UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

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Report Nos.: 50-269/86-29, 50-270/86-29, and 50-287/86-29

Licensee: Duke Power Company
422 South Church Street
Charlotte, NC 28242

Docket Nos.: 50-269, 50-270, and 50-287 License Nos.: DPR-38, DPR-47, and DPR-55

Facility Name: Oconee 1, 2, and 3

Inspection Conducted: October 14-17, 1986

Inspector: Douglas M. Collins for W. J. Ross — 11-11-86 Date Signed

Approved by: Douglas M. Collins — 11-11-86 Date Signed
D. M. Collins, Chief
Emergency Preparedness and Radiological Protection Branch
Division of Radiation Safety and Safeguards

SUMMARY

Scope: This routine, unannounced inspection was performed in the area of plant chemistry.

Results: No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*M. S. Tuckman, Station Manager
*J. J. Sevic, Station Chemist
L. J. Benge, Staff Coordinator/Chemistry
J. R. Brown, Training Coordinator/Chemistry
M. A. Hipps, Engineer/Mechanical Technical Support
P. A. Hall, Quality Control Coordinator/Chemistry
E. L. Jackson, Specialist/Mechanical Special Projects
B. K. Jones, Chemistry Coordinator/Chemistry
D. Mays, Mechanical Engineer/General Office
D. Rochester, Chemical Specialist/General Office
L. B. Schreier, Engineer/Mechanical

Other licensee employees contacted included chemistry technicians.

NRC Regulatory Commission

J. C. Bryant, Senior Resident Inspector
*M. K. Sasser, Resident Inspector

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on October 17, 1986, with those persons indicated in Paragraph 1 above. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee. The licensee did not identify as proprietary any of the materials provided to or reviewed by the inspector during this inspection.

3. Licensee Action on Previous Enforcement Matters

This subject was not addressed in the inspection.

4. Plant Chemistry (79701 and 79502)

As a result of its continuing concern for steam generator tube integrity, the NRC staff has recently issued recommended actions and review guidelines that are directed toward the resolution of unresolved safety issues regarding this subject (see Generic Letter 85-02 dated April 17, 1985). One recommended action is as follows:

"Licensees and applicants should have a secondary water chemistry program (SWCP) to minimize steam generator tube degradation. The specific plant program should incorporate the secondary water chemistry guidelines in the Steam Generator Owners Group (SGOG) and Electric Power Research Institute (EPRI) Special Report EPRI-NP-2704, "PWR Secondary Water Chemistry Guidelines," October 1982, and should address measures taken to minimize steam generator corrosion, including materials selection, chemistry limits, and control methods. In addition, the specific plant procedures should include progressively more stringent corrective actions for out-of-specification water chemistry conditions. These corrective actions should include power reductions and shutdowns, as appropriate, when excessively corrosive conditions exists. Specific functional individuals should be identified as having the responsibility/authority to interpret plant water chemistry information and initiate appropriate plant actions to adjust chemistry, as necessary.

The reference guidelines were prepared by the Steam Generator Owners Group Water Chemistry Guidelines Committee and represented a consensus opinion of a significant portion of the industry for state-of-the-art secondary water chemistry control."

Reference

Section 2.5 of NUREG-0844

In parallel action, the NRC Office of Inspection and Enforcement has developed two new Inspection Procedures to verify that the design of a plant provides conditions that ensure long term integrity of the reactor coolant pressure boundary and to determine a licensee's capability to control the chemical quality of plant process water in order to minimize corrosion and occupational radiation exposure.

Actually, most of the intent of these two procedures was met during previous inspections (cf. Inspection Report Nos. 50-269, 270, 287/83-32 dated November 25, 1983, and Inspection Report Nos. 50-269/84-24, 50-270/84-23, 50-287/84-25 dated October 22, 1984). These inspections had shown that the three Oconee units had been designed and constructed to minimize ingress of potential corrodants into the secondary water system and, therefore, to provide protection against degradation of the steam generator tubes (i.e., the primary coolant pressure boundary). In addition, because of its involvement in the activities of the SGOG, the licensee had begun to revise the Oconee water chemistry program so as to incorporate the guidelines for PWR chemistry that had been published in EPRI-NP-2704.

The principal concerns that were identified by the inspector during these earlier inspections related to the buildup of iron oxide deposits within the broached openings between the tubes and tube support plates of the once-through-steam-generators (OTSGs) and the transport of large amounts of iron oxide sludge to the lower tube sheet region of the OTSGs. During the last two years the licensee had devoted a significant amount of effort to

removing the deposits and the sludge from the OTSGs. (cf. Inspection Report Nos. 50-269, 270, 287/85-16 dated July 8, 1985, and Inspection Report Nos. 50-269, 270, 287/86-09 dated March 21, 1986).

