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

Report Nos.: 50-327/85-18 and 50-328/85-18

Licensee: Tennessee Valley Authority
500A Chestnut Street
Chattanooga, TN 37401

Docket Nos.: 50-327 and 50-328 License Nos.: DPR-77 and DPR-79

Facility Name: Sequoyah 1 and 2

Inspection Conducted: May 27-31, 1985

Inspector: W J Ross 6/13/85
W. J. Ross Date Signed

Approved by: J J Blake 6/14/85
J. J. Blake, Section Chief Date Signed
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope: This rou:ine unannounced inspection involved 35 inspector-hours on site in the areas of plant chemistry and inservice testing of pumps and valves.

Results: No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

   Licensee Employees

   *P. R. Wallace, Plant Manager
   *M. R. Harding, Engineering Group Supevisor
   *R. W. Fortenberry, Engineering Section Supervisor
   *J. A. McPherson, Engineering and Test Unit Supervisor
   *W. L. Williams, Chemistry Unit Supervisor
   M. Cooper, Test Engineer, Engineering and Test Unit
   J. Barker, Engineer, Chemistry Unit
   *D. Goetcheus, Staff Specialist/Chemistry

   Other Organization

   K. M. Rajan, Combustion Engineering, Inc.

   NRC Resident Inspectors

   K. Jenison
   L. Watson

   *Attended exit interview

2. Exit Interview

   The inspection scope and findings were summarized on May 31, 1985, with those persons indicated in paragraph 1 above. The inspector described the areas inspected and discussed in detail the inspection findings listed below.

   (Open) Unresolved Item 50-327/85-18-01. Operability of Containment Spray Pump 1A paragraph 6.b.

   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. Unresolved Items

   Unresolved items are matters about which more information is required to determine whether they are acceptable or may involve violations or deviations. One new unresolved item identified during this inspection is discussed in paragraph 6.b.

5. Plant Chemistry (79501 and 795021)

During an earlier inspection, the inspector observed that integrity of the primary coolant pressure boundary was being maintained satisfactorily through appropriate design of the secondary water system and control of the secondary water chemistry (see Inspection Report Nos. 50-327/84-16 and 50-328/84-16). The current inspection consisted of an assessment of continued activities in these areas during the past year.

During 1984, both Sequoyah units underwent refueling outages, and Unit 1 was in an ice-weighing outage during the current inspection. The licensee took advantage of these shutdowns to inspect the steam generators and to eddy-current test the steam generator tubes (i.e., the primary coolant pressure boundary). A single "pin hole" tube leak was observed in each unit; however, these tube failures were attributed to mechanical causes rather than to chemistry-induced corrosion. Twenty-one tubes in Row 1 of one steam generator in Unit 1 have been plugged as a preventative measure against additional leaking. No further evidence of degradation of the tubes in Unit 1 from "denting" was seen during the last refueling outage. Although more than 100 pounds of copper oxide-iron oxide sludge was removed from each of the steam generators in Unit 2, no tube degradation was identified through eddy-current tests.

a. Reassessment of Plant Design and Operation

The absence of indications of corrosive environments in the steam generators continues to show that, although oxidation (corrosion) products are being produced within the copper alloy and carbon steel pipes of the secondary water system, the inconel steam generator tubes are not being corroded. This situation is considered by the inspector to result from the prevention of ingress of corrosive chemicals (chloride, sulfate, fluoride) from the condenser cooling water or through the makeup water plant and as the result of the degree of purification of feedwater achieved by the units' condensate cleanup system. Through discussions with plant personnel and audits of the licensee's control and diagnostic surveillance program, the inspector re-assessed the effectiveness of major components of the secondary water system. The results of this assessment are summarized below.

