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PSEG Nuclear LLC

LR-N05-0193

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING STEAM GENERATOR TUBE INSPECTION CONDUCTED DURING THE 2003 REFUELING OUTAGE SALEM NUCLEAR GENERATING STATION, UNIT 2 FACILITY OPERATING LICENSE NO. DPR-75 DOCKET NO. 50-311

By letters dated November 17, 2003, February 19, 2004, and March 9, 2004, PSEG Nuclear, LLC, (PSEG) submitted reports summarizing the steam generator (SG) tube inspections for Salem Nuclear Generating Station, Unit 2 during the thirteenth refueling outage (2R13). NRC letter dated March 21, 2005, requested additional information. Attachment 1 contains PSEG's response to the request for additional information.

If you have any questions or require additional information, please contact Mr. Michael Mosier at (856) 339-5434.

Sincerely,

Christina L. Perino
Director – Regulatory Assurance

Attachment

A047

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REQUEST FOR ADDITIONAL INFORMATION

REGARDING STEAM GENERATOR TUBE INSPECTION CONDUCTED

DURING THE 2003 REFUELING OUTAGE

SALEM GENERATING STATION, UNIT 2

DOCKET NO. 50-311

By letters dated November 17, 2003, February 19, 2004, and March 9, 2004, (located in the Agencywide Documents Access and Management System (ADAMS) under accession numbers ML033290440, ML040620694, and ML040760608, respectively), PSEG Nuclear LLC, the licensee for Salem Nuclear Generating Station, submitted reports summarizing the steam generator (SG) tube inspections conducted at Salem 2 during the 2003 refueling outage (2R13). A summary of conference calls concerning these inspections are also in ADAMS under accession number ML040800008.

The Nuclear Regulatory Commission staff has been reviewing the inspection results and analysis and has determined that the following additional information is required in order to complete their review.

NRC Question 1

A population of bobbin coil anti-vibration bar (AVB) wear indications were inspected with a rotating probe. These examinations verified that the reported indications displayed a volumetric response and were not crack-like. Please clarify the scope of the rotating probe examinations at locations with AVB wear. That is, of the 601 AVB wear indications detected during 2R13, how many were inspected with a rotating probe?

PSEG Response

Technical Standard SC.DE-TS.ZZ-3502(Q), Revision 4, "Steam Generator Data Management Guidelines," was utilized during the Fall 2003 Salem Generating Station Unit 2 Inspections. Attachment 3, step 2.2, of this document provides guidance for special interest inspections of AVB wear locations. The step stated, "A sample population of new and/or high % through-wall indications (via bobbin coil) should be inspected with rotating coil probes." The bases for these inspections were to (a) provide indication characterization to tube integrity engineering (e.g., single sided or double sided wear), and, (b) provide a sampling type of approach to ensure AVB wear indications reported with a percent through-wall with the bobbin coil are volumetric and not crack-like. The table below provides an overview of the number of AVB wear indications

inspected as special interest during 2R13. A total of 44 were inspected with a rotating probe.

Steam Generator	21	22	23	24
Bobbin Coil AVB Wear Indications Inspected with Rotating Coil	18	0	17	9

It should be noted that the use of the term "sample" in the Technical Standard listed above is NOT intended to be consistent with the use of the term "sample" as defined in EPRI Report 1003138, "Pressurized Water Reactor Steam Generator Examination Guidelines". Therefore, "sample" is not intended to mean "20%".

NRC Question 2
Provide and discuss the results of your rotating probe examinations performed at the dents and the u-bend regions of the tubes.

PSEG Response
Approximately 415 rotating coil examinations were performed at dents and dings within the u-bend region. There was no degradation reported at these locations.

NRC Question 3
On page 8 of Enclosure 4 to your February 19, 2004 letter, it was indicated that nine tubes in SG 23 were preventively plugged due to small anomalous signals. This statement matches data in the table on page 3 of Enclosure 4 to your February 19, 2004 letter. However, the table on page 8 indicates that eight tubes in SG 23 and one tube in SG 24 had anomalous signals. Please clarify.

PSEG Response
The table on Page 8 of Enclosure 4 to our February 2004 letter contains a typographical error in listing 24 SG. The nine tubes plugged due to small anomalous signals were all in SG 23.

NRC Question 4
Several crack-like indications have been found at dented locations during recent inspections at Salem Generating Station Unit 2. Both axially and circumferentially oriented crack-like indications have been detected. As of refueling outage 12, there were approximately 21,000 dents at tube supports and approximately 900 dings in the free span portion of the tube. Of the 21,000 dents, approximately 33% were greater than 5 volts. Of the 900 dings, approximately 19% are greater than 5 volts. During 2R13, not all dents or dings greater than 5 volts were inspected with a rotating probe, although all dents at the lower tube supports greater than 1 volt on the hot-leg were inspected. Given that (1) temperature and stress affect a tube's susceptibility to cracking (i.e., a larger dent at a lower temperature may be as susceptible to stress corrosion

cracking as a smaller dent at a higher temperature), and (2) that the bobbin coil is not considered qualified for detecting degradation at dented/dinged locations when the dent/ding exceeds 5 volts, please discuss the basis for concluding that the structural and leakage integrity performance criteria were met during Cycle 13 and will continue to be met throughout subsequent cycles.

