brief description of the change was given including figures where appropriate. Changes to valve lineups and procedures were also discussed. In addition, formal operator training covering all new design changes is conducted prior to start-up from each refueling outage.

Based on review of these programs, the inspector concluded the licensee's programs cover both safety-related and BOP topics, and are adequate to disseminate information to the licensee personnel.

3.4 Vendor Technical Manual

The inspector reviewed controlled vendor technical manuals for the following equipment:

Component	Vendor
Steam Generator Feed Pumps	Worthington
SG Feed Pump Turbines	Transamerica Delaval
Condensate Pumps	Ingersoll-Rand
Condensate Pump Motors	Electric Mach. Mfr. Co.

The inspector confirmed that the vendors' recommendations for operation of the above equipment were consistent with the licensee's operating procedures. The precautions, safety notes, operating limits and other parameters were included in the procedures. No problems were identified with incorporation of vendor technical information into station procedures for the identified BOP equipment.

3.5 LER Review

The inspector reviewed several recently submitted LERs that detailed reactor trips as a result of events initiated within the balance of plant. Those reactor trips initiated by the secondary plant and attributed to operator or personnel error were frequently accompanied by the following factors:

- passive component failures
- off normal conditions
- unusual tests or operating procedures
- restriction in BOP flexibility

The inspector expressed his concern that reactor trips and safety system challenges seem to occur when accompanied by one or several of the above conditions which should be emphasized to the operators when any of the above conditions are anticipated. The licensee acknowledged the inspector's concern.

No violations were identified.

4.0 Maintenance Activities

4.1 Corrective Maintenance Program

Site activities with regard to corrective maintenance are described in the station administrative and maintenance procedures. Activities associated with mechanical, electrical and I&C maintenance utilize separate control procedures. The scope of this inspection was limited to maintenance procedures related to the feedwater and condensate system.

The inspector selected certain procedures, as described below, for detailed review. Procedure M-6F provides guidelines and detailed instructions for the repair, overhaul, inspection, and reassembly of the Steam Generator Feed Pump (SGFP). Procedure M-24 includes eight subsections for feed and condensate systems as well as heater bypass control valve inspection guidelines. Procedure M-24D delineates various instructions for the SGFP recirculation control valve, including removal, installation, and disassembly.

Based on the review of these procedures, the inspector determined that the maintenance procedural steps were appropriately highlighted in some areas to avoid a safety system challenge caused by equipment malfunction or failures in the feedwater system. The inspector also noted that design and facility modifications for the feedwater system or related support systems were evaluated in accordance with the 10 CFR 50.59 requirements. In fact, the maintenance program for the feedwater system was treated the same as a safety-related system, and the tasks were routinely performed by personnel qualified to perform work on safety-related systems.

A computerized Maintenance Information Retrieval System is currently operational. This program provides automated material history and maintenance planning information for all plant equipment. The licensee is continuing to make refinements and intends to consolidate all maintenance activities into one centralized information retrieval system which will include the station work orders.

4.1.1 Corrective Measures to Improve Equipment Failures

Equipment failures in the feedwater system were routinely evaluated and their results were incorporated into the corrective and preventive maintenance programs. Such evaluation results aided in providing an input into the possible design changes or modifications. The following corrective measures to minimize valve packing leaks and to improve system performance were reviewed:

- An orifice was installed in the moisture separator reheaters to improve system stability and performance.

- Special leak-sealing chemicals were sprayed over the condenser joints to reduce the air inleakage to the main condenser.

- The feedwater regulating valves were repacked with Chesterton live-loaded packing. This has reduced valve packing leaks and improved system reliability.

Three steps of preventive and corrective measures were being applied to eliminate water accumulation in the SGFP control oil system. A weekly surveillance check for water accumulation in the control oil sump was implemented, a design change was implemented to upgrade the moisture separator system and reroute the moisture separator piping in order to draw a suction on the bottom of the control oil sump, and a Design Change Request (DCR) has been initiated to install separator filters at the inlet of the SGFP governor. In addition, a SGFP turbine drain modification, DCR No. 25M-00094, has been scheduled to be completed during the next outage.