(1) Integrity of the Main Condenser

The licensee is cognizant of the corrosion/erosion of copper alloy condenser tubes that is being encountered in the nuclear power industry and the potential for inleakage of corrosive contaminants into the condensate/feedwater/steam generator water train as well as the transport of potentially detrimental copper metal and copper oxide to the steam generators. Consequently, the licensee has a condenser maintenance program to prevent deterioration of the condenser tubes (90-10 copper-nickel). Although some steam erosion of the outside of tubes in the Unit 2 condenser was encountered during the past year, the absence of significant

inleakage of condenser cooling water was evident from the low values (<0.2 umho/cm) of cation conductivity of water in the hotwells of both units. Air inleakage into the hotwells has been high (up to ~35 cfm); however, the level of dissolved oxygen in the hotwell water normally has been <5 ppb. This indicates that the leaks are above the water level and may be associated with the turbine; i.e., steam glands, rupture disks, pump seals, turbine boot; and low-pressure steam lines. Although a definite correlation has not been established, there are indications that the tendency for cracks to initiate in turbine disks is related to the concentration of air in the low pressure turbine. Air inleakage is a common problem; although, through constant surveillance and maintenance levels of ~5 SCFM are being achieved at several nuclear plants in Region II.

(2) Purity of Condensate Makeup Water

Because of the high demand for demineralized water for plant operation, the licensee remains dependent on temporary water treatment systems to provide an adequate supply while a new water treatment plant is being constructed. An audit of analyses of water in the Condensate Storage Tank showed that the quality of this water is being maintained at a high level, and control parameters (silica, chloride, sulfate) are normally present in less than detectable amounts. (The purity of this water also ensures that the Technical Specification limits (TS 3.4.7) for impurities in the primary water system are being met.)

(3) Effectiveness of the Condensate Cleanup Systems

In an effort to prevent corrosion of the steam generator tubes, the licensee has set very low limits on contaminants in the steam generator water; i.e., 20 ppb for ionic species and 300 ppb for silica. In order to maintain this high quality, after startup cleanup, the licensee currently is polishing the condensate by the use of two of the six demineralizer beds in the condensate cleanup system. One bed is filled with anion exchange resin only and valved to accept full flow (~2500 gpm) while the second bed contains the normal mixture of anion and cation resin and is valved for a trickle flow of ~250 gpm. The remainder of the six deep resin beds are normally bypassed during plant operation but are maintained in a regenerated condition as protection against serious inleakage of condenser cooling water.

The inspector was informed that the use of an anion bed was selected to maximize removal of corrosive anions (chloride and sulfate) and carbonate while minimizing "throw" of sodium from cation resins into the feedwater. Although the anion resin bed must be regenerated every week or two, there is less concern about leakage of the regenerant chemical (sodium hydroxide) from the

regenerated bed and consequently, a saving in the volume of deionized water that is used in the regeneration procedure.

Trickle flow through one mixed bed is maintained primarily to control the concentration of ammonia in the feedwater.

(4) Feedwater Chemistry

In addition to the purity of condensate and polisher effluents, the quality of the steam generator feedwater is dependent on the purity of water pumped forward from the Nos. 3 and 7 feedwater drain tanks (bypassing the condensate polishers) and on the chemicals (ammonia and hydrazine) that are added to control the pH and dissolved oxygen content of the feedwater.

As discussed in Inspection Report 50-327, 328/84-16, the licensee has plans to remove all copper-alloy heat exchangers from the secondary system (except from the main condensers) and replace them with stainless steel so that transport of copper to the steam generators can be minimized. The inspector was informed that the feedwater-pump turbine condensers were retubed during the last refueling outage for both units. The moisture separator reheaters and feedwater heaters Nos. 1 and 2 will be retubed during the next refueling outages (September 1985 for Unit 1 and February 1986 for Unit 2) and the remaining feedwater heaters will be retubed during the following refueling outages.