Include in this response how the integrity of dented/dinged locations exceeding 5 volts that were not inspected with a rotating probe during 2R13 were assessed. These locations potentially have undetected degradation that may have been growing since the last rotating probe inspection. Provide the technical basis for any assumptions in your analysis.

PSEG Response

It has been generally observed in the industry, and in the Salem Generating Station Unit 2 experience, that stress corrosion cracking tends to be at the hot leg Tube Support Plates (TSPs) with greatest temperature (e.g., those closest to the hot leg side of the tubesheet; 01H, 02H...), and tends to be at lower voltage dents. Therefore, temperature has typically been more of a contributor to stress corrosion cracking than the magnitude of the dent (or ding). It has also been observed that steam generators with tubing material comparable to that of Salem Generating Station Unit 2 (I600MA), and that are similarly operated at lower temperatures (e.g., hot leg temperatures at approximately 595 degrees Fahrenheit), have demonstrated improved resistance to stress corrosion cracking compared to SGs operating at hot leg temperatures of approximately 603 degrees Fahrenheit.

Stress corrosion cracking is a complicated damage mechanism. Industry application of Arrhenius equations in the evaluation of temperature sensitive damage mechanisms demonstrates that reduction in temperature can provide a reduction in stress corrosion cracking potential. Even relatively small reductions in temperature can provide notable improvement in stress corrosion cracking resistance.

The tubing temperature from the hot leg side of the tube to the cold leg side of the tube declines along the tube length, with an approximate 60 degrees Fahrenheit difference from hot leg to cold leg. Therefore, it would be expected that the potential for stress corrosion cracking would be reduced with the declining temperature. The previous discussion follows the basis for inspection and expansion requirements for temperature sensitive damage mechanisms (e.g., Stress Corrosion Cracking), as delineated in the EPRI PWR Examination Guidelines. Therefore, it could be reasoned that TSPs of similar dent magnitude (or dings) located at differing temperatures, would tend to provide an environment where the higher temperature dent (or ding) would be expected to be more conducive to stress corrosion cracking.

The Salem Generating Station Unit 2 distribution of dents is approximately 85% in the hot leg TSPs. The magnitude of the denting on a per TSP average is more severe on the hot leg side than on the cold leg side. The Salem Generating Station Unit 2 dings are relatively evenly distributed; with slightly more dings on the hot leg side than on the cold leg side. The magnitudes of the dings are similar on the hot leg side and the cold leg side. Dents and dings in the U-bend region are a small percentage of the overall dent and ding population.

During 2R9, all hot leg TSP intersections (dented or not dented) in each steam generator and all cold leg TSP intersections (dented or not dented) in 22 SG were inspected with rotating coil (+Point). Approximately 112,000 intersections were inspected using the rotating coil probe. No tubes were plugged due to cold leg degradation. PSEG also utilized inspection histories from Salem 2R9, 2R10, 2R11 and 2R12 and industry operating experience to technically justify the areas of interest and/or Critical Areas (C-A) for Salem's 2R13 dent and ding inspection programs. As documented in PSEG letter LR-N04-0066, dated February 19, 2004, a sampling inspection strategy was implemented for examining the dents that were greater than or equal to 5 volts at the higher hot leg TSP locations and for dings that were greater than or equal to 2 volts.

During 2R13, rotating coil examinations were performed at the hot leg dented TSP structures and within the U-bend region (including special interest inspections to disposition bobbin coil "I" codes). As documented in Enclosure 4 to our February 19, 2004, letter, only four indications were detected in three tubes during the these inspections: two axial Primary Water Stress Corrosion Cracking (PWSCC), one circumferential PWSCC, and one volumetric Outside Diameter Stress Corrosion Cracking (ODSCC). All were at lower hot leg tube support structures at dents less than 5 volts. In 21 SG, the indications were located at the second (02H) hot leg TSP. In 22 and 23 SG's, the indications were at the first (01H) hot leg TSP. There was no degradation reported at the dents or dings inspected in the U-bend region.

The inspections performed during 2R13 were in accordance with the PSEG SG program, the 2R13 Degradation Assessment, the EPRI PWR SG Examination Guidelines, and Technical Specifications. All detected degradation satisfied the structural and leakage performance criteria (NEI 97-06); therefore, the performance criteria for cycle 13 are satisfied. In addition, the inspections performed bounded the degradation that was expected and detected. Therefore the structural and leakage integrity performance criteria were also assured for cycle 14.