November 8, 2002

Mr. John L. Skolds, President
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Warrenville, IL 60555

SUBJECT: BYRON STATION, UNIT 2 - SUMMARY OF CONFERENCE CALLS WITH EXELON GENERATION COMPANY REGARDING ITS 2002 STEAM GENERATOR TUBE INSPECTION RESULTS (TAC NOS. MB6310 AND MB4017)

Dear Mr. Skolds:

On June 25, 2002, and September 23, 2002, the NRC staff participated in conference calls with Exelon Generation Company representatives regarding the steam generator tube inspection activities at Byron 2. Enclosure 1 summarizes the June 25, 2002 call, and Enclosure 2 summarizes the September 23, 2002 call.

As discussed in the summaries, we did not identify any issues with the results of the examination that warranted additional regulatory actions.

Please contact me at (301) 415-8371 if you have any questions on this issue.

Sincerely,

/RA/

Mahesh Chawla, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. STN 50-454 and STN 50-455

Enclosures: As stated

cc: See next page

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SUMMARY OF CONFERENCE CALL

WITH

EXELON GENERATION COMPANY

REGARDING THEIR JUNE 2002 STEAM GENERATOR INSPECTION RESULTS

AT BYRON 2

On June 25, 2002, members of the NRC staff held a conference call with representatives of Exelon Generation Company to discuss their steam generator tube inspection activities at Byron 2 during their June 2002 outage.

Topics discussed during the conference call consisted of background, leakage history, inspection scope and results, and repair/plugging plans.

Background

Byron 2 is a four-loop Westinghouse pressurized water reactor with four Westinghouse Model D5 recirculating steam generators (A, B, C, D). Each steam generator contains 4,570 thermally treated Alloy 600 tubes, which are nominally 0.750 inch in diameter and have a nominal wall thickness of 0.043 inches. The tubes are hydraulically expanded for the full depth of the tubesheet at each end. The tubes are supported by a number of stainless steel tube support plates with quatrefoil shaped holes and V-shaped chrome plated Alloy 600 anti-vibration bars. Prior to installation, the tubes in Rows 1 through 9 were treated in a furnace in order to relieve the stresses from bending the tubes.

The model D5 steam generators have several unique design features that set them apart from other steam generators which have thermally treated Alloy 600 tubes. These include a preheater and a T-slot. The preheater is a region in the tube bundle which preheats the incoming feedwater (secondary coolant) prior to entering the main region of the tube bundle. The preheater has tubes that were expanded into various support plates to address tube wear which was observed in this region as a result of tube vibration. The T-slot is an untubed portion of the tube bundle which is in the shape of a “T” and is used in the blowdown of the steam generator for sludge removal.

Leakage History

In June 2001, primary-to-secondary leakage was observed in steam generator C. The leakage increased with time with spikes in the leakage corresponding to changes in the primary-to-secondary system differential pressure. The licensee provided graphs depicting the trend in leakage. On June 22, 2002, the plant was shut down when the leak rate reached a level of 75 to 80 gallons per day (gpd).

Inspection Scope and Results

During the forced outage, the licensee visually observed a steady stream of water coming from the cold-leg side of the tube in Row 43 Column 23 (R43C23). There was no pressure on the secondary side of the steam generator during this observation (i.e., there was a static head of water covering the tube bundle during the test). To ensure all leakers were identified, a 50 pound per square inch (psi) nitrogen overpressure was placed on the secondary side of the steam generator, and no additional leaking tubes were identified.

A bobbin and rotating probe inspection was conducted on the leaking tube and a flaw slightly above cold-leg tube support 2C was identified. The flaw was approximately 0.125-inch above the top of the tube support and was characterized as an outside diameter initiated volumetric flaw. The flaw was 0.3-inch in length and affected 103-degrees of the tube circumference. The depth was estimated by two techniques to be either 71-percent through-wall (amplitude technique) or 97-percent through-wall (phase analysis).