4.1.2 Post-Trip Maintenance Activities

The post-trip work activities covering the period between 1982 and 1987 were reviewed (see Appendix D). Since 1982 a total of 27 feedwater system induced reactor trips were experienced for Salem Units 1 and 2. Seven of the 27 trips were related to feedwater regulating valves (BF-19s), 12 of 27 trips due to SGFP problems, 3 of 27 due to instrumentation and logic problems. Five others could not be categorized. Within the scope of this review, the inspector determined that adequate corrective measures were taken, and the root-cause analysis of the problems were properly evaluated and assessed. The preventive measures and the immediate actions taken were accomplished in a timely manner.

The inspector noted that the licensee was not able to locate some of the completed work orders, and the status of some work orders was unknown. The licensee representative stated that because of recent reorganization of the maintenance department and ongoing implementation of MMIS computerized system, some work orders were filed out of sequence and it would take a longer time to locate them. In the interest of time and the amount of work orders reviewed the inspector did not pursue the work orders in question.

4.2 Preventive Maintenance Program

The station preventive maintenance program is delineated in procedure TD 8, Preventive Maintenance, Revision 0, and prescribes the managers responsibilities as well as periodic actions, and predictive methods to be utilized by station personnel to determine and schedule preventive maintenance. Procedure TI 14, Vendor Manual Review Program, Revision 0, provides instructions related to the vendor manual review program.

Instrument calibration activities are conducted in accordance with the station I&C calibration procedures. The inspector reviewed general instrument calibration procedure, IC-1.4.003, and channel sensor calibration procedures, 2PD-2.9.109 and 2PD-2.9.110, for the steam generator feedwater pumps and steam dump pressure sensors respectively. The associated calibration data sheets were also reviewed. The pressure sensor for No. 21 condensate pump discharge flow was calibrated on February 13, 1985. The associated flow transmitter was calibrated on February 14, 1985. Within the scope of this review, the inspector concluded that the preventive maintenance procedures with regard to the feedwater system were consistent with the other safety-related system procedures, and met the guidance specified in ANSI N18.7-1976 and Regulatory Guide 1.33.

The licensee also instituted a Machine Condition Monitoring Program to monitor component performance, and predict required maintenance prior to failure. This will allow the licensee to schedule maintenance during available plant load reductions, and prevent trips related to component failure. The heater drain pump and condensate pump are monitored for excessive vibration, and spectral frequency analyses are performed, and the results are applied to the pump predictive maintenance program.

An Equipment Performance and Reliability Trending Program has been instituted, in which oxygen content in the condensate system and condenser air inleakage are trended. The inleakage trending program resulted in a preventive measure to reduce the inleakage by spraying the condenser penetrations with a special chemical, which increased the vacuum from 1.7 inch-Hg to 1.2 inch-Hg.

A pump bearing temperature trending program led to a minor design change request (DCR), No. ISM-0280, which increased the bearing temperature alarm setpoints. An excessive number of alarms had been actuated for the condensate pump, unnecessarily diverting the operator's attention.

As a part of the reactor trip reduction program for critical components, a program has been initiated addressing INPO standards for contractor bid specifications. The objective is to provide detailed instructions and specifications for future contract bidders, and includes the following items:

- Reliability-Centered Maintenance (RCM) tasks
- Spare parts controls for the preventive maintenance
- Monitoring standards and performance trending systems

In addition, a quote document, QUOTE NO. 87015, was released on January 19, 1987 to solicit bidders to develop a Level I Probabilistic Risk Assessment (PRA) model. The objective was to utilize the PRA study to identify the risk and weaknesses of the plant, and incorporate the study results into the maintenance program. Even prior to the PRA bid solicitation from vendors, the licensee MMIS project prioritized the Salem plant systems by rank order as determined by employing the Value Oriented Decision Analysis Process (VODAP). The VODAP ranks the plant systems by assessing the tangible and intangible parameters regarding system operation and reliability. Therefore, a higher ranked system offers a better return in terms of operating and maintenance costs.