The licensee has placed a limit of $\leq$2 ppb on the concentration of copper in the feedwater (Technical Instruction (TI)-37 Logsheet 26). However, based on the inspector's audit of test results obtained during the last year, very few determinations of copper had been made. Analyses of the sludge removed from the Unit 2 steam generators during the Fall 1984 refueling outage indicated that significant amounts of copper (~100 pounds) had been removed from heat exchanger surfaces and transported to the steam generators.

The inspector's audit of analytical results acquired during the last six months in 1984 indicated that, except during plant transients, the conductivity (specific and cation) of the feedwater remained within the stringent limits that have been recommended by the Steam Generators Owners Group (SGOG) and the Electric Power Research Institute (EPRI). This high purity indicated that the licensee's procedures for cleaning the low and high pressure water lines and steam lines during startups had been efficient and that the "chemistry holds" at 30% power, to ensure that this cleanup is complete, had achieved their goals.

During this inspection, the inspector was informed that the injection point for AVT chemicals in Unit 2 had been relocated, during the last refueling outage, closer to the condensate

polishers, so that better control of the pH of the feedwater could be maintained by achieving earlier mixing. The injection point in Unit 1 was already located at a similar position.

On the basis of the inspector's audit, the concentration of ammonia in the feedwater, especially in Unit 1, was frequently less than the 0.3 ppm lower limit that is specified in TI-37 Logsheet 26. The pH, however, was normally within the 8.8-9.2 range specified in the same document. The concentration of hydrazine was always measurable, indicating an excess over that needed to reduce the dissolved oxygen content to below detectable limits (<5 ppb).

(5) Steam Generator Inspections

As discussed earlier, the steam generators of both units were inspected in 1984, and essentially no degradation was observed from eddy-current tests of the steam generator tubes and fiberscopic examinations of the tube sheet regions. The sludge lancing and subsequent visual examination of the Unit 2 steam generators were considered by the licensee to be especially successful because of the efficiency of the sludge removal method and the relatively small amount of sludge found (~125 pounds in each of three steam generators and ~145 pounds in the fourth steam generator). The licensee had also used a depressurization technique to remove scale from the lowest sections of the steam generator tubes where the sludge had settled on the tube sheet.

The inspector's audit showed that, except during plant transients, the cation conductivity of the steam generator water was always below the limit of 0.8 umho/cm set in TI-37 Logsheets 45-48. Normally, this parameter was <0.4 umho/cm. During power fluctuations and other plant transients, rapid hideout return of such species as chlorides, sulfates, phosphates (from cleaning compounds), sodium, and silica caused the cation conductivity to increase to >1.0 umho/cm. The inspector observed that TI-37 requires the following parameters of the steam generator water to be within specification before 30% power is exceeded: cation conductivity, pH, sodium and chloride. A new specification of <20 ppb for sulfate is not being met consistently; however, the licensee hopes to have better control on all steam generator parameters when an improved blowdown system has been installed.

(6) Integrity of Low-Pressure Turbine Disks

The inspector was informed that no indications of key-way or bore cracking of low-pressure turbine disks were observed during the inspection of the Unit 2 rotors during the last refueling outage. The licensee continues to monitor main steam for pH, cation conductively, and specific conductivity as a means of detecting the transport of corrosive chemical species to the turbines. The

inspector observed that all results of analyses were within the specifications set in TI-37 Logsheet 34.

(7) Summary

After two fuel cycles, the steam generators in both units appear to have been maintained in good condition, and the earlier indication of tube denting has been stopped. Although copper and iron oxides are still being transported to the steam generator, and evidence of sulfate and chloride is observed as hideout in the steam generator, no indication of stress corrosion cracking of tubes or tubesheets was observed during fiberscopic and eddy-current examinations. The licensee is planning to upgrade the recovery of blowdown so that even higher purity levels of steam generator water can be attained.

b. Chemistry Control

Through discussions with licensee personnel, review of Technical Instructions that constitute the licensee's water chemistry program, audit of analytical chemistry procedures and results, and observation of laboratory activities and in-line monitoring instrumentation, the inspector updated his earlier evaluation of the licensee's capability to control the secondary water chemistry at Sequoyah.

