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

MAR 25 1986

Report Nos.: 50-259/86-07, 50-260/86-07, and 50-296/86-07

Licensee: Tennessee Valley Authority
6N38 A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Docket Nos.: 50-259, 50-260 and 50-296   License Nos.: DPR-33, DPR-52, and DPR-68

Facility Name: Browns Ferry

Inspection Conducted: February 18-21, 1986

Inspector: W J Ross   3/17/86
W. J. Ross   Date Signed

Accompanying Personnel: E. J. Witt (NRR)

Approved by: P G Stoddart   3/20/86
P. G. Stoddart, Acting Section Chief   Date Signed
Radiological Effluents and Chemistry Section

SUMMARY

Scope: This routine special announced inspection involved 31 inspector-hours onsite in the area of plant chemistry.

Results: No violations or deviations were identified.

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REPORT DETAILS

1. Persons Contacted

Licensee Employees

*E. A. Grimm, Assistant to the Plant Manger
J. E. Swindell, Superintendent of Operations and Engineering
J. R. Clark, Chemistry Unit Supervisor/Engineering
*D. R. Gallien, Engineer, Chemistry Unit
*F. E. Hartwig, Engineering
*D. C. Mims, Engineering Supervisor
R. R. Rahn, Specialist, Division of Nuclear Services
R. D. Shireman, Laboratory Supervisor, Chemistry Unit
*W. C. Thomison, Engineering Assistant Supervisor

Other licensee employees contacted included Chemistry Technicians

Other Organization

C. Stuart, S. G. Pinney and Associates

NRC Resident Inspectors

G. L. Paulk
*C. A. Patterson
*C. Brooks

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on February 21, 1986, with those persons indicated in Paragraph 1 above.

The licensee did not identify as proprietary any of the material 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

All three units of Browns Ferry have been shutdown since March 1985, and the exact dates for restart were not definite. However, the licensee informed the inspector that for the purpose of scheduling a chemistry upgrade program it was assumed that Unit 2 would start up in September 1986, Unit 3 in July 1987, and Unit 1 at a later date. During this inspection the inspector evaluated the extent to which the reactor and reactor coolant system were

being protected from corrosion and corrosion induced cracking. In addition, the licensee's chemistry control upgrade program was reviewed, and the licensee's capability to implement a water chemistry control program was reassessed.

a. Plant Layup

During this inspection period the three units were in the following conditions.

(1) Units 1 and 2 were defueled, the heads were off both reactors, and the entire reactor coolant systems were filled with deionized water. Water was being cycled through the "long-cycle cleanup train" (i.e., hotwell-condensate lines condensate-polishers-feedwater lines as far as the first isolation valve-and back to the hotwell) as well as through the Reactor Water Cleanup (RWCU) System to minimize contamination by corrosive soluble and solid species and to reduce radiation levels. The inspector observed that the conductivities of the reactor water in Units 1 and 2 were 0.7 and 0.5 umho/cm respectively and, therefore, less than the upper limit of 1.0 umho/cm specified for cold shutdown in the licensee's water chemistry program (Procedure BF CI-100, Water Quality Limits, dated February 4, 1986).

The inspector was informed that no special layup conditions were implemented in the high-pressure water and steam lines or in the high and low-pressure turbines to minimize or prevent degradation from humid air or residual moisture.

(2) Unit 3 still had fuel in the core, the reactor vessel was closed, and the condensate/feedwater train and the reacter coolant were being continually purified in the same manner as in the other two units.

The actions taken by the licensee would protect the carbon steel condensate/feedwater lines from corrosion to the extent that corrosive ions, such were chloride or sulfate, and other ionic and solid contaminates were being maintained at a low level. The inspector did not establish if dissolved oxygen was being monitored; however, while the condensers were at atmospheric pressure there was no means for preventing the water in the hotwells from being saturated with air.

Likewise the stainless steel lines in the reactor coolant systems were being protected from corrosive impurities by the RWCU System in that ~1% of the volume of the reactor coolant was constantly being cycled through the RWCU demineralizers. The reactor coolant also probably had been partially saturated with oxygen since these systems were at atmospheric pressure and had not been covered with an inert atmosphere. Consequently, both the carbon steel systems, and to a lesser extent the stainless steel reactor vessel and associated pipes, were considered to be vulnerable to oxidation or oxygen induced stress corrosion whenever they were in contact with oxygen saturated water or in humid environments.