The current inspection was based on the two new inspection modules and consisted of an updated assessment of the licensee's capability to prevent degradation or catastrophic failure of the primary coolant pressure boundary. As before, this assessment focused on the effectiveness of plant design and chemistry control in preventing degradation, through corrosion, of OTSG tubes. The inspector also reviewed the results of the licensee's efforts to remove sludge from the OTSGs of Units 1 and 2 in 1986 as well as plans to chemically clean these OTSGs in 1987.

a. Effectiveness of Plant Design to Prevent Corrosion

Through audits of the licensee's chemistry records and discussions with cognizant plant personnel, the inspector reviewed the effectiveness of the principal components of the secondary water cycle during the last two years.

(1) Main Condensers - One tube leak was experienced in Unit 3 as the result of steam impingement on the perimeter tubes. Because of the high chemical quality of the condenser cooling water and the low rate of inleakage, this water leak caused only slight contamination of the water in the hotwells of this unit. The licensee had an active program for identifying potential erosion problems through eddy-current testing and for replacing or installing additional baffles to prevent steam impingement of the stainless steel condenser tubes. The usual quality of the hotwell water had been kept very high; i.e., the cation conductivity had been ~ 0.1 umho/cm and the concentration of dissolved oxygen ~3ppb. Air inleakage through the condensers had also been maintained within the limit usually stated by a manufacturer (5 to 10 standard cubic feet per minute or SCFM). The inspector and licensee representatives discussed the merits of striving for even lower levels of air inleakage to reduce the potential for oxidation of carbon steel components and to prevent stress corrosion of low-pressure turbine rotors.

(2) Water Treatment Plant - The inspector considered the very low (<5ppb) concentration of silica in the hotwell water to indicate that makeup water of high quality was being produced so that makeup was not a pathway for contaminants entry into the secondary water cycle.

(3) Condensate Cleanup System - The licensee had continued to provide continuous, full-flow polishing for the condensate. The purity of the effluent from the powder demineralizers approximated that of pure water; i.e., a cation conductivity of 0.06-0.1 umho/cm. Each demineralizer was being precoated once per twenty-five days (one demineralizer is precoated every two days) to maintain its

effectiveness. The licensee did not think that the demineralizers were "throwing" ions or leaking resin beads into the feedwater. The inspector, however, considered that the significant amount of sulfate (600-700 ppb) that had been removed during "hideout soaks" of the OTSGs was indicative of resin leakage throughout the relatively long operating history of these three units (9 to 10 fuel cycles). Consequently, the inspector encouraged the use of the licensee's new ion-chromatograph to monitor the possibility of resin leakage.

The inspector was informed that the operation of the condensate polishers had been less efficient than desired because of faulty valves. As a consequence, different types of valves had been installed in Unit 2 during its last fuel cycle as well as in part of the polisher systems in Units 1 and 3. Performance appeared to have been improved through these actions.

(4) Feedwater Heater Drain Tanks - Industry experience has shown that the bulk (~80%) of iron oxides that are transported to the OTSGs originate in the carbon steel pipes of the high pressure steam and drain lines. In an effort to minimize the buildup of oxide sludge in the OTSGs, the licensee's operating procedures for plant startup had been written so as to require that the water from the feedwater heater drain tanks be cycled back to the condenser (for additional cleanup) until this water is needed to supplement the feedwater supply (at 70% and 90% power levels).

The licensee also has placed limits on the amount of suspended solids that are allowed in the final feedwater; i.e. 100 ppb at <15% power and 10ppb at >15% power. Consequently, the water in the drain tanks must be essentially free of solids before these drains may be pumped forward to the feedwater pumps.

(5) Once-Through-Steam-Generators - The inspector was informed that one leaking tube had been identified in both OTSGs in Unit 1 during the past year. As the result of eddy current tests of this unit, four tubes in "A" steam generator and 47 tubes in "B" steam generator were plugged. The degradation of the OTSG tubes was attributed to high cycle fatigue of tubes adjacent to the tube lane in the region of the fifteenth tube support plate. Fatigue was thought to have been caused by the cooling effect of auxiliary feedwater during heatup and cooldown of the unit. Similar fatigue cracks had been observed in the two OTSGs in Unit 3; consequently 14 tubes were plugged in during the refueling outage for this unit during the second half of 1985. During the last refueling outage for Unit 2, in August 1986, eddy current tests did not identify any indications that were sufficiently deep to require that a tube be plugged.