Operation of the Chemistry Unit is being directed and supervised by the same personnel as during the previous inspection in July 1984. The inspector was informed that attrition within the technician ranks remains relatively high, so that replacement and training are continuous concerns. The Chemistry Unit continues to effectively use the Chemical Engineering Support Staff for revising procedures and improving monitoring capabilities. The inspector considered the working environment within the laboratory to be rather hectic during the day shifts because of the presence of a large number of technicians (the equivalent of two shifts) and the background noise resulting from the combination of several conversations and radio music.

The licensee has installed an in-line ion chromatograph in the secondary chemistry laboratory and is developing the use of this instrument for continual monitoring of the following points in the secondary system: hotwell discharge, condensate booster pump discharge, feedwater, steam generator blowdown, and main steam. Procedures have been tentatively developed for the determinations of key cations and anions as well as ammonia and hydrazine and oxalate (oxalate is a means of measuring ionic organic species). This instrument is also useful for detecting primary to secondary leaks through the detection of as little as 0.25 ppb lithium in the steam generator blowdown.

As discussed in Section 5.a of this report, the inspector audited test results obtained during the period of August 1984 to February 1985. These data were reviewed for consistency with the limits set in TI-37 and for short and long-term trends. No violations or deviations were identified during this audit. However, the inspector noted that a significant number of key parameters exceeded the limits set for power operation whenever the power level was ≤30% or when power was decreased from 100%. This appeared to indicate considerable "hideout" was occurring and therefore, the presence of impurities (deposits, scale, etc.) not detected by fiberscopic examinations of the steam generators.

6. Inservice Testing (IST) of Pumps and Valves (92706)

As a followup of a previous inspection (see Inspection Report Nos. 50-327, 328/83-17), the inspector reviewed the following aspects of the licensee's compliance with Section XI of the ASME Boiler and Pressure Vessel Code (the Code) per the requirement of Technical Specification 4.0.4:

° on-going activities related to the NRC staff's Safety Evaluation Report on the Sequoyah IST program.

° evaluation and audit of the licensee's compliance for maintaining Summary Listings of pumps and valves.

a. IST Program

By letter dated April 5, 1985, the NRC transmitted to the licensee a copy of the Safety Evaluation Report (SER) of the pump and valve IST program submitted by the licensee for Sequoyah Units 1 and 2. This SER responded to the licensee's requests for specific relief from Code requirements as well as provided an evaluation of the completeness of the program. This letter also requested that the NRC be advised within 45 days that the IST program has been revised in accordance with the SER.

The licensee informed the inspector that the findings and positions in the SER had subsequently been discussed by telephone with the reviewer in the Office of Nuclear Reactor Regulation (NRR). The inspector was requested to expand on the NRC staff's positions and interpretations of the Code so that a more accurate and adequate basis for requests for relief could be developed or the reviewer's reasons for denying relief requests could be better understood. The inspector was able to clarify many of the positions taken by the SER and committed to seek additional information from the NRR reviewer so that all parties would be cognizant of the final positions.

The licensee provided the inspector with a copy of the Sequoyah IST program.

b. Review of Summary Lists

The licensee's IST program is based on the 74S75 edition of the Code for Unit 1 and the 77S78 edition for Unit 2. Both editions require that summary listings of pumps and valves be maintained to record the status of the inspection program. The inspector interprets the pertinent sections of the Code to require that someone in the licensee's organization must be aware of the operability of each pump and valve and of any trend in test results that would indicate short or long term degradation of the component.