In the VODAP rank order (see Appendix D), the steam generator feedwater and condensate system ranks seventh, and the feedwater pump lube oil system ranks twentieth. Other safety-related systems such as reactor coolant, reactor protection, vital electric power and service water ranked higher than feedwater system. The licensee evaluated failure history of the systems from the corrective maintenance work orders, and performed a time series analysis. The study further subdivided and analyzed the component level for the failure cause and failure modes, and specific recommendations and maintenance tasks were developed. Some of the recommended maintenance tasks for the Main Feedwater and Condensate System are as follows:

Equipment/Component	Frequency	Maintenance Task
Valves		
11 thru 14 BF40 21 thru 24 BF40	Every 3 years (3Y)	Calibrate electric position transmitter
13, 23 CN22 12, 21 CN27	3Y	Inspect, lubricate exercise positioner linkage
11, 12, 21, 22 CN8 21, 22 CN22 12 CN36 21 CN27	3Y	Inspect and adjust switches as necessary
Pumps		
11 and 12 Feedwater Pump 21 and 22 Feedwater Pump Pump Suction Line Flanges Pump/Turbine Drain Line Flanges Turbine Gland Seal Flanges	5Y	Inspect flange, tighten flange bolts to specification or replace gasket as required.

Equipment/Component	Frequency	Maintenance Task
11, 12, 21 and 22 Feedwater Pump Turning Gear Engagement Mechanism	3Y	Inspect/overhaul solenoid valve. Test limit switch actuation, adjust as necessary. Exercise and lubricate engagement components.
Mechanical		
11 Pump/Turbine Lube Oil Piping System 12 Pump/Turbine Lube Oil Piping System 21 Pump/Turbine Lube Oil Piping System 22 Pump/Turbine Lube Oil Piping System	5Y	Inspect all flanges and joints for leaks. Torque flange bolts or renew sealing compound/gaskets, as required.
1 Lube Oil Separator 2 Lube Oil Separator	4Y	Disassemble, inspect and overhaul, as necessary.
Instruments		
1, 2 PD-2319 1, 2 PD-2340 1, 2 PD-2765 1, 2 PD-2766	2Y	Calibrate
1, 2 PL-2901 1, 2 PL-2902	2Y	Calibrate
1, 2 PL-2176	2Y	Calibrate

In conclusion, the inspector determined that the above innovative program should enhance both the preventive and corrective maintenance tasks, and that the availability of the feedwater system and the challenges to the safety-related systems would be improved should such a program reach full implementation. Furthermore, the inspector noted that activities related to the feedwater and condensate system were treated the same as those for the safety-related systems including use of procedures, documentation of work, and quality control inspection.

4.3 Inservice Inspection Program

The Inservice Inspection (ISI) program is limited to those valves associated with the containment isolation specified in technical specifications, which included feedwater regulating bypass valves (BF-40s) and feedwater regulating valves (BF-19s). Inservice testing for these technical specification valves was performed using procedure, SP(O)4.0.5-V-MS-5, Revision 0, Inservice Testing - Valves Main Steam and Boiler Feed. The ISI records were reviewed as follows:

Valves	Date Performed
Bypass valve BF-40	9/15/86
Stop Check valve BF-22	9/15/86
Regulating valve BF-19	9/15/86

In a letter dated June 4, 1987, SPE-87-0135, the licensee instituted an inspection procedure to meet the anticipated requirements for inspection of high energy, carbon steel piping systems by Institute of Nuclear Power Operation (INPO) and USNRC. The initiative was a coordinated effort to inspect single phase erosion/corrosion of the high energy piping system. The licensee also conducted ultrasonic examinations of selected feedwater piping systems in conjunction with their response to the feedwater line rupture event at Surry. The examination results were documented in a summary report dated February 2, 1987. Based on the above reviews, the inspector determined that no unacceptable conditions were identified.

