From:	Kim, James
Sent:	Thursday, February 11, 2021 1:40 PM
To:	Duke, Paul R.
Cc:	Thomas, Brian J.; Danna, James
Subject:	Salem - Final RAI RE: Alternative for Examination of ASME Section XI, Category B-B, Item Number B2.11and B2.12 (L-2020-LRR-0103)
Attachments:	Final RAI - Salem RR_Pressurizer Weld Interval Extension.docx

SUBJECT: Salem Generating Station Units 1 and 2.– FINAL REQUEST FOR ADDITIONAL

INFORMATION REGARDING ALTERNATIVE FOR EXAMINATION OF ASME SECTION XI,

CATEGORY B-B, ITEM NUMBER B2.11 AND B2.12 (L-2020-LRR-0103)

Mr. Duke,

By letter dated August 5, 2020 (ADAMS Accession No. ML20218A587), PSEG Nuclear LLC (PSEG, the licensee), submitted to the Nuclear Regulatory Commission (NRC), a proposed alternative to the inservice inspection (ISI) requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for pressurized water reactor (PWR) pressurizer (PZR) circumferential and longitudinal shell-to-head welds (SHWs) of Salem Generating Station (Salem) Units 1 and 2.

The NRC staff has determined that additional information is needed to complete its review of the request. On February 3, 2021, the NRC staff sent PSEG the draft Request for Additional Information (RAI). On February 11, 2021, the NRC staff and the licensee held conference call to clarify the draft RAI questions. Subsequently, PSEG agreed to respond to this request within 60 days. A publicly available version of this final RAI (attached) will be placed in the NRC's ADAMS.

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REQUESTS FOR ADDITIONAL INFORMATION REGARDING SALEM GENERATING STATION UNITS NOS. 1 AND 2 REGARDING ALTERNATIVE FOR EXAMINATION OF ASME SECTION XI, CATEGORY B-B, ITEM NUMBER B2.11 AND B2.12

EPID L-2020-LRR-0103

By letter dated August 5, 2020 (ADAMS Accession No. ML20218A587), PSEG Nuclear LLC (PSEG, the licensee), submitted to the United States Nuclear Regulatory Commission (NRC), a proposed alternative to the inservice inspection (ISI) requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for pressurized water reactor (PWR) pressurizer (PZR) circumferential and longitudinal shell-to-head welds (SHWs) of Salem Generating Station (Salem) Units 1 and 2.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Paragraph 50.55a(z)(1), the licensee proposed to increase the ISI interval for the subject components to 30 years, from the current ASME Code Section, Section XI requirement of 10 years. 10 CFR 50.55a(z)(1) requires the licensee to demonstrate that the proposed alternative provides an acceptable level of quality and safety. The licensee referred to the analyses in non-proprietary Electric Power Research Institute (EPRI) Report No. 3002015905, "Technical Bases for Inspection Requirements for PWR Pressurizer Head, Shell-to-Head, and Nozzle-to-Vessel Welds", December 2019 (ADAMS Accession No. ML21021A271) to support the proposed alternative in the submittal. The licensee also included an applicability evaluation of EPRI report 3002015905 to Salem Units 1 and 2 in the submittal. The NRC staff (the staff) needs to issue requests for additional information (RAIs) to complete its review of the licensee's proposed alternative.

RAI 1

Regulatory Basis

The NRC has established requirements in 10 CFR Part 50 to protect the structural integrity of structures and components in nuclear power plants. Among these requirements are the ISI requirements of Section XI of the ASME Code incorporated by reference in 10 CFR Part 50.55a to ensure that adequate structural integrity of the PZR vessel is maintained through the service life of the vessel. Therefore, the regulatory basis for the following RAI has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the subject PZR SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per 10 CFR 50.55a(z)(1) for these welds.

