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

MAY 17 1988

Report Nos.: 50-321/88-13 and 50-366/88-13

Licensee: Georgia Power Company
P. O. Box 4545
Atlanta, GA 30302

Docket Nos.: 50-321 and 50-366 License Nos.: DPR-57 and NPF-5

Facility Name: Hatch 1 and 2

Inspection Conducted: April 18-20, 1988

Inspector: John B Kahle for W. J. Ross 5/13/88 Date Signed

Approved by: John B Kahle J. B. Kahle, Section Chief, Division of Reactor Safety 5/13/88 Date Signed

SUMMARY

Scope: This routine, unannounced inspection was conducted in the areas of hydrogen water chemistry and plant chemistry control.

Results: No violations or deviations were identified.

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REPORT DETAILS

1. Persons Contacted

   Licensee Employees

   B. Arnold, Chemistry Supervisor
   R. Bryant, Staff Chemist
   R. Dedrierson, Assistant to the Vice-President/Hatch
   B. Feimster, Chemistry Foreman
   *W. Kirkley, HP/Chemical Engineering
   *V. McGowan, Chemistry Supervisor
   W. Rogers, Chemistry Superintendent
   S. Shipman, Systems Engineer
   R. Tracey, Systems Engineer
   *P. Read, Plant Support Manager
   *D. Self, Nuclear Superintendent

   Other Organizations

   M. Terrell, General Electric Company

   NRC Resident Inspectors

   P. Holmes-Ray, SRI
   *J. Menning, RI
   *R. Musser, RI

   *Attended exit interview

2. Exit Interview

   The inspection scope and findings were summarized on April 20, 1988, with those persons indicated in Paragraph 1 above. The inspector described the areas inspected and discussed the insp[illegible]ion results. No dissenting comments were received from the licensee.

   In response to a request by the inspector for clarification of actions taken in response to findings by the Institute of Nuclear Power Operations (INPO), the licensee provided information that was considered proprietary to INPO. This subject is not included in this report.

3. Licensee Action on Previous Enforcement Matters

   This subject was not addressed in the inspection.

4. Hydrogen Water Chemistry

This phase of the inspection was a review of actions taken by the licensee since the last inspection in this area (see Inspection Report Nos. 50-331; 366/87-03 dated February 11, 1987) to implement a hydrogen water chemistry (HWC) program to control initiation and/or growth of intergranular stress corrosion cracking (IGSCC) in the reactor coolant recirculating piping. This review consisted of discussions with personnel from the licensee's Chemistry Department and Systems Engineering Department as well as with the Gereral Electric contractor who was operating the current hydrogen and oxygen injection system in Unit 1. In addition, the inspector walked down the current system and the proposed pipe runs for permanent injection systems for both units.

a. Status of HWC for Unit 1

Beginning in February 1987 the licensee had performed a second HWC test for approximately ten weeks to establish optimum conditions for preventing IGSCC while minimizing radiation levels caused by carry over of volatile nitrogen-16 species with the steam. Likewise, beginning September 1987 Unit 1 had been operating in the current fuel cycle using HWC control. As occurred in the initial feasibility tests, the results of the second test were inconclusive in that a stable corrosion potential between stainless steel and the reactor coolant could not be established through the reduction of dissolved oxygen by a hydrogen flow rate as high as 44 SCFM.

At a rate of 44 SCFM of hydrogen the radiation level at critical parts of the plant was as much as four times the level under normal (non-HWC) conditions. Consequently, during most of the test and during the current fuel cycle the injection rate of hydrogen had been reduced for 22 SCFM. At this rate the radiation levels were as much as twice normal background. Also, at this injection rate the concentrations of dissolved oxygen in the feedwater and recirculatory water were ≥20 ppb and 6 ppb respectively. The electrochemical potential of stainless steel stabilized within the range of ±10 millivolts versus a standard hydrogen electrode (SHE). This electrochemical potential is considerably more positive than the 230 mv range recommended by the BWR owners group for prevention of IGSCC.