4.4 Procurement of Replacement Parts

The station replacement and spare parts are controlled by a computerized Materials Management System (MMS), and they are classified into approximately 1300 QA classifications by requirements and functions. There were only 20 exception items listed in the attachment 5, QA Exception List, VPN-PRP-01, Revision 2. Several procurement records were reviewed to verify that the replacement parts for the feedwater system were either equivalent to or better in quality than the original parts. The following purchase orders were reviewed:

Item	Purchase Order	Date	Comments
BF-19 FWS Regulating, Vulcan 14" Globe Valve	918437	3/29/84	same as original
gasket	917893	3/27/84	same as original

Item	Purchase Order	Date	Comments
BF-19 Vulcan Globe packing	919715	4/10/84	same as original
	939556	3/27/85	same as original
	117520	11/18/85	same as original
SGFP Worthington Pump shaft	943267	6/13/85	same as original
SGFP Worthington Pump bearing retainer	785281	1/02/81	same as original
BF-19 Vulcan Globe Valve	788048	2/03/81	same as original
Valve stem	141570	4/22/86	same as original

Within the scope of this inspection for the feedwater system, the replacement parts and materials were equivalent to original parts in quality, and their procurement controls were consistent with those of safety-related parts and components. No unacceptable conditions were identified.

No violations were identified.

5. System Design and Modifications

The condensate and feedwater systems at each of the Salem units consist of three condensate pumps, three parallel low pressure heater strings, a full-flow condensate polishing unit, two steam-driven steam generator feedwater pumps (SGFP), three parallel high pressure feedwater heaters, followed by air operated feedwater control valves (BF19) and low flow bypass valves (BF40). Heater drain pumps provide additional water inventory at the SGFP suction. The condensate polishers were not in the original system design. The Unit 2 polishers were operational at plant licensing and the Unit 1 polishers were installed during the first refueling outage. As stated in the Updated Facility Safety Analysis Report (UFSAR), Section 10.4.7.1.1, the design codes for feedwater piping were ANSI B31.7 (1969) inside containment and ANSI B31.1.0 (1967) outside containment.

The inspectors reviewed a number of proposed and completed design changes made to the feedwater system. Since the licensee uses the same design change control and documentation system for all facility modifications, an extensive and complete record exists for all modifications, regardless of system and component classification. A number of system and component modifications were made in response to plant events which were initiated

by the feedwater system. Typically, these resulted from post-trip reviews. However, several analyses were conducted which were broader in scope and which served to focus on system vulnerabilities.

The first of these analyses reviewed was completed in 1982 following a series of feedwater pump trips resulting from low suction pressure. The analysis was done on a synergistic system basis covering the steam, condensate, and feedwater system. In this broader view, secondary system interactions leading to low feedwater pump suction pressure were analyzed to better determine root cause. In general, part of the problem was the addition of the full flow polisher to the original system design. The additional pressure drop through the polisher put SGFP suction pressure closer to the trip point, making the system less forgiving of secondary plant transients. This was compounded by reduction in heater drain flow on power reduction, a condition which then had to be compensated by increased condensate flow. A proposed corrective action was an upgrade of the condensate pumps' head-capacity. This action has been completed on both units within the last year.

A second detailed analysis, completed in December 1986, dealt with operation of the steam dumps or turbine bypass valve system. The licensee recognized that the original steam dump system, twelve valves operating in ganged groups of three, was oversized, tended to overlift, and had a control system which did not lend itself to low power pressure control. The system had been designed primarily to handle high power transients and did not perform well at low power levels. A design modification, changing valve trim, controls, and sequencing the operation of the first six valves has been completed on Unit 2 and is scheduled for installation on Unit 1.

The inspector reviewed a licensee prepared printout showing the status of all proposed design change requests related to the condensate and feedwater systems. All facility modifications, regardless of safety classification, are tracked and documented in the same system in accordance with licensee procedure GM8-EMP-009, Operational Design Change Control, Revision 1, dated August 1, 1986. Since a single system is employed, detailed design change information is readily available for historical review. Since licensing of the plants, 173 design changes have been proposed for these systems in Unit 1, 98 changes have been proposed for Unit 2. Recently, management initiated an effort to reevaluate all outstanding changes to focus attention on those with significance to system reliability. As a result, 91 changes on Unit 1 and 61 changes on Unit 2 were cancelled. The remaining design modifications are complete or in progress.

