U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report Nos. 50-272/87-37
50-311/87-37

Docket Nos. 50-272
50-311

License Nos. DPR-70
DPR-75 Priority_____ Category C

Licensee: Public Service Electric & Gas Company
P. O. Box 236
Hancocks Bridge, New Jersey 08038

Facility Name: Salem Generating Station

Inspection At: Hancocks Bridge, New Jersey

Inspection Conducted: December 14-18, 1987

Inspector: H. J. Bicehouse 1/14/88
H. J. Bicehouse, Radiation Specialist date

Approved by: W. J. Pasciak 1/21/88
W. J. Pasciak, Chief, Effluents Radiation Protection Section date

Inspection Summary: Inspection on December 14-18, 1987 (Combined Report Nos. 50-272/87-37 and 50-311/87-37)

Areas Inspected: Routine, unannounced safety inspection of the licensee's water chemistry control program including management controls, plant water chemistry systems and implementation.

Results: No violations or deviations were identified. The licensee was implementing a generally effective water chemistry control program. However, weaknesses were noted in the licensee's controls of inline chemistry instruments needing licensee attention and correction.

Details

1. Persons Contacted

During the course of this routine inspection, the following personnel were contacted or interviewed.

1.1 Licensee Personnel

*J. Zupko, Jr., General Manager, Salem Operations
*R. Dolan, Chemistry Engineer, Salem
*R. Dulee, Principal Engineer, Quality Assurance
*G. Roggio, Station Licensing Engineer, Salem
*J. Trejo, Radiation Protection and Chemistry Manager

Other licensee personnel were also contacted or interviewed during the inspection.

1.2 NRC Personnel

K. Gibson, Resident Inspector
R. Summers, Project Engineer

*Attended the exit interview on December 18, 1987.

2. Scope

This routine safety inspection reviewed the licensee's water chemistry control program. The purpose of the inspection was to review the licensee's program to control corrosion and out-of-core radiation field buildup, ensure long-term integrity of the reactor coolant and secondary pressure boundaries and minimize fuel leakage caused by corrosion-induced failures. The licensee's program in these areas was reviewed relative to requirements, commitments and industry practices provided in the licensee's Technical Specifications, Updated Final Safety Analysis Report (UFSAR), NRC Regulatory Guides, Bulletins and Information Notices and industry-consensus standards provided by the Electric Power Research Institute (EPRI) and the American Society for Testing and Materials (ASTM).

3. Previously Identified Item

(Closed) 25-00-13 TI-Trial Use of Water Chemistry Inspection Modules

This inspection completed a series of inspections of the licensee's water chemistry control program which involved the trial use of two inspection modules.

4. Plant Description

The inspector reviewed the design and operating history of two units. Salem Unit 1 (Salem-1) is a four-loop Westinghouse Pressurized Water Reactor (PWR) rated at 1079 MWe which began commercial operation in June, 1977. Salem Unit 2 (Salem-2) is also a four-loop Westinghouse PWR rated at 1106 MWe which began commercial operation in October 1981. Both units employ Westinghouse Model 51 Steam Generators and have operated on All-Volatile Treatment (AVT) since initial operation.

Most older Westinghouse units exhibit some degree of denting in their steam generators. The damaging consequences are most pronounced in the outer periphery wedge and flow slot area. Units that have used all solids (i.e. phosphate) secondary water treatment tend to experience thinning attack. It occurs on both the hot leg and cold leg sides, at and above the steam generator tube sheet, within the sludge pile. Units with open tube sheet crevices are prone to Intergranular Attack/Stress-Corrosion Cracking (IGA/SCC) within the crevice region. Models 51 and 51 A/M Steam Generators are susceptible to primary side cracking at inner row U-bends and at the roll transition. Models 24, 27, 33 and 51 steam generators experience fretting wear at the anti-vibration bars (AVBs). Salem-1 has experienced thinning, fretting and minor denting. Salem-2 has experienced fretting and minor denting.

During 1977, Unit-1 operated for the majority of its first fuel cycle with leaking condenser tubes and high dissolved oxygen concentrations in the feedwater system. Nondestructive examinations (NDE) during the first refueling outage revealed some tube-to-tube support plate intersection denting. Although the denting was minor, the licensee installed a full-flow condensate polishing system, retubed the condenser (replacing copper/nickel (90/10) tubes with AL-6X tubes) and instituted 1/3 flow condensate cleanup system for cleanup prior to power operations. NDE for Unit 1 following the second fuel cycle showed no detectable increase in the number of dented intersections. During the refueling outage, the licensee installed a system to return steam generator blowdown to the condenser hot well. Salem-2 began its first operating cycle in 1981 with a full-flow condensate polishing system and copper-nickel condenser tubes. Subsequently, the licensee retubed that condenser with AL-6X tubing.

