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U.S. Nuclear Regulatory Commission
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Braidwood Station, Unit 2
Facility Operating License No. NPF-77
NRC Docket No. STN 50-457

Subject: Response to Request for Additional Information Regarding the Steam Generator Tube Inspection Report for Braidwood Station, Unit 2, Refueling Outage 16

References: (1) Letter from D. Enright (Exelon Generation Company, LLC) to NRC, "Braidwood Station, Unit 2 Steam Generator Tube Inspection Report for Refueling Outage 16," dated February 5, 2013

(2) Letter from J. S. Wiebe (NRC) to M. J. Pacilio (Exelon Generation Company, LLC), "Braidwood Station, Unit 2 – Request for Additional Information Related to the Steam Generator Tube Inservice Inspection Report for Refueling Outage 16 (TAC No. MF0659)," dated July 10, 2013

In Reference 1, in accordance with Technical Specification 5.6.9, "Steam Generator (SG) Tube Inspection Report," Exelon Generation Company, LLC (EGC) submitted the results of the SG inspections that were completed during the Braidwood Station, Unit 2 Refueling Outage 16. The report was also submitted in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, 2001 Edition through 2003 Addenda, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," Article IWA-6000, "Records and Reports," and Paragraph 11-890.2.3, "Reporting" of ASME Section V "Nondestructive Examination, Article 8 - Appendix II, "Eddy Current Examination of Nonferromagnetic Heat Exchanger Tubing," 2001 Edition through 2003 Addenda.

In Reference 2, the NRC notified EGC that additional information was needed in order to complete their review of the subject report. The requested information is provided in Attachment 1 of this letter. As noted in Reference 2, this response is due to the NRC by August 9, 2013; i.e., 30 days from the data of the letter.

This letter contains no new regulatory commitments.

If you have any questions concerning this letter, please contact Joseph A. Bauer at (630) 657-2804.

Respectfully,

David M. Gullott
Manager – Licensing
Exelon Generation Company, LLC

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector – Braidwood Station
Illinois Emergency Management Agency – Division of Nuclear Safety

ATTACHMENT 1

Response to Request for Additional Information
Regarding the Steam Generator Tube Inspection Report for Braidwood Station, Unit 2
Refueling Outage 16

In Reference 1, in accordance with Technical Specification 5.6.9, "Steam Generator (SG) Tube Inspection Report," Exelon Generation Company, LLC (EGC) submitted the results of the SG inspections that were completed during the Braidwood Station, Unit 2 Refueling Outage 16. The report was also submitted in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, 2001 Edition through 2003 Addenda, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," Article IWA-6000, "Records and Reports," and Paragraph 11-890.2.3, "Reporting" of ASME Section V "Nondestructive Examination, Article 8 - Appendix II, "Eddy Current Examination of Nonferromagnetic Heat Exchanger Tubing," 2001 Edition through 2003 Addenda.

In Reference 2, the NRC notified EGC that additional information was needed in order to complete their review of the subject report. The requested information is provided below.

NRC RAI

In reviewing the Exelon Generation Company, LLC's (Exelon) submittal dated February 5, 2013, regarding the Steam Generator [SG] Tube Inspection Report for Braidwood Station, Unit 2, refueling outage 16 (RFO16), the NRC staff has determined that the following information is needed in order to complete its review:

RAI #1

Discuss the scope and results of any secondary side visual inspections that were performed in RFO16 including the results of any foreign object search and retrieval inspections.

Response

The following list defines the scope of the secondary side visual inspections performed during RFO16:

1) Visual inspection of top of tubesheet in 2A SG, 2B SG, 2C SG, and 2D SG after sludge lance completion. The top of tubesheet region visual inspection included the tube lane, tube annulus, and tube peripherals to 3-5 tubes into the tube bundle. The tube peripherals included the T-slot.

2) Visual inspection of the 2B and 2C SG preheater high flow regions on the pre-heater tube support baffle plate TSP 02C, which is the first support that experiences incoming main feedwater flow. The high flow regions included the pre-heater waterbox rib and cap plate region.

3) Visual inspection of the 2C SG upper tube bundle. The upper tube bundle region was inspected through the 2.5" inspection ports located at the 8th and 11th tube support plates. The inspections included the tube lanes and four in-bundle columns at each tube support plate. The purpose of these inspections was to assess the general condition of the upper tube bundle.

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The following paragraphs summarize the results of secondary side visual inspections performed in RFO16. SG components that were visually inspected were not degraded.

For all SGs (2A, 2B, 2C, and 2D), the integrity of the tube bundle wrapper was confirmed with insertion without resistance (i.e., obstruction) of the sludge lance equipment through the manway access openings.

Visual inspection of top of tubesheet in all four SG's did not identify any anomalous structural conditions. The tube surfaces at top of tubesheet (i.e., tube lane, tube annulus, tube peripherals, and tube T-slot) in all four SG's were mostly clean with minor soft sludge deposition in all tube surfaces inspected except at the hot leg in-bundle columns within the kidney region, which had scale deposition on the tubes to a maximum height of 0.5" above the tubesheet. This is typical of past top of tubesheet visual inspections.