The inspector also reviewed the following specific modifications which were intended to correct conditions responsible for plant trips: DCP Nos. 1EC1207 and 2EC1251. These design changes on Unit 1 and 2, respectively, were completed in early 1983 (1) and early 1984 (2). The modification provides narrow range control room indication of feedwater flow and steam flow as a means of providing better information to the operator during low power operation, especially with feedwater flow control in manual. An

additional feature provided is automatic control capability for the feedwater flow control bypass valves (BF40's). This allows an earlier shift to automatic level control, reducing the time necessary for the operator to maintain level control in manual on four steam generators simultaneously.

Also reviewed were DCP Nos. 1EC1380A and 2EC1381A. These modifications were completed in late 1986 on both units. As discussed above, the design changes upgraded the condensate pumps to provide better head-flow characteristics. The modification consisted of replacing the condensate pump impeller with a nine stage impeller and replacing the 3000 BHP motors with 4000 BHP motors.

Discussions with plant personnel and review of status records indicated that a number of other modifications have been completed to improve system operation. These include: providing a two level feedwater suction pressure trip (190 psi, and 215 psi with 5 second time delay), the addition of diodes in feedwater pump controls to reduce noise induced signals, deletion of interlocks with valves in the low pressure recirculation system which have caused pump trips, and modifications to the SGFP annunciator panel to provide more useful first-out indication to assess reasons for pump trips. In the above cases, continuing attempts to improve system operation and assessment capabilities were evident. In each case, appropriate codes were called out in the design documentation, retests were specified and documented, and operators were trained in the modifications by way of the operations newsletter and inclusion in the requalification program. In almost all cases reviewed, procedures had been changed to reflect the modified system.

An examination of plant trips (particularly those involving the main feedwater system) indicates that recent trips are not related to the recurring and chronic problems seen in the early 1980's. Since recent trips appear to be the result of new problems, the licensee is also exploring the possibility of making the entire system more forgiving in the event of transients such as loss of a main feedwater pump. Proposals being reviewed by the licensee include the installation of an automatic runback in the Electro-Hydraulic Control (EHC) system to reduce power at a predetermined rate in the event of an SGFP loss. The EHC is currently set up to manually initiate this runback by depressing one pushbutton. The licensee is also evaluating reactor protection system setpoint changes in order to increase system flexibility. These will be subject to NRC review as part of a Technical Specification change request.

The inspector found that the licensee is making changes to the system as analysis dictates the need. The changes are consistent with the construction codes used, and the changes appear to have been effective in reducing trips which have a feedwater system implication.

No violations were identified.

6. Management Support

Management has committed to improvements in Balance of Plant (BOP) and issued an Administrative Procedure AP-41 which delineates the systems which will be encompassed by the program to enhance reliability of station operation. The program is designed to reduce challenges to safeguard systems releases to the environment and significant capital risk. This procedure outlines the responsibilities of the plant managers with regard to maintenance, purchasing of materials, and quality assurance surveillance of the systems. The following is a list of BOP systems included in AP-41:

- Main steam system piping and valves between MSIVs and main turbine condensate, feedwater, and heater drain pumps, piping, motor-operated valves, check valves, control valves, and flow control system. (Vent and drain valves and valves less than 2" are exempt from the program unless specifically identified.)

- Main turbine, generator, electro-hydraulic control system, lube oil system, generator cooling system, and hydrogen seal oil system

- Main turbine gland seal steam pressure controller

- Main condenser, circulating water pumps, and screens

- Feedwater heaters, moisture separator reheaters, extraction steam piping, heater drain valves, and heater level control systems

- Turbine auxiliary cooling system

- Station air compressors, air dryers, and filters

- Main station power, and auxiliary power transformers

- 4160 VAC and 480 VAC group buses, breakers, and relays affecting the above-listed equipment

- Reactor control systems and M/G power supplies (not reactor protection system)

- Non-safety-related instrument bus and power supply inverters

Management has created groups that function to identify and track items which could challenge the safeguards systems. These groups, described below, create reports for upper management to become aware of BOP problems. Several of these groups were instrumental in major modifications to the facility which have aided in reducing feedwater related trips, such as the steam dump refinement described in section 5.

- Reliability Group - Reviews IE notices, NRC inspection reports, SALP reports, INPO reports, vendor technical bulletins, etc. to generate a computerized document which delineates if further action is required on the part of management to address any potential generic concerns.