The following additional items were noted during review of the units current configurations:

- Low-pressure feedwater heater tubes and high-pressure feedwater heater tubes for both units are 304 stainless steel.

- The moisture separator reheaters (six per unit) are being changed from 90/10 copper/nickel alloy to stainless steel. Salem-1 has one remaining copper/nickel alloy moisture separator reheater and Salem-2 has two.

- Low-pressure heater drains for both units are pumped back to the hotwell but high pressure heater and moisture separator drains are pumped forward.

- Strainers are provided in both units' Feedwater systems for particulate removal. Auxiliary feedwater is not filtered. Deaeration of auxiliary feedwater is not provided. However feedwater dissolved oxygen is routinely maintained less than five parts per billion (ppb).

- The steam generator blowdown rates are 40,000 pounds per hour (maximum up to 1½ % main steam flow). Blowdown is returned to the hotwell for both units.

- Circulating condenser rate averages (annually) about 3,000 parts per million (ppm) chloride being taken from the Delaware River estuary. Condenser air in-leakage rate, for the units aren't currently known but the licensee is planning to provide monitoring capability.

- Fuel performance has been good since 1980 with very few leaking pins noted. Radiochemistry indications are nearly "tramp" uranium levels routinely.

- Cation conductivities for the two units have been consistently among the PWR industry's best readings.

- Low pressure and high pressure turbine examinations have revealed no corrosion-induced problems with discs and blades.

- Primary-to-secondary leakage rates have been low and well within Technical Specifications. Leaks in Salem-1 (Steam Generator No. 13) of 20 gallons per day (gpd) and Salem-2 (Steam Generator No. 24) of 50-60 gpd were noted in recent cycles. Licensee methods of detection are capable of detecting leakage rates from about 1 gpd.

- Steam generator sludge is removed routinely during refueling outages. Clear indications of copper (in addition to iron) have been noted in sludge analyses. Sludge piles by fuel cycle are shown below:

Fuel Cycle No.	Unit	Steam Generator	Pounds of Sludge
1	1	11	94
1	1	12	106
1	1	13	70
1	1	14	106
1	2	21	34
1	2	22	24
1	2	23	14
1	2	24	19
2	1	11	94
2	1	12	94
2	1	13	82
2	1	14	105
2	2	21	0
2	2	22	24
2	2	23	49
2	2	24	12
3	1	11	59
3	1	12	35
3	1	13	35
3	1	14	70
3	2	21	5
3	2	22	14.5
3	2	23	28.5
3	2	24	12
4	1	11	24
4	1	12	47
4	1	14	35
4	1	14	47
5	1	11	46
5	1	12	30
5	1	13	43
5	1	14	41
6	1	11	29
6	1	12	21
6	1	13	62
6	1	13	62
7	1	11	24
7	1	12	29
7	1	13	46
7	1	14	41

Both units have conventional Westinghouse four-loop PWR designs for the primary systems employing chemical and volume control systems (CVCS) for chemical control, addition and cleanup. Conventional reactor grade primary resins are used in the CVCS. The licensee employs the "constant pH" (lithium hydroxide/boric acid coordinated) operating scheme for both units. The primary system materials include Zircalloy-4 in the fuel rods, stellite on wear surfaces, inconel steam generator tubing and stainless steel elsewhere. Recent channel head dose rates of 15-20 R/hr (Salem-1) and 5 R/Hr (Salem-2) were noted. The licensee plans to try the "elevated lithium" operating scheme in one unit (see related discussion on Task Force recommendations below). Cobalt source reduction is also undergoing discussion by the licensee.

In summary, both units showed designs, materials and basic operating schemes generally consistent with industry recommendations. The licensee has made modifications to improve secondary water chemistry and has shown improved steam generator performance with apparently arrested denting in the tubes.

5.1 Organization

Figure 13.1-10 of the licensee's UFSAR describes the general organization of licensee's chemistry function for the station. Within the Radiation Protection/Chemistry Department, the Chemistry Engineer is responsible for the development and implementation of the chemistry, radiochemistry and liquid effluent monitoring program. The Chemistry Engineer is also responsible for plant water treatment and control systems. The Senior Chemistry Supervisor reports to the Chemistry Engineer and is responsible for the sampling/analyis of plant fluid systems, data reporting, calibration of chemical instrumentation, evaluation of laboratory and chemical systems operation and techniques, operation of water treatment/control systems and maintenance of fluid systems within established limits. Three Technical Supervisors report to the Senior Chemistry Supervisor with responsibility for laboratory systems, and instruments. The licensee employs technicians as analysts, treatment system operators and instrument technicians and trains them in an Institute of Nuclear Plant Operations (INPO) accredited program. The inspector noted that the licensee was reorganizing the chemistry function. The reorganization will be reviewed in a subsequent inspection. No deviations from UFSAR commitments were noted in this review.