During the most recent refueling outages of each unit, the OTSGs were subjected to a "water slap" technique to dislodge oxide

deposits from the broached holes of the tube support plates. Subsequently, each OTSG was sludge lanced to remove solid oxides that had been deposited on the lower tube sheet. Approximately 514 pounds, 600 pounds, and 84 pounds of sludge were removed from Units 1, 2, and 3 respectively. The licensee estimated that these amounts represented 60%, 70%, and 90% removal of the sludge.

The "water slap" process had been designed to increase the flow of water through the OTSGs by reducing the resistance to flow through the tube support plates, especially in the region of the fourth through the eighth plates. Although some of the deposits were removed, the process had not been considered to be successful. Subsequent to the inspector's site he was notified by the NRC Resident Inspector that both Units 1 and 2 had returned to power, after a two-week maintenance outage, but had not been able to attain 100% power because the pressure differential in the OTSGs remained high.

Because of the ineffectiveness of "water slap" cleaning techniques, the licensee is continuing with plans to remove the oxide deposits and residual sludge by means of a chemical method that has been developed by EPRI (refer to Inspection Report Nos. 50-269/84-24, 50-270/84-23, and 50-287/84-25 dated October 22, 1984). The inspector was briefed on the progress of this program and shown models of the equipment that will be used. The licensee intends to inform the NRC Office of Nuclear Reactor Regulation of the specifics of the program when they have been fully developed.

(6) Moisture Separator Reheaters (MSRs) - The inspector was informed that steam leaks had been experienced in the MSR tubes in Unit 3 and that these tube bundles would be replaced during the next refueling outage of this unit. Similar problems had been experienced in the other two units approximately eight years earlier. Tube degradation has been attributed to the increase of the pH of the condensate and the concentration and buildup of impurities transported in the steam when the condensate is fractionated from the steam (and ammonia). In an effort to reduce the corrosion caused by both of these occurrences, the new tube bundles will be fabricated from a more resistant stainless steel (439 SS).

(7) Summary - The licensee continued to provide high grade feedwater to the OTSGs. This favorable situation was attributable to the absence of pathways for ingress of potential contaminants from the condenser cooling water or through the makeup water treatment system. Pre-startup cleanup of the low-pressure (condensate/feedwater) lines, followed by similar cleanup of the condensate in the feedwater heater drains, had minimized transport of iron oxides to the OTSGs. This cleanup process had been continued during plant operation by full-flow polishing of the

condensate (including MSR drain water). The major chemistry concern is the presence of deposits within the broached holes of the tube support plates, sludge deposits on the lower tube sheet, and potentially corrosive ions that form "hideout" deposits on the OTSG tubes.

b. Chemistry Control Program

As discussed earlier, the inspector observed that the level of chemistry control in the three Oconee units had exceeded the criteria recommended by the SGOG/EPRI. In addition to the design of the plant and the relatively stable operational history of these units, this commendable condition appeared to be attributable to the manner in which the licensee's chemistry program had been being implemented. This conclusion was reached by the inspector after an overall review of the key elements of this program, as summarized below.

(1) Staffing - The inspector established that the chemistry staff was organized in much the same manner as had been observed during the last inspection, although several personnel changes had been made. This staff of 37 chemists and technicians represented ~40% of the people who reported to the Station Chemist; the remainder had responsibilities in areas related to radwaste. As a result of his review of the effectiveness of this organization the inspector identified two perceived weaknesses that were discussed with chemistry supervision and plant management. One concern related to the capability of the chemistry staff to carry out its responsibilities (as defined in the SGOG/EPRI guidelines) to monitor key chemical variables and to initiate corrective actions in a timely manner during the twelve-hour backshift when only one chemistry technician was on duty. This technician (actually a technician specialist) must be capable of performing assigned laboratory and operational (e.g., operation of the water treatment plant and the condensate polishers) duties related to all three units and also must be available to support the Operations Department in routine or emergency requests related to chemistry control. The other apparent weakness was the limited number of technicians who were qualified in the use of the ion-chromatograph and the atomic absorption spectrophotometer. These two instruments provide the most sensitive measurements of many chemistry parameters and are essential for control and/or diagnostic measurements within the stringent ranges of SGOG/EPRI criteria.

(2) Training - The inspector established that three members of the support group, under the Staff Coordinator, had been given responsibilities for coordinating an on-the-job training (OJT) program in chemistry. This program had the dual goals of qualifying all technicians in 144 chemistry tasks as well as for promotion through the three grades of technician. At the time of this inspection thirteen of the twenty four technicians had been qualified as specialists, the top grade, and seven had been

qualified as Technicians, the middle grade. The inspector was informed that only specialists were allowed to man a backshift alone.