The inspector was informed that after the present outage had lasted four or five months the licensee began investigating alternative methods for lay-up that would extend the useful life of the units. The inspector reviewed preliminary lay-up guidelines that had been prepared for scheduling, sequencing, and implementation of various systems and components as the result of this study.

This preliminary instruction recognized that extended plant outages could cause accelerated corrosion rates resulting in increased amounts of corrosion products being transferred through the reactor coolant system. These corrosion products are capable of aggravating the formation and transfer of radioactive activation products such as cobalt-60, nickel-58, and iron-58 as well as having adverse effects on fuel performance. Greater amounts of corrosion products require more frequent precoating of the filter/demineralizers, with the economic penalty associated with procurement and disposal of precoat materials.

The preliminary instruction recommended that all water systems be circulated and polished and, as soon as possible, drained and maintained in a dehumidified environment through the use of dry-air circulators.

The inspector discussed this instruction with plant management. Although the consensus of opinions was that dry lay-up would eliminate many of the unknown corrosion factors associated with wet and humid environments, no definite plans had been made to implement this alternative. Inasmuch as the Browns Ferry units had already been exposed to potentially damaging conditions for a year, the licensee should have given priority to this study and to the recommendations in the draft instructions for dry lay-up.

b. Upgrade of Chemistry Control

During this extended outage the licensee had been upgrading the capability to meet the stringent chemistry control recommended by the BWR Owners Group (BWROG) by refurbishing the front end components of the condensate/feedwater train and by implementing an extensive chemistry improvement plan. The inspector reviewed these activities and evaluated their progress and their effect on the future capabilities for chemistry control.

(1) Plant Improvements

(a) The inspector was informed that all potential sources of air inleakage through the condensers and turbines were being investigated; however this effort was to be intensified during plant startup, after a vacuum has been drawn on the condenser and before these components again became radiation hazards.

(b) The water treatment plant was to be refurbished and new instrumentation installed within the next two or three months.

(c) The Demineralized Water Storage Tank and the Condensate Storage Tanks were cleaned to remove corrosion sludge and other solid material from the inner surfaces so as to decrease the radiation level associated with these tanks. This work, as well as minor repair of the inner epoxy linings, was performed, by divers, with water in the tanks for radiation shielding.

(d) The condensate cleanup system was modified to add an air-surge backwash system in Unit 1 in an effort to expedite removal of spent resins from the filter/demineralizer septums. The inspector was informed that representatives of the vendor of these condensate polishers were scheduled to visit the site to review the operation of the three systems.

(2) Program Upgrading

An extensive chemistry improvement program with 1,015 action items was underway during this outage period. Some of the areas that were considered to be most important by the inspector was briefly described below, and the licensee's estimate of the degree of completion was included.

- Staffing (95%) - Seventeen new Engineers and Laboratory Analysts were hired to bring the Chemistry Unit to its authorized level of 19 Engineers and 30 Laboratory Analysts under the Chemistry Unit Supervisor. The Engineers were divided into six areas of responsibility: Environmental; Water Processing and Purification; Analytical; Radiochemical Laboratory; Radiochemical Analysis; and Support Systems. The laboratory analysts were divided into five crews consisting of a Shift Supervisor and five Analysts, all of whom were under the Radiochemical Laboratory Supervisor. The inspector reviewed an internal Chemical Unit Instructions Letter (dated 12/23/85) that described the Chemistry Unit organization and established responsibilities, duties, and accountability.

- Training (88%) - A multilevel training program was being implemented for all members of the Chemistry Unit. Engineers and Supervisors were given formal training in BWR systems, Shift Technical Advisor duties, and additional training by General Electric. The Analysts were trained or retrained in plant systems at the TVA Training Center and were receiving instructions in monitoring and control through a course developed by a contractor. In addition, a Training Coordinator in the Radiochemistry Laboratory oversaw the licensee's on-the-job training program.

- Procedures (82%) - In July 1985 the Radiochemistry Laboratory began to use chemistry procedures that were revised to incorporate the guidelines recommended by the BWR Owners Group. As of the date of this inspection 116 of 140 procedures had undergone revision, including a draft of new instructions related to abnormal chemistry conditions.

- Instrumentation (61%) - The licensee installed online sampling capabilities for the following key locations in the reactor coolant cycle of Unit 2; condenser hotwells, condensate pump inlet, condensate polisher inlet and outlet, and feedwater. Automated instrumentation was installed for the measurement of three control parameters (conductivity, pH, and dissolved oxygen). In addition, an inline ion chromatographic system was installed and was tested for monitoring trace concentrations of anions and cations for control and diagnostic purposes. This entire inline system was computer controlled to monitor each key sample tap eight to twelve times a day and to print out the results automatically.