- Salem Trip Reduction Task Group - Serves to study the above mentioned reports to apply the information to reduce challenges to the safeguards systems.

- On Site Safety Review Group - Reviews each reactor trip or safety system challenge in depth to identify trends and corrective measures to prevent recurrence. This is in addition to the required Site Operations Review Committee meetings for post-trip review.

- Morning Meetings - Serve to identify any daily problems in BOP and corrective measures in progress. The resident inspectors attend these meetings on a daily basis.

The licensee has members in the following industry organizations.

- Nuclear Utility Management Advisory Committee
- Electric Power Research Institute
- Institute of Nuclear Power Operations
- Westinghouse Owners Group

These members serve to bring generic issues to the attention of management for resolution as they may apply to Salem. The licensee also sends managers and engineers to other facilities (including several in Europe) to investigate and study new ideas to incorporate into BOP systems.

Management has provided adequate resources to the betterment of BOP systems. Management policies and attitudes regarding BOP are understood and implemented down to the worker levels. Management is involved and strongly interested in reducing challenges to the safety systems from the BOP and have expended both time and resources to reach their goal of 3 or less reactor trips per unit per year. (The industry average is 4.3 trips per unit per year).

No violations were identified.

7. Summary of Findings

Strengths

- There is strong management support for trip reduction that is evident from the Senior Vice President to the worker level.

- 10 CFR 50.59 reviews and design changes to BOP are well documented and are reflected down to control room procedures.

- There is active participation in industry groups as a whole and in particular in the trip reduction effort.

- There are strong review groups on site that analyze and document trips and root cause, especially for generic trends.

- There is the beginning of strong failure analysis and performance monitoring programs.

- Recent operator errors are not similar to those of the past.

- A reduction in trip frequency has been noted and the trips have very little similarity to each other - they appear to be random in nature.

Weaknesses

- Operating procedures, although understood by operating personnel, did not always reflect changes made to plant systems.

- There was evidence of missing gages and valve stem protectors; some insulation was not replaced and small leaks were noted on the system walkdowns.

In addition, there was a perception on the part of the team that the plant betterment engineering department and nondestructive testing groups off site needed to communicate more with the on site groups to more fully understand the newly instituted preventative and predictive maintenance programs. No violations were identified.

8. Exit Interview

At periodic intervals during the course of the inspection, meetings were held with senior facility management to discuss the inspection scope and findings. An exit interview was held with licensee management at the end of the reporting period. The licensee did not identify 2.790 material.

APPENDIX A

ENTRANCE

PSE&G

NAME	TITLE
B. M. Connor	Salem Operations Staff
P. J. Landers	Principal Training Supervisor
D. J. McCollum	System Engineer
L. K. Miller	Assistant General Manager - Salem Operations
S. E. Miltenberger	Vice President - Nuclear Operations
J. W. Morrison	Maintenance Engineer - Salem
D. A. Perkins	Manager - Station Quality Assurance
G. A. Roggio	Station Licensing Engineer
D. K. Strong	Maintenance Engineer - Electrical Controls
C. M. Williamson	Senior Staff Engineer
J. M. Zupko, Jr.	General Manager - Salem Operations

NRC

W. M. Hill	Senior Reactor Engineer
T. J. Kenny	Senior Resident Inspector - Salem
L. J. Norrholm	Section Chief SIB-HQ
A. J. Szczepaniec	Reactor Inspector (Region II)

EXIT

PSE&G

NAME	TITLE
B. M. Connor	Salem Operations Staff
M. K. Gray	Licensing Engineer
D. J. McCollum	System Engineer
L. K. Miller	Assistant General Manager - Salem Operations
D. A. Perkins	Manager - Station Quality Assurance
B. A. Preston	Manager - Licensing and Regulation
G. A. Roggio	Station Licensing Engineer
J. P. Ronafalvy	Technical Manager - Salem
C. M. Williamson	Senior Staff Engineer
J. M. Zupko, Jr.	General Manager - Salem Operations

NRC

J. W. Chung	Lead Reactor Engineer
W. M. Hill	Senior Reactor Engineer
T. J. Kenny	Senior Resident Inspector - Salem
L. J. Norrholm	Section Chief SIB-HQ