Training of the technicians was being performed by "trainers" who, themselves, had to be qualified for this responsibility through a special training course. Final qualification of a technician in one of the chemistry tasks had to be certified by one of the supervisors or chemists.

(3) Procedures - The inspector again reviewed selected sections of the licensee's Chemistry Manual to audit changes that had been made during the last two years. The guidance provided in this manual was considered by the inspector to be consistent with the SGOG/EPRI guidelines. Consequently, Inspector Followup Item 83-32-02, Completion and Implementation of the Oconee Chemistry Manual, is considered to be closed.

(4) Quality Assurance - The inspector established that the licensee had a program for calibrating analytical instrumentation, standardizing analytical procedures, and verifying analytical results. The responsibility for coordinating this program had been delegated to a chemist in the support group, and the program was being implemented by the Relief Laboratory Supervisor, following the guidance in Section 3.6 of the Chemistry Manual. This guidance also required that an overall quality control inspection of chemistry activities and responsibilities be performed annually. The reports of these inspections will be reviewed during future site visits by the inspector; however, to the extent the QA program was reviewed during this inspection, the inspector considered that the licensee was implementing quality control in an acceptable manner.

(5) Facilities - The inspector re-assessed the physical facilities used by the chemistry staff to implement the Oconee water chemistry program. Inasmuch as the Oconee station was one of the earliest nuclear power plants constructed, the chemistry facilities reflect the scope of chemistry control perceived to have been needed 15 years ago. However, because of extensive corrosion problems in PWRs during the following decade and the extensive review of these problems by the SGOG, the role of chemistry control and diagnostics has changed extensively in recent years.

As the result of this inspection, the licensee's sampling and analysis facilities were considered to provide only minimum capability for chemistry control and for the diagnosis of abnormal conditions based on current technology. The inspector was informed that new facilities would be installed during the next year to augment inline monitoring capability, so that present dependence on grab sampling could be reduced. Also, an ion

chromatograph had been acquired during the past year and was being set up to determine anions, specifically at the low levels recommended as SGOG/EPRI criteria for control of the secondary water system. (Currently, this capability for both primary and secondary water systems is available only through a corporate laboratory near the McGuire Nuclear Power Station).

Because of space limitations the ion chromatograph had been placed in a small "instrument room" with the licensee's other sensitive analytical instruments; i.e., an atomic absorption spectrophotometer and a flame photometer. During the inspector's visit the air conditioning system for this room was not operable, consequently the environmental conditions were not considered to be conducive to the operation of these instruments.

The inspector was informed that the licensee's capability for meeting the SGOG/EPRI criteria was to be further upgraded in 1987 through the installation of an inline ion-chromatographic system. On the basis of his limited knowledge of this system, the inspector considers this system to have state-of-the-art capability for determining trace (ppb and less) amounts of organic and inorganic ions. However, because of its complexity (especially when controlled by a computer), an inline ion-chromatograph will require an increased level of training and comprehension on the part of the Oconee chemistry staff. Also, because of the increased sensitivity of this system over other analytical procedures, verification of data obtained by inline sampling becomes more difficult.

Upon completion of the licensee's upgrade program, the disadvantages of an older plant design should be removed, and the licensee's capability to control secondary water chemistry should be enhanced.

(6) Data Management - The inspector established that the licensee was using a computerized data system for meeting regulatory and administrative requirements for data control and management. After reviewing printouts that were being removed daily from the computer and filed in the chemistry office, the inspector considered this system to be acceptable as a legal record. However, the inspector did not consider the data to be available in a convenient form for monitoring long or short trends or for other diagnostic uses that involved comparison of data related to multiple chemistry parameters or to power level. The licensee informed the inspector that this shortcoming had already been identified, and plans for an improved computer capability were underway.

(7) Summary - Although the licensee had provided adequate protection to the integrity of the OTSG tubes in the past through an acceptable level of chemistry control, the results of the

SGOG/EPRI studies have shown that even tighter control is preferable and achievable. Consequently, after endorsing the technical guidelines recommended by the SGOG/EPRI, the licensee has begun revising/upgrading the key elements of the Oconee chemistry control program so as to meet these guidelines. Although the inspector could not identify a formal corporate or plant statement related to endorsement of the philosophical and management guidelines published by the SGDG/EPRI, the resources that were being given to the chemistry program were indicative of corporate and plant management support of the chemistry goals and program.

c. Audit

During this inspection the licensee's records were audited to the extent that the inspector was confident that Technical Specification requirements were being implemented in a satisfactory manner. No violations or deviations were identified.

d. (Closed) Inspector Followup Item 83-32-02, Completion and Implementation of the Oconee Chemistry Manual.