The Sequoyah Pump Summary List is actually a set of Pump Books wherein the values of all test parameters have been documented along with specified reference values for each parameter. The Valve Summary List is a computerized printout that lists the following: each valve in the program; date of stroke time tests performed during 1984 and 1985; the Surveillance Instruction used to perform the test; and the measured stroke time. The inspector considers that the Pump Books meet the intent of the Code; however, several data sheets were identified where the reference values were incorrect or absent. The licensee committed to review the Pump Books and ensure that all data sheets reflect correct information. The valve lists are considered to be deficient in that the present list is limited to data acquired during 1984 and 1985 and does not provide sufficient information on which to base trends, especially when some tests are performed only during refueling outages. The licensee also committed to review the value of retaining all previous valve test data and to take appropriate action to expand the valve list.

During his audit of data documented for Containment Spray Pump 1A (Unit 1), the inspector observed that the pump flow rate during the initial tests was ≥5500 gpm but dropped to 3500-4000 gpm in April 1981 and thereafter. The test data for the differential pressure of this pump remained 132 to 145 psi during the operational life of the pump, thereby indicating that the pump had remained operable. The licensee was not able to explain the drop in flow rate or why the flow rate was allowed to remain below the rated 4700 gpm that is designated on the drawing for this system.

The 74S75 edition of the Code (paragraph IWP-3110) states that "in a fixed resistance system, it is required to measure ΔP or Q (flow rate), not both." All later editions of the Code require that both ΔP and Q be measured. The NRC staff endorses the positions of the later Codes. Inasmuch as the licensee documented both ΔP and Q, it is necessary to establish the reason for the change in Q only and whether or not the pump has been in a degraded condition since April 1981. The inspector designates this matter as Unresolved Issue 50-327/85-18-01, Operability of Containment Spray Pump 1A. The licensee committed to expedite review and resolution of this issue.

7. Briefing by Combustion Engineering Personnel

As discussed earlier, during the last refueling outage for Sequoyah Unit 2 (Fall 1984) the steam generators of this unit were sludge-lanced using a method recently made available by Combustion Engineering, Inc., (CE) of Chattanooga, TN. In order to facilitate the inspector's review, the licensee arranged a non-proprietary briefing and demonstration of this method by CE personnel at the CE plant (approximately 30 miles from the Sequoyah plant).

The CE method is similar to those provided by other vendors in that the metal oxide sludge is washed out of the tube bundle (primarily off of the tube sheet) by jets of water and then removed from the steam generator by suction. The licensee considers the CE method to be very effective because subsequent visual inspection of the tube sheet region revealed essentially no residual solids. CE personnel attribute the high efficiency of their method to the accuracy with which they can direct their hydrolasers and the use of repeated applications of the lancing if needed.

The CE hydrolaser component consists of a small, rubber wheel cart on which is mounted three water-jet nozzles, a miniature television camera, and a small spotlight. All components can move with three degrees of freedom and are focused remotely from a trailer outside the containment building. The cart is inserted through the lower hand hold of a steam generator and then placed on the annular ring that circles the tube bundle. The cart can be moved (by remote control) around the ring and stopped at any desired location where the hydrolaser, camera, and light are then aligned to ensure the water jets traverse the tube lanes. The sludge is forced into the large lane in the center of the tube bundle, where the blowdown pipe is located, and is removed by means of a suction component. This small 'vacuum cleaner' and its associated spotlight, are also placed inside the steam generator by means of the hand hold: The sludge and water are transferred through the suction line to the trailer where the solids are removed by filtration and the water is then cycled back to the hydrolaser.

The inspector was informed that the jets of water are focused on tube lanes in all possible directions (i.e., two directions for Westinghouse's rectangular tube bundles and three directions for CE tube bundles). Consequently, 'shadowing' of solids is minimized and, by repeated applications, approximately 85% to 90% of all loose sludge can be removed. The CE personnel have observed sludge in another nuclear power plant however that consisted of intermixed layers of powdery solids and hard, massive material, and where the hand material resisted breakup by repeated applications of the water jets.

The inspector was also briefed on the fiberscope technology that was utilized to establish the effectiveness of the sludge removal at Sequoyah Unit 2.

The inspector did not identify any unreviewed safety issue associated with the CE sludge lancing method.