The licensee is developing a corporate chemistry function. At the time of the inspection, there was little evidence of corporate involvement in Salem Chemistry operations:

- Senior management hadn't provided a policy statement regarding plant water chemistry control.

- Oversight functions appeared unorganized and unfocused in both the corporate engineering and new Radiation Protection/Chemistry Services organizations.

- Systematic review/audit of chemistry activities (other than Quality Assurance) for technical direction weren't evident.

- Long-term trending and suggestions for program improvement weren't evident.

- Corporate sponsored inter-and intra-laboratory analytical intercomparisons for chemical parameters weren't in place.

Industry practices commonly show corporate involvement, sponsorship and participation in all the aforementioned areas. Lack of the above is considered a weakness in the licensee's program.

5.6 Policies/Procedures

Twelve chemistry procedures (governing specifications, routine surveillance activities, in-line and grab sampling/analyses and system operations) were reviewed and discussed with the licensee's representatives to determine if:

- critical chemical variables and limit/action levels for control of those variables had been identified;

- Resin replenishment intervals or criteria were specified;

- Sampling schedules, flush lines for grab sampling normally statement stagnant lines and locations for obtaining samples had been provided;

- Control, comparison and actions to be taken were provided for inline monitors (conductivity, specific conductivity, pH, hydrazine and dissolved oxygen monitors); and

- investigative and corrective actions to be taken when control or diagnostic parameters exceeded action levels were established.

Within the scope of the review, the following weakness was identified:

- The licensee makes routine intercomparisons of in-line and laboratory instrument readings for process monitors providing continuous indications of plant parameters, (e.g. conductivity, dissolved oxygen, etc.). However, review of licensee's procedures showed that acceptance criteria for determining that an inline monitor was performing properly weren't provided. At the exit interview on December 18, 1987, the licensee indicated

that a contractor would develop acceptance criteria during the next operational run by statistical review of the intercomparisons made between the in-line monitors and the laboratory measurements. Other aspects of the licensee's procedures were in reasonable agreement with EPRI and ASTM guidance, Westinghouse-recommended practices or manufacturer's suggested practices.

5.3 Resources

Chemistry staffing was reviewed relative to analytical/sampling, instrument calibration/maintenance and water systems operational responsibilities. Staffing of chemistry technicians, assistants and workers appeared to be adequate since no backlogs of assigned work were noted in the areas reviewed. Laboratory and inline analytical capabilities were reviewed relative to EPRI guidance and typical NRC Region I utility capabilities. State-of-the-art analytical instrumentation allowing ppb measurements to be routinely made were noted.

Within the scope of this review, the inspector concluded that adequate resources had been provided by the licensee to support the licensee's basic water chemistry control program.

5.4 Audit/Review Processes

The two most recent quality assurance audits of the licensee's chemistry program were reviewed to determine if Technical Specification and Quality Assurance Plan requirements had been met in the scope, coverage, management review and resolution of findings from those audits. The inspector noted that the licensee had contracted for additional audits by a contract chemistry organization every six months.

During the recent refueling outage, the licensee's Maintenance Department proposed the use of a refueling gasket material containing a chloride/fluoride organic compound. The inspector noted that introduction of the gasket material into the core could result in localized chloride/fluoride attack of the Zircalloy-4 cladding due to breakdown of the material in the heat and radiation environment. The inspector reviewed Site Operations Review Committee (SORC) meeting minutes to determine if the concern had been raised, addressed and resolved. SORC Meeting No. 87-086 (October 16, 1987) extensively discussed the potential problem and subsequent revisions provided material controls to reduce the likelihood of gasket material intrusion.

During periods of operation, daily and monthly reports were provided to Station Management giving chemical and radiochemical data/trends by the Chemistry group. The reports were reviewed to determine if key chemical and radiochemical parameters were identified, the

report received wide management distribution and significant results were acted upon. No concerns were identified. The reports were accurate and reasonable presentations of key parameters and received wide station distribution.

6. Sampling/Measurement

The inspector reviewed the licensee's sampling and measurement program to determine if:

- reactor coolant, steam generator and feedwater chemistry were adequately sampled relative to Technical Specifications, UFSAR commitments and industry consensus standards; and

- surveillance of in-line instrumentation sample stream temperature control and conditioning, quality control of inline instrumentation accuracy, acceptance and correction criteria for conductivity and cation conductivity measurements, sample line valve operation and radiological control met industry-consensus standards provided by EPRI AND ASTM.