The inspector was informed that a permanent HWC procedure was being developed based on an injection rate of 22 SCFM with the expectation that crack initiation or crack growth will be significantly hindered even though optimum conditions are not attainable. In the interim, Special Purpose Procedure "Hydrogen Injection and Control" was being followed to govern the addition of hydrogen to reactor feedwater. This procedure also covered the addition of oxygen into the common offgas line downstream of the third stage Steam Jet Air Ejector to assure an oxygen-rich mixture in the recombiner. This interim procedure also provided for personnel requirements, coordination with the Operations Department, as well as for operating and safety precautions and authorization. The injection system was being monitored and operated by General Electric contract personnel.

The inspector verified that Technical Specifications (Tables 3.2-1 and 3.2-8) had been revised to allow the trip setting of the Main Steam Line Radiation Monitor to be maintained at ≤3 times normal full background under the following conditions:

> "Within 24 hours prior to the planned start of the hydrogen injection test with the reactor power at greater than 20% rated power, the normal full power radiation background level and associated trip setpoints may be changed based on a calculated value of the radiation level expected during the test. The background radiation level and associated trip setpoints may be adjusted during the test based on either calculations or measurements of actual radiation levels resulting from hydrogen injection. The background radiation level shall be determined and associated trip setpoints shall be set within 24 hours of re-establishing normal radiation levels after completion of hydrogen injection and prior to establishing reactor power levels below 20% rated power."

An operations standing order had been implemented to assure that these setpoints were properly coordinated with power level.

The inspector walked down the lines of the current HWC injection system from the skids for hydrogen and oxygen cylinders to the penetrations for the hydrogen lines at the suction of the three condensate booster pumps. Injection flow was being controlled at a panel in the Unit 1 Turbine, and hydrogen was being injected at a rate of 24 SCFM and oxygen of 12 SCFM. Hydrogen could be manually isolated if the reactor tripped or was isolated, or if the injection rate exceeded 35 SCFM. The isolation valve panel was being monitored by hydrogen analyzers that would also isolate hydrogen flow if the atmospheric hydrogen concentration exceeded two percent. Finally, hydrogen flow would also be isolated if the concentration of oxygen in the discharge of the hydrogen-oxygen recombiner in the condenser air ejection system is <5%.

b. Permanent HWC System

The inspector reviewed the licensee's plans for installing a permanent HWC injection system and established the following facts:

- Plans for initiating HWC on Unit 2 were being postponed until the effectiveness of IGSCC control in Unit 1 could be established.

- Designs for a permanent injection system were being developed by Southern Company Services and construction was to begin in June 1988. These designs are based on recommendations published by the Electric Power Research Institute (EPRI) and appropriate fire protection codes.

- Use of the permanent system is scheduled to begin after the next Unit 1 refueling outage in the fourth quarter of 1988.

- Hydrogen will be stored as a liquid in a 20,000 gallon tank and oxygen will be stored in a 9000 gallon tank. These tanks are to be located outside the Protective Area fence at the southeast corner of the plant site, approximately 1000 yards from the power block.

- Both hydrogen and oxygen will be pumped as gases through stainless steel lines (1½ inch for oxygen and 1 inch for hydrogen) buried below the frost line (i.e. ~18 inches deep) in a single trench from the cryogenic tanks to the west cableway at the south end of the plant's turbine building. The hydrogen line will be enclosed in a carbon steel guard pipe whenever the line passes under a road or rail road. Within the west cableway the lines will be reduced to 3/4 inch diameter and routed to the existing isolation panels and then to existing penetrations at the suction of condensate booster pumps and at the air ejector lines. Hydrogen monitors are to be installed in the guard pipes that will enclose the hydrogen lines throughout the unventilated cableway. All joints will be welded.

- Purge valves will be installed at the condensate booster pumps so that hydrogen lines can be purged in a backwards direction if required.

The licensee's plans were considered to be consistent with guidance provided by the NRC (see letter dated July 13, 1987 from James E. Richardson, Office of Nuclear Reactor Regulation to Mr. G. H. Neils, Chairman Regulatory Advisory Committee, BWR Owners Group II for IGSCC). However, the inspector reemphasized the need to take maximum precautions to design and operate the hydrogen and oxygen injection systems so as to minimize leaks and to maximize surveillance for leaks, especially in regions of the plant with poor ventilation.