  Other important elements of this chemistry improvement program that received less attention from the inspector were:

- QA/QC (98%) - This program was coordinated by an Analytical Instrumentation Specialist in association with the Radiochemistry Laboratory Supervisor.

- Data Management (77%) - The licensee was developing a computer-based program for archiving and trending.

- Facilities (82%) - The Radiochemistry Laboratory was equipped with new lab benches.

- Chemical Traffic Control - A program for tracking and disposing of all chemicals used in the Radiochemistry Laboratory and elsewhere in the plant was being implemented.

- Representative sampling (74%) and Systems Chemistry (75%) - These elements were included in the training program of all inexperienced engineers and analysts.

Summary

The licensee was in the process of upgrading the design of the plant to minimize ingress of air and potentially corrosive contaminants into the condensate and, thus, reduce the burden on the condensate cleanup system. By these means the licensee was striving to meet the very stringent limitations on conductivity (e.g., 0.2 umho/om in the reactor water) recommended by the BWROG. These goals would be more difficult to achieve if the filter/demineralizers were not effective or if fragments of or whole ion-exchange resin beads were to be "thrown" into the effluent of the demineralizers and, subsequently, into the reactor water where they could be thermally decomposed into corrosive chemical species. The licensee was addressing this problem by having the vendor of the condensate cleanup system (Graver) perform an assessment of the effectiveness of this system.

The BWROG guidelines for controlling the purity of the reactor coolant required the licensee to completely revise and upgrade the plant's water chemistry program. This activity had been underway for the past three years and appeared to the inspector to have made significant progress since the last inspection (February 1985). Although the chemistry improvement program was approximately 80% completed, continual emphasis on improvement of training and quality control would be required to control such high purity water systems and to utilize the state-of-the-art, automated, and computer-controlled analytical instrumentation that was installed in Unit 2. Finally, the inspector believed that in order for the Chemistry Unit and Operations Department to fully implement the technical guidelines recommended by the BWROG, the management of the plant should subscribe to both the technical and philosophical goals of the BWROG.

(3) Hydrogen Water Chemistry (HWC)

The BWROG included, as an appendix to its guidelines, information related to the use of hydrogen addition for control of the dissolved oxygen content of the reactor coolant and reduction of intergranular stress corrosion cracking of stainless steel, especially as observed in sensitized weld regions. The inspector was informed that planning for implementation of HWC in Unit 3 had reached the stage where the necessary design modifications might be made during the current outage or during the next fuel cycle. This work will be based on the BWROG/EPRI Design Guide that was submitted for NRC review on another licensee's docket. The licensee had not determined what method would be used to provide a supply of hydrogen (i.e., cryogenic tank, bottled gas, or use of

an electrolytic cell); however, the use of a cryogenic tank (~20,000 gallons) was the preferred method at the time of the inspection.

Future activities related to HWC implementations will be monitored by the inspector.

c. Fuel Degradation

The licensee briefed the inspector on studies that had been made to establish the cause of numerous perforations in the cladding of fuel in Units 1 and 2 during the initial five fuel cycles. (Only Unit 3 consistently met the reliability goals set by the vendor.) The principal failure mechanism was attributed to crud-induced-localized-corrosion (CILC) fuel rods that contained gadolinia and which were fabricated from certain ingots of zirconium and which appeared to be the most susceptible. This type of nodular corrosion also seemed to be related to the presence of copper, as it was limited to plants with copper alloy condenser tubes and filter/demineralizer condensate cleanup systems. The licensee attempted to identify potentially susceptible fuel rods still remaining in the cores of Units 1 and 2 so that core configurations could be altered to minimize the possibility for additional leakers. The licensee planned to install new fuel rods, which had been heat treated to reduce their susceptability to CILC. The licensee was also investigating the effect on the rate of CILC, as well as the rate of hydrogen uptake by Zircaloy cladding, which would result from implementation of HWC control.

d. Conclusions -

No violations or deviations were identified. Because of the vulnerability of the materials of the reactor coolant pressure boundary to corrosion during the current extended outage, it was the inspector's conclusion that the licensee should give high priority to improving the lay-up procedures and should develop methods for determining the extent to which corrosion may have been initiated in those systems that were in wet lay-up or in humid environments.