The units' sampling and inline instrumentation was observed during plant tours, discussed with Chemistry personnel and key procedures and records were reviewed to complete the determination.

Within the scope of this review, the following weakness was noted:

- The licensee's control of sample temperatures for inline instrumentation failed to meet ASTM standards. ASTM recommends that sample temperatures be controlled to 25 degrees centigrade (±1 degree) to avoid errors associated with calculated temperature correction. The licensee's sample conditioning used circulating cooling water to reduce temperature from plant conditions to measurement temperatures. However, circulating cooling water varies seasonally in temperature from 48 degrees to 115 degrees Fahrenheit (8-46 degrees Centigrade). No other control of sample temperature was provided. Conductivity and dissolved oxygen readings are particularly sensitive to widely variable temperatures. Since the licensee did not control temperatures, systematic errors in the measurement of key chemical parameters by inline instruments were introduced lessening the accuracy and reliability of those measurements. At the exit interview on December 18, 1987, the licensee indicated that sample temperature control would be improved.

7. Implementation

The licensee's implementation of the water chemistry control program was reviewed relative to Technical Specifications, recommendations and guidance in NRC Regulatory Guides, licensee commitments in response to NRC Bulletins and EPRI and ASTM concensus standards.

7.1 Surveillances

For Salem-1, (under Technical Specification No. 3/4.4.7) and for Salem-2, (under Technical Specification No. 3/4.4.8), the licensee is required to determine dissolved oxygen, chloride and fluoride concentrations in the Reactor Coolant System at least once per 72 hours. Chemistry logs and other records were reviewed to determine if the surveillances and limits had been met for both units during periods of operation in 1986 and 1987. Within the scope of this review, no violations were noted.

The licensee's general chemistry sampling and analysis program for control and diagnostic parameters on the two units' primary and secondary coolant loops was reviewed relative to the licensee's procedures. Chemistry logs and other records were reviewed and discussed with chemistry personnel to determine that sampling frequencies and analyses as specified in the procedures had been met and, if any unusual concentrations had been noted that they were investigated by the licensee. Within the scope of this review, no violations were identified.

7.2 NRC Bulletin No. 79-17

In response to NRC Bulletin No. 79-17, the licensee committed to examinations and surveillances to ensure the integrity of piping systems containing stagnant borated water was maintained. The inspector briefly reviewed surveillance and sampling activities and discussed pipe examinations with the licensee to determine whether the commitments were being fulfilled. No deviations were noted.

7.3 NRC Bulletin No. 87-01

In response to NRC Bulletin No. 87-01, the licensee responded to questions concerning programs for monitoring the wall thickness in condensate, feedwater, steam and related piping subject to erosion/corrosion phenomena. In addition, the licensee responded to a questionnaire regarding typical chemical parameters in those systems. The inspector reviewed the accuracy and representativeness of the chemistry values reported by the licensee on a sampling basis and determined that the chemical data presented was representative of plant conditions.

7.4 Task Force Recommendations

The licensee chartered and staffed several in-house special task forces to provide recommendations to improve performance in several areas. The inspector reviewed three task force reports for recommendations related to improved corrosion and radiation field buildup control and noted the following:

- The licensee implemented a recommendation to increase CVCS letdown flowrates to better utilize the cleanup system for the primary coolant.

- The licensee is considering nonchemical fuel rod cleaning and chemical decontamination of selected primary coolant loop heat exchangers to control radiation field buildup.

- The licensee plans to implement an elevated lithium hydroxide operating scheme in place of the current coordinated lithium hydroxide/boric acid to maximize cobalt solubility and reduce radiation fields.

- Control of debris associated with valve maintenance were reviewed and suggested improvements were recommended.

- Recommendations for reduced primary loop cobalt alloys were made.

The inspector noted that the recommendations were consistent with industry-suggested improvements for radiation field control and lauded the licensee for this in-house initiative.

8. Exit Interview

The inspector met with the licensee's representatives (denoted in Detail 1) at the conclusion of the inspection on December 18, 1987. During the meeting, the inspector summarized the purpose and scope of the inspection, identified findings and expressed concern over the in-line instrument sample temperature control and reading intercomparison weaknesses. The licensee indicated a willingness to address and resolve those weaknesses.

At no time during this inspection was written material provided to the licensee by the inspector. No information exempt from disclosure under 10 CFR 2.790 is discussed in this report.