Visual inspection of top of the pre-heater baffle plate TSP 02C in the 2B and 2C SG preheaters did not identify any anomalous structural conditions. Soft loose sludge was found in some in-bundle tube column locations, less than 0.125" sludge height. No hard sludge deposits were identified.

Visual inspection of the 2C SG upper tube bundle inspections of the 8^{th} and 11^{th} support plate identified trace amounts of loose scale deposits on the support plates and a layer of scale deposits on the tubes at both the hot leg and cold leg in-bundle tube column region. The quatrefoil flow holes were also inspected at various points throughout the tube bundle in both the hot and cold legs at the 8^{th} and 11^{th} support plates. In general, the quatrefoils on the cold leg were free of blockage and only contained trace amounts of scale. Several quatrefoils on the hot leg side however, exhibited the initiation of minor scale forming at the bottom edge of several quatrefoil flow holes. Based on visual estimation, the amount of blockage in the affected quatrefoil flow holes is approximately 10% or less. However, the majority of the quatrefoil flow holes inspected did not exhibit scale formation or blockage. Comparing the results of the RFO16 inspections to the last inspections during RFO14 did not identify notable changes in deposit characteristics and blockage. It was observed, however, that deposit blockage appears to have affected more quatrefoil flow holes during RFO16 than it did during RFO14. There were no anomalous structural conditions identified.

During the secondary side visual inspections in all four SGs in the above-mentioned regions, a total of 75 foreign objects were identified. Of the 75 foreign objects, 23 (which included two legacy objects) were retrieved, 20 were instances where an unknown red substance was identified, and 12 were legacy objects that were identified during previous inspections, but could not be successfully retrieved. The red substance was not able to be retrieved or sampled. The other 20 foreign objects were new items not retrieved (i.e., mostly wire and one machine turning).

The majority of the foreign objects found were small wires that are similar to bristles from wire brushes, small machine turnings, and weld slag.

Eddy current inspections showed no sign of tube wear associated with these foreign objects. All foreign objects and substances left within the steam generators were evaluated to be

acceptable for one or more cycles of operation. The evaluation was based on foreign object size, mass, materials and flow conditions. The substance was evaluated based on various expected sources and materials and was also determined to be acceptable.

RAI #2

In Sections 5.1.4 and 5.2.1 of Exelon's February 5, 2013, submittal, it states that the tube at Row 44 Column 47 (R44C47) in SG C was found to contain the characteristic signature indicative of high residual stress (i.e. a -2 sigma tube with no voltage offset between the straight and U-bend portions of the tube). Since it appears that this tube was not captured in its previous search for -2 sigma tubes, discuss the scope and results of any additional reviews that you might have performed to ensure you have identified all -2 sigma tubes.

Response

Detection of three axial outside diameter stress corrosion cracking (ODSCC) indications in the tube at R44C47 and none elsewhere during RFO16, SG inspection raised suspicion about the residual stress condition of the tube. Therefore the bobbin data of the tube at R44C47 was reviewed, and the bobbin traces showed no voltage offset between the straight portions of the tube and the U-bend (11H-11C). This is the characteristic signature indicative of potentially elevated residual stress in a high row tube. This review concluded that the tube at R44C47 had the characteristic signature indicative of potentially elevated residual stress in high row tubes, similar to the three tubes that contained axial ODSCC during RFO10.

The tube (R44C47) was missed during the screening process for the residual stress evaluation of the October 2000 Braidwood Station Unit 2 eddy current data due to an undetected analyst error. The analyst mistakenly used peak to peak voltage (V_{PP}) on one leg instead of maximum voltage rate (V_{VM}) as the screening criteria required. This caused the tube to fall outside the reporting criteria for a -2 sigma tube. As a result of the error, re-evaluation of the high row tube database results was performed. This error is easily identified via a database review; a V_{PP} value has a non-zero phase angle recorded in the database. A V_{VM} value has a phase angle of zero. Additionally, all indications identified for Lead Analyst Review were reviewed to ensure proper voltage values were assigned. A tube with potentially elevated stress should have similar voltage offsets between the hot and cold legs. Therefore, all tubes that had large hot leg and cold leg voltage differences were identified and re-evaluated to ensure the voltages were properly assigned. As a result of the database review and re-evaluation of suspect voltages, no additional -2 sigma tubes were identified.

In addition, all -2 sigma tubes that were in service were reviewed for the no voltage offset condition. As a result of this review, two inservice tubes were identified and were preventatively plugged.

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RAI #3

Section 5.2.1. also discusses the additional inspections performed on the 71 previously known -2 sigma tubes. Clarify if these inspections were performed on the tube at R44C47 and any other newly discovered -2 sigma tubes.