As part of the permanent HWC installation the licensee had also acquired a Crack Arrest Verification (CAV) system which will be used to monitor the effect of HWC on three representative stainless steel coupons, and, thereby, monitor the effectiveness of HWC control. In addition, two new inline monitors for dissolved oxygen had been installed to increase the licensee's capability to determine and to trend the oxygen concentration in the condensate and feedwater. Finally, in a effort to establish the effect of metals (dissolved and soluble) o HWC, three inline corrosion product samples had been installed to monitor water in the hotwell (especially for corrosion products from the brass condenser tubes), in the condensate polisher effluent, and in the feedwater. As will be discussed later, the instability of the electrochemical potentials observed in the recirculating water when hydrogen was injected into the feedwater had been attributed, in part, to the presence of metallic species in the reactor water and recirculating water.

5. Plant Chemistry

Through discussions with cognizant plant personnel and through an audit of chemistry control data the inspector reassessed the licensee's ability to prevent degradation of the reactor coolant pressure boundary. This part of the inspection consisted of a review of the design and operation of key components of the reactor water system and the implementation of the licensee's water chemistry program.

a. Plant Design and Operation

During the fifteen month interval since the last inspection in this area, both units had operated in stable modes except during refueling outages (April - June 1987 for Unit 1 and January - April 1988 for Unit 2). Except for four brief (1-2 days) shutdowns, Unit 1 had operated at 100% power and, most of the time, with hydrogen water chemistry control. Although Unit 2 only had three short shutdowns, the licensee had decreased the power level of this unit to 90% in May 1987, and to lower levels since October 1987, because of fuel failure problems.

Although air inleakage had remained higher than desired (~15-40 SCFM in Unit 1 and ~15-20 SCFM in Unit 2) the main condensers had provided effective barriers against ingress of condenser cooling water. Only one tube leak had occurred, and this leak had been caused by mechanical damage rather than by corrosion mechanism. The licensee attributed the integrity of the main condensers, in part, to a program of visual and eddy current tests performed during refueling outages.

The principal concern with the main condensers was still the continual loss of metal from the condenser tubes as soluble and/or insoluble species of copper and zinc. In an effort to prevent these metals, especially copper, from being transported to the reactor, the licensee had attempted to enhance the efficiency of the condensate polishers in Unit 2 by increasing the length of the filter-demineralizer tubes from 70 inches to 80 inches. Also, 'body-feed' technique of continually adding thin layers of ion-exchange resins to the filter-demineralizer elements was still in use. This technique had extended the intervals between proecoating (complete removal and replacement of resin from the tubes) to approximately three weeks; thereby, conserving water, resin, and manpower.

However, an audit of analyses of effluents from the polishers, as well as analyses of feedwater samples, showed that measureable amounts of cooper (~0.3 ppb) were still passing through the demineralizers and into the reactor, where the copper is a concentrated by a factor of ~100.

Both Hatch units have experienced fuel rod failure as the result of corrosion and embrittlement of zircaloy cladding attributed to 'copper crud' (see Inspection Report 50-321;366/84-06 dated March 23, 1984). The presence of easily reduced species of copper has been considered by the licensee to also contribute to the instability of the electrochemical potential of the reactor water and the recirculating water when hydrogen is injected to reduce dissolved oxygen (see Paragraph 4a of this report). Consequently, the licensee has an ongoing program to reduce the concentrations of both soluble and insoluble copper in the feedwater.

From the audit of control and diagnostic chemistry variables the inspector observed that trace (0.1-1.0 ppb) amounts of soluble iron, zinc, and nickel were also being transported into the feedwater. This magnitude of iron and nickel is not considered to be a significant contributor to the loading of the reactor with oxide sludge. Recent investigations by EPRI have shown that the presence of trace amounts of zinc in the reactor water acutally is beneficial to the maintenance of low ex-core radiation levels throughout the reactor coolant system and does not pose a corrosion hazard.

The Chemistry Groups's capability for monitoring general corrosion of the brass condenser tubes as well as carbon steel and stainless steel pipe throughout the reactor coolant system had been enhanced by the installation of corrosion product samplers for hotwell water, polisher effluents, and feedwater.

The inspector also established that although the licensee had not encountered micro or macro biological problems in the Service Water systems, two intrusions of raw river water into closed cycle cooling systems had occurred through heat exchangers cooled by Service Water. One of these leaks contaminated the Unit 1 Recombiner Closed Cycle Cooling Water System.