In addition to the leaking tube, 10 surrounding tubes were also inspected. These inspections resulted in the identification of three additional flaws in two tubes. As with the leaking tube these flaws were outside diameter initiated volumetric flaws. In tube R43C22, a 0.3-inch long flaw affecting 106-degrees of the tube circumference and estimated at 37-percent through-wall was observed 0.125-inch above cold-leg tube support 2C. In tube R43C24, there were two indications. One indication was 0.237-inch in length, affected 67-degrees of the tube circumference, and was estimated at 11-percent through-wall. This indication was 0.125-inch above the top of cold-leg tube support 2C. The second indication on this tube was 0.475-inch above the top of cold-leg tube support 2C and was 0.267-inch in length, affected 51-degrees of the tube circumference, and was estimated at 13-percent through-wall. These tubes were last examined in 1999 and there was no indication of degradation at that time.

Given the nature (volumetric) and location of the signals (periphery near feedwater inlet), the flaws were attributed to wear from a loose part; however, no loose parts were observed during the eddy current inspection.

The leaking tube was in-situ pressure tested to confirm its structural and leakage integrity. At a pressure corresponding to normal operating pressure, the leakage from the tube measured 36 gpd. The licensee attributed the difference between this value and the value observed during operation (i.e., 76 gpd) to the sensitivities/accuracies of the techniques. At a pressure corresponding to a steam line break (target pressure of 2918 psi given that the tests were performed at ambient temperature), the leakage from the tube measured 59 gpd. The actual test pressure was 3000 psi. After inserting a bladder in the tube to avoid excessive leakage, the tube was pressurized to 4700 psi (slightly above the target pressure of 4617 psi) and the tube did not burst. All pressures were held for 5 minutes. These results confirmed the tube had adequate structural and leakage integrity.

The licensee postulated three possible causes regarding the varying trend in leakage: 1) debris in the primary restricted flow through the tube, 2) a loose part was located against the tube and restricted flow through the tube, and 3) the tube support covered the flaw during operation (i.e., because of tube support plate deflection or differential expansion between the tube and steam generator shell).

Repair/Plugging Plans

The licensee plugged and stabilized all three tubes with indications. The licensee plans to perform foreign object search and retrieval (FOSAR) during the next outage at cold-leg tube support 2C and the top of the tubesheet in order to look for loose parts. The next outage is scheduled for September 2002.

Based on the scope and results of the inspection, the results of the in-situ pressure test, and an evaluation of operating with a known loose part, the licensee concluded that operation until the next scheduled refueling outage was acceptable.

NRC Observations

During the call, the NRC raised concerns regarding the scope of the inspection. The NRC's concerns involved whether the licensee should have inspected the tube in Row 42 Column 21 and more broadly whether the licensee took too narrow an interpretation of the EPRI Steam Generator Examination Guidelines in determining the extent of the condition. Regarding the latter, the licensee concluded that the leakage was a result of a loose part. As a result, they inspected the tubes surrounding the location of this specific part. A more robust root cause evaluation may have concluded that there was a breakdown in the foreign material exclusion program and that all areas where loose parts could be found should be inspected. This interpretation is the one the NRC staff would recommend. Although the licensee's root cause evaluation was narrow, it could be argued that it was not inconsistent with industry guidelines.

In addition to concerns regarding the scope of the eddy current inspection, the staff noticed that the EPRI guidelines, which the licensee has committed to, indicate that a visual inspection should be performed on the steam generator secondary side in the vicinity of the tubesheet for the purpose of identifying loose parts or foreign objects during a leaker outage caused by loose parts. The licensee elected not to perform this inspection at this time, but will perform this inspection at its upcoming refueling outage scheduled to begin in September 2002.

With respect to damage to the steam generator tubes from loose parts, the NRC staff expressed concern that the licensee's loose parts program (e.g., foreign material exclusion program) appeared weak (compared to other plants with thermally treated tubes) based on the number of tubes plugged and the occurrence of two primary-to-secondary leaks which resulted in plant shutdowns as a result of this damage mechanism.