Response

Section 5.2.1 of Reference 1 listed the following inspections for the 71 previously known -2 sigma tubes:

- Full Length bobbin coil inspection hot leg tubesheet inspection (+4 inches to -14.01 inches) with a +Point™ probe
- Inspection of all hot leg dents and dings >3.0 volts with a +Point™ probe
- Inspection of all wear indications with a +Point™ probe

Tube R44C47 in SG 2C had no dent/ding indications or any indications of wear. Therefore, inspections at these locations were not applicable. Full length bobbin coil inspections were performed on tube R44C47 every refueling outage since plant start-up with the exception of Refueling Outage 9, (i.e., RFO9), when the 2C SG was not selected for inspection. No indications were reported during these inspections until the current outage, RFO16. Top of tubesheet +Point™ probe inspections were performed during RFO15, RFO13, RFO10, and RFO6. No indications were reported during these inspections.

No other newly discovered -2 sigma tubes were identified.

RAI #4

Exelon's letter indicated that the SGs had accumulated 241.06 effective full power months (EFPMs) of operation and that Braidwood, Unit 2, outage was at 31.06 EFPMs within the first 60 EFPM period. Since the first period (120 EFPM) starts after the first inservice inspection (ISI), clarify whether the SGs at Braidwood, Unit 2, had operated for 241.06 EFPMs since the first ISI since commencement of commercial operation.

Response

The Braidwood Station Unit 2 steam generators operated for 241.06 EFPMs since the first in-service inspection (ISI) during RFO1. The 241.06 EFPM are accumulated since the first ISI and not since commercial operation. With completion of the 120 EFPM and 90 EFPM Inspection Periods, results in 31.06 EFPM accumulated in the first 60 EFPM Inspection Period at the current RFO16 (241.06 EFPM – 120 EFPM - 90 EFPM = 31.06 EFPM). Therefore, the RFO16 inspection is the mid-point inspection.

It is noted that following the completion of the current outage, RFO16, Braidwood Station adopted TSTF-510, Revision 2, "Revision to Steam Generator Programmed Inspection Frequencies and Tube Sample Selection," that modified the Inspection Period durations.

ATTACHMENT 1

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TSTF-510, Revision 2 was approved by the NRC on March 21, 2013 in Braidwood Station License Amendment 172 (ML13009A182). Consequently, Braidwood Station Unit 2 is in the first 72 EFPM Inspection Period in accordance with the revised Technical Specification.

RAI #5

In several instances, a 25 percent inspection of specific locations (e.g., pre-heater baffle plate expansions) was performed. If the 2012 inspections were nearest to the mid-point of the 60 EFPM period, confirm that 50 percent of these locations had been inspected since the start of the 60 EFPM period.

Response

The first RFO of the current 60 EFPM Inspection Period was RFO15, which occurred during 2011. The current outage, RFO16, was the second and mid-point outage of the 60 EFPM Inspection Period. A 100% full length bobbin coil inspection was performed in each of the four steam generators during the RFO15 and RFO16 steam generator inspections, which more than meets the 50% mid-point inspection requirement.

25% plus-point samples were performed in each outage's (i.e., RFO15 and RFO16) steam generator inspections to satisfy the 50% mid-point RFO16 inspection requirement. The following 25% plus-point sampling programs were completed during RFO15 and RFO16 in each of the four steam generators.

- 25% hot leg top of tubesheet (+4"/-14.01")
- 25% hot leg bulges/overexpansions within the tubesheet from top of the tubesheet to 15" below the top of the tubesheet
- 25% Row 1 and Row 2 U-bend region
- 25% hot leg dents/dings >3.0 volts
- 25% pre-heater baffle plate expansions

RAI #6

Discuss the scope and results of any inspections of the SG channel head.

Response

During Braidwood Station Unit 2 RFO16, visual inspections of the 2A, 2B, 2C, and 2D internal channel head (hot and cold leg) cladding were performed in accordance with the recommendations contained in Westinghouse Nuclear Safety Advisory Letter (NSAL) 12-1, "Steam Generator Channel Head Degradation." Indications of cladding degradation were not identified. The visual inspection was performed using a video camera.

The visual inspections were limited to the lower portion of the channel head, within approximately 36 inches radially from the channel head drain tube. The location was defined at the highest potential location for concentrated borated water accumulation during refueling

outages. The visual scan included the divider plate-to-channel head weld, the top of the channel head bowl drain tube, and general area channel head cladding.

Gross defects such as through-holes or breaches that could expose the carbon steel base material underneath the cladding were not identified during the visual inspections. Similarly, wastage resulting from borated water corroding the carbon steel base material was not identified during the inspections; this was confirmed via lack of rust-colored stains. In most cases, the camera exceeded the coverage requirement (i.e., greater than 36 inches radially from drain) and scanned larger areas of the channel head. Similarly, cladding damage was not identified in those areas.

REFERENCES

1. Letter from Letter from D.Enright (Exelon Generation Company, LLC) to NRC, "Braidwood Station, Unit 2 Steam Generator Tube Inspection Report for Refueling Outage 16," dated February 5, 2013

2. Letter from J. S. Wiebe (NRC) to M. J. Pacilio (Exelon Generation Company, LLC), "Braidwood Station, Unit 2 – Request for Additional Information Related to the Steam Generator Tube Inservice Inspection Report for Refueling Outage 16 (TAC No. MF0659)," dated July 10, 2013