The other leak contaminated the water in the Suppression Pool of Unit 1 with approximately 0.5 ppm of chloride and 300-400 ppb of silica; thereby, exceeding administrative limits of <50 ppb chloride and <100 ppb silica. At the time of this inspection the licensee had not begun to reduce the levels of these contaminants. The inspector was informed that the reason for the delay was because an efficent cleanup method had not been settled on. The radwaste system had a capacity of about 2000 gallons per week while the Torus water volume was over 600,000 gallons. The licensee was considering the use of a demineralizer system that could be used to cycle and cleanup this volume of water. Although the walls of the carbon steel Torus were supposed to be coated with paint, the inspector emphasized the potential for corrosion when carbon steel is exposed to water with dissolved oxygen, detectable chloride concentrations, neutral pH, and, especially, in a stagnant condition.

Finally, the inspector was informed that the discrepancies in the concentrations of corrosion inhibitor (sodium nitrite) in the Reactor Building Closed Cycle Water (RBCCW)(as shown on the HP/CHEM Daily Report) was caused by leaks in pump seals that depleted the treated water. Because of difficulties involved with the cleanup or disposal of nitrite-containing water, the licensee had chosen to discontinue addition of the corrosion inhibitor until the pump problem was corrected. The licensee was aware of the potential for degradation of the carbon steel pipe in the RBCCW unless all dissolved oxygen in the cooling water was eliminted.

b. Water Chemistry Program

The inspector reviewed the following elements of the licensee's water chemistry program

- Staffing
- Training
- Physical Facilities
- Quality Control Program

(1) Staffing - Since the last inspection in this area the organization reporting to the Manager-Health Physics/Chemistry had been modified so that three Superintendents (Health Physics, Chemistry and HP/CHEM Support) provide a secondary line of supervision. The Chemistry Group was divided under two Supervisors, one for instrumental analysis and the second responsible for all other chemistry activities. The analytical staff, eight foremen and thirty-four technicians, was divided into five rotating shifts and one day shift. The inspector was informed that the rotating shifts would soon be of twelve hours duration rather than the current eight hours.

The professional staff under the Superintendent/Support included chemists and chemical engineers who not only provided daily support but who also had responsibilities for upgrading capabilities and initiating HWC.

(2) Training - The stability of the Chemistry staff continued to improve during the interval since the last inspection in this area. Consequently, the licensee had been able to continue with its formal training (classroom) programs as well as with the on-the-job qualification program. An average of two weeks out of every ten was being dedicated to training.

(3) Physical Facilities - By means of a walkdown of sampling rooms and laboratories the inspector reassessed the facilities available to perform the responsibilities of the water chemistry program. During the last year the licensee had developed an instrument laboratory separate from the existing hot laboratory. This additional space permitted more effective use of the ion chromatography systems, but, because of inefficient venting, could not be used for atomic absorption spectrometric analysis. As mentioned earlier, the sampling rooms for both Units had been upgraded with inline monitors for oxygen, conductivity, and corrosion products.

(4) Quality Control - This element of the water chemistry program was reviewed through observations and discussions with the Instrument Supervisor, Instrument Foreman, and technicians in the Instrument Sub Group while these personnel were involved in the analysis of a series of unknown standards that had been provided by the inspector. These standards consisted of aqueous solutions of the key chemistry ionic variables that have been identified for the control of BWR chemistry by the BWR Owners Group (i.e., chloride, sulfate, silica, iron, copper, nickel, chromium, and sodium). These solutions were prepared in ppm concentrations for the NRC by the Brookhaven National Laboratory and were to be analyzed by the licensee's usual procedures after dilution to concentrations similar to routine control and diagnostic values.

Although some analyses had been completed and evaluated by the inspector before the end of the inspection, the results of all analyses will be presented in a supplemented Inspection Report. IFI 50-321/88-13-01; 50-366/88-13-01

(5) Conclusions

Violations or deviations were not identified during any phase of this inspection. The inspector verified that the Technical Specifications pertinent to chemistry control had been met. The steps being taken to implement HWC, to upgrade the design and operation of key plant components related to chemistry control, and to further improve control and diagnostic capabilities were considered to be acceptable and to indicate a commendable understanding of corrosion mechanisms and industry approaches to this prevention.