Despite these shortcomings, the staff concluded based on the results of the examinations and the short timeframe before the next scheduled inspection (i.e., 2 to 3 months) that no additional regulatory actions are warranted.

SUMMARY OF CONFERENCE CALL

WITH EXELON GENERATION COMPANY

REGARDING ITS SEPTEMBER 2002 STEAM GENERATOR

INSPECTION RESULTS AT BYRON 2

On September 23, 2002, members of the NRC staff held a conference call with representatives of Exelon Generation Company to discuss its steam generator tube inspection activities at Byron 2 during their September 2002 refueling outage. Topics discussed during the conference call included those provided to the licensee by letter dated September 18, 2002, (ADAMS Accession Number ML022590386) and consisted of background, leakage history, inspection scope and results, and repair/plugging plans. At the time of the call, the licensee was approximately 70 percent complete with its inspections.

Background

Byron 2 is a four-loop Westinghouse pressurized water reactor with four Westinghouse Model D5 recirculating steam generators (A, B, C, D). Each steam generator contains 4,570 thermally treated Alloy 600 tubes, which are nominally 0.750 inches in diameter and have a nominal wall thickness of 0.043 inches. The tubes are hydraulically expanded for the full depth of the tubesheet at each end. The tubes are supported by a number of stainless steel tube support plates with quatrefoil shaped holes and V-shaped chrome plated Alloy 600 anti-vibration bars (AVBs). Prior to installation, the tubes in Rows 1 through 9 were treated in a furnace in order to relieve the stresses from bending the tubes.

Prior to this refueling outage, a total of 226 tubes had been plugged in the four steam generators. Three modes of degradation have historically been observed in the Byron 2 steam generator tubes; wear at the AVBs, wear in the preheater region, and wear from foreign objects.

Leakage History

During the prior cycle, primary-to-secondary leakage was observed in steam generator C. This leakage resulted in a forced outage in June 2002. The maximum leak rate reached 76 gallons per day. During the June 2002 outage, a static head pressure test resulted in the identification of one leaking tube. Upon increasing the pressure to 50 pounds per square inch, no additional leaking tubes were identified. The leaking tube was in-situ pressure tested during the June 2002 outage and it met all structural and leakage integrity criteria. Details of the inspections conducted and the results are discussed in Enclosure 1 of this letter.

From June 2002 to the start of the refueling outage, no primary-to-secondary leakage was observed. As a result, no pressure tests were performed on the steam generators during the September 2002 refueling outage (pressure tests are typically conducted to identify tubes with through-wall or near through-wall flaws).

Inspection Scope

During the September 2002 inspection, the licensee was using analysts and techniques qualified in accordance with the Electric Power Research Institute's (EPRI's) "PWR Steam Generator Examination Guidelines." Personnel were qualified to Appendix G of these guidelines and techniques were qualified to Appendix H.

The licensee planned to perform the following inspections in each of the four steam generators during the outage:

Full length bobbin examination of 100 percent of the in-service/active tubes.

Rotating probe (equipped with a plus-point coil) examination of 75 percent of the tubes from 3 inches above to 3 inches below the top of the hot-leg tubesheet. This examination would include the expansion transition.

Rotating probe (equipped with a plus-point coil) examination of the U-bend region of 75 percent of the tubes in Rows 1 and 2.

Rotating probe (equipped with a plus-point coil) examination of 75 percent of the dents/dings on the hot-leg side of the steam generator, which have bobbin voltages greater than 5 volts.

Visual examination of all tube plugs.

In addition to the above, the licensee planned to inspect the expanded region of 25 percent of the tubes which had been expanded into tube supports in the preheater region. These examinations were being performed in three of the four steam generators with a rotating probe (equipped with a plus-point coil).

On the secondary side of the steam generator, the licensee planned to perform sludge lancing and foreign object search and retrieval (FOSAR) at the tubesheet in each of the four steam generators. In addition, FOSAR was being conducted in the preheater/waterbox region of steam generator C as a result of the degradation observed during the forced outage in June 2002, discussed above. In steam generator B, an upper bundle inspection was also planned to evaluate thermal performance.