APPENDIX B

FEEDWATER INDUCED TRIPS

YEAR	OPERATOR CAUSED	MAIN FEED REG. VALVE	MAIN FEED PUMP	INSTRUMENT	OTHER	TOTAL
1976 Dec. Only	5	1	1			7
1977	1	2	15			18
1978				2		2
1979			1	1		2
1980		3	2			5
1981	17		17	4	1	39
1982	5		6			11
1983	7	2		2	1	12
1984	2	2	2	1	2	9
1985	4					4
1986		3	4		2	9
1987						0
TOTAL	41	13	48	10	6	118

UNIT 1 ONLY

UNIT 2 START 1ST TRIP 5/20

OD-16 POST TRIP REVIEWS START APRIL

OPERATOR CAUSED - Trips caused during the operation of the unit through faults of the operator or procedural errors.

MAIN FEED REG. VALVE - Trips caused by the malfunctioning of the feed regulation valves (BF-19's) or feed bypass.

MAIN FEED PUMP - Trips caused by the malfunctioning of the main feed pump, including control instrumentation for the feed pump only.

INSTRUMENT - Trips caused by control instrumentation related to the feed system eg. feed flow/steam flow or S/G level.

OTHER - Any other category that could not be fit into the first four categories.

APPENDIX C

DOCUMENTS REVIEWED

Number	Revision	Title
IOP-3	5	Hot Standby to Minimum Load
IOP-4	3	Power Operation
IOP-5	3	Minimum Load to Hot Standby
OP-III-9.3.1	9	Placing Feed and Condensate System in Service
OP-III-9.3.2	6	Feed Pump Operation
OP-III-9.3.5	2	Condensate Pump Strainer Cleaning
OP-III-9.3.6	0	Feed Pump Strainer Cleaning
OP-III-12.3.2	1	Returning a Feedwater Heater Group to Service
OP-III-12.3.3	1	Removing a Feedwater Heater Group from Service
EI I-4.12	6	Loss of Feedwater

Trip No.	Work Order Date	Work Order No.	Equipment
84-02	11/22/84	942135	1CN47
84-09	6/15/84	948661	14BF40
	10/04/84	948665	23BF19
84-14	8/27/84	9909921	21SFGP
	8/27/84	99102943	21SGFP
	9/20/84	8408280015	21SGFP flow
	8/27/84	8408270346	21SGFP turbine
	9/24/84	99098989	21SGFP turbine
84-15	* 9/05/84	0099100011	22SGFP
84-21	1/17/85	0099104261	11BF19
86-02	2/02/86	0099180081	11BF40
86-03	2/20/86	0099182858	14BF19
86-04	5/29/86	0099184401	21BF19
86-08	6/13/86	8606120499	13CN27
86-12	7/21/86	0099170116	21SGFP governor
86-13	8/11/86	8608050391	11SGFP overspeed
	8/08/86	8608050382	11SGFP
86-18	* 12/28/86	0099171198	23SGFP
	* 12/29/86	8612290015	23BF19

* those reviewed from computer files

APPENDIX D

VODAP RANKING

1. Reactor Coolant
2. Reactor Protection and Control
3. Service Water, Turbine/Nuclear Area
4. 115 VAC
5. CVCS
6. NIS
7. S/G Feed and Condensate
8. Auxiliary Feedwater
9. Rod Control
10. Diesel Generator
11. DC Distribution
12. Vital HVAC
13. Containment Building Ventilation
14. RHR
15. Component Cooling
16. EHC
17. Radiation Monitoring
18. Circulating Water, Screen Wash
19. SIS
20. S/G Feed Pump Lube Oil
21. RPI
22. 4KV Switchgear and Bus
23. Main Steam and Turbine Bypass
24. Compressed Air
25. Main Generator
26. Bleed Steam, Heater Drain
27. 460 VAC Switchgear
28. Heat Tracing
29. Gas Turbine
30. Waste Liquid, Radioactive
31. Gland Seal Steam and Leak Off, Turbine
32. Waste Gas, Radioactive
33. S/G Drains and Blowdown
34. Condenser Air Removal
35. MSR, Drains
36. Condensate Polishing