Inspection Results

As indicated above, the inspections were approximately 70 percent complete on the day of the call. Based on the inspections performed, the following results were provided:

Wear at the AVBs: Approximately 660 indications had been identified to date. The number of indications is consistent (based on the number of tubes inspected) with previous inspections in which approximately 811 indications are identified. The maximum depth of any of the AVB wear indications was 40 percent through-wall.

Wear in the pre-heater: Approximately 11 indications had been identified to date. No information on the size of these indications was available at the time of the call.

Wear from foreign objects: In steam generator C, several significant and non-significant foreign objects were identified. All of the significant foreign objects were removed from the steam generator and all but three of the non-significant foreign objects were removed. The three non-significant indications included two small Fermanite "balls" and a metal shaving. The Fermanite was postulated to have come from the repair of leaking valves during the cycle. The significant objects included the foreign objects believed to be the cause of the wear on the leaking tube in June 2002. The licensee attributed the wear in the June 2002 leaking tube to two pieces of spiral wound sheathing (speculated to be fabricated from carbon steel since it was magnetic). The licensee postulated that originally these two pieces were one piece. This sheathing was attributed to the degradation observed in June 2002 since it had wear marks and a geometry which matched the degradation on the affected tubes. The licensee did not identify any maintenance activities which would have resulted in leaving this sheathing in the secondary system, and the licensee postulated that it may have been in the steam generator since fabrication and recently became mobile as a result of a power uprate. No tube wear in the preheater region (other than that identified in June 2002) was observed as a result of foreign objects.

Although no wear was attributed to foreign objects in the preheater region, five wear indications at the flow distribution baffle of steam generator C were attributed to foreign objects. These indications were in five tubes and were estimated to be 30 percent, 15 percent, 11 percent, 4 percent, and 3 percent through-wall. A foreign object was in the general vicinity of these indications and the licensee is in the process of attempting to retrieve the object.

No wear attributed to foreign objects has been observed in any of the other steam generators based on the inspections performed to date.

The history of all tubes with indications was being reviewed during this outage. No issues were identified as a result of this review. No new degradation mechanisms were identified to date (the licensee was cognizant of the cracking indications identified at Seabrook and included the eddy current data from these indications in its site specific performance demonstration).

No ultrasonic testing was planned for this outage, and based on the results to-date no in-situ pressure testing or tube pulls were planned. The licensee plans to follow industry guidelines for identifying tubes to in-situ pressure test.

Based on the results to date, the licensee indicated all tubes meet the structural and leakage integrity criteria and are projected to meet these criteria for the next two cycles.

Tube Repairs

The licensee plans to repair all tubes with indications greater than or equal to 40 percent through-wall and all tubes with cracks (if any are identified) with thermally treated Alloy 690 mechanical tube plugs. Tubes with wear from foreign objects will be plugged on detection including the five tubes with wear indications at the flow distribution baffle. If the foreign object in the vicinity of these five tubes cannot be retrieved, the licensee will evaluate the potential for tube wear on other tubes to determine if additional actions are necessary. This evaluation will include the need to stabilize the tubes.

At the time of the call, six tubes were identified to be plugged. These tubes included the one tube with AVB wear measuring 40 percent through-wall and the five tubes with wear indications at the flow distribution baffle.

Future Activities

The licensee's schedule at the time of the call included completing the FOSAR examination by 8:00 p.m. on September 24, the eddy current examination at 2:00 a.m. on September 26, the tube plugging at 8:00 a.m. on September 26, and installing the steam generator man-way on September 27.

NRC Observations

The NRC did not identify any issues with the scope or results of the examinations as a result of the information provided during the call. The NRC asked to be informed if any unusual findings (e.g., new degradation mechanisms, results not consistent with those above) were identified during the remainder of the inspections.