Issue

Table 5-6 of EPRI report 3002015905 shows that the temperature of the pressurizer (TPZR in the table) applicable to the Examination Item Numbers B2.11 and B2.12 PZR SHWs of Salem Units 1 and 2 requested in the submittal ranges from 70°F to 653°F for the Heatup/Cooldown transient. Section 8.2.2.6 of EPRI report 3002015905 explains that a fracture toughness (KIC)

set at the upper shelf value of the ASME Code KIC curve, 200 ksi√in, may be used. In the audit summary report for PROMISE Version 1.0 (ADAMS Accession No. ML20258A002, Item No. 2.e.iii), the NRC staff observed that for the steam generator feedwater nozzle, KIC could be as low as 130 ksi√in during the Heatup/Cooldown transient and that this lower value of KIC is addressed by the sensitivity study on fracture toughness in Tables 8-13 and 8-14 of non-proprietary EPRI Report No. 3002014590, "Technical Bases for Inspection Requirements for PWR Steam Generator Feedwater and Main Steam Nozzle-to-Shell Welds and Nozzle Inside Radius Sections", April 2019 (ADAMS Accession No. ML19347B107). The NRC staff noted that the lowest KIC value, 80 ksi√in, used in the sensitivity study on fracture toughness in EPRI report 3002015905 is the same as the lowest KIC value used in the sensitivity study on fracture toughness in EPRI report 3002014590. However, the NRC staff noted that the pressure for the B2.11 and B2.12 PZR SHWs of Salem Units 1 and 2 is more than twice the pressure analyzed for the SG feedwater nozzle in EPRI report 3002014590 since these welds are on the primary side of the reactor coolant system. Since the pressure is more than twice than what was previously analyzed for the SG feedwater nozzle, the staff cannot determine how much lower than 200 ksi√in the KIC value could be during the ramp periods in the beginning and ending of Heatup/Cooldown transient for the subject PZR SHWs.

Request

Given the NRC staff's observations discussed above for the B2.11 and B2.12 PZR SHWs of Salem Units 1 and 2, explain how the sensitivity study on fracture toughness in EPRI report 3002015905 addresses the low KIC value that could exist during the ramp periods in the beginning and ending of the Heatup/Cooldown transient for the subject PZR SHWs.

RAI 2

Regulatory Basis

The regulatory basis for the following requests has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the requested PZR SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per 10 CFR 50.55a(z)(1) for these welds.

Issue

In Section 5.2 of EPRI report 3002015905, EPRI stated that it did not consider test conditions beyond a system leakage test in the analyses, and stated that since any pressure tests will be performed at operating pressure, no separate test conditions need to be included in the analyses because the test conditions are captured in the other transients included in the analyses. Even though the pressure test conditions are not included in the analyses, the NRC staff determined that the appropriate temperature conditions for an upper shelf fracture toughness (KIC) value of 200 ksi√in assumed in the EPRI report should exist during the hydrostatic and leak tests at Salem Units 1 and 2.

Request

Confirm that at the maximum pressures during the hydrostatic and leak tests of Salem Units 1 and 2, the temperature of the subject PZR SHWs of Salem Units 1 and 2 is high enough such

that the upper shelf KIC of value of 200 ksi√in assumed in EPRI report 3002015905 for fracture toughness is appropriate, considering the value of the nil-ductility reference temperature (RTNDT) of 60°F assumed in calculating KIC in EPRI report 3002015905.

RAI 3

Regulatory Basis

The regulatory basis for the following requests has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the requested PZR SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per 10 CFR 50.55a(z)(1) for these welds.

Issue

The through-wall stress distribution plots for the thermal transients in Figures 7-10 and 7-11, 7-22 through 7-25 of EPRI report 3002015905 for the subject PZR welds show compressive stresses at the inner surface. However, tensile stresses at the inside surface are typically expected for transients that have temperature drops, such as the Insurge/Outsurge transients listed in Table 5-9 of EPRI report 3002015905 and the Loss of Load transient in Table 5-6 of EPRI report 3002015905.

Request

To assure that the thermal stress behavior in the subject PZR welds analyzed is reasonable, explain if the thermal stresses on the inside surface shown in the referenced figures of EPRI report 002015905 become tensile at times other than those shown in the figures.

RAI 4

Regulatory Basis

The regulatory basis for the following requests has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the requested PZR vessel lower SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per 10 CFR 50.55a(z)(1) for these welds.

Issue

In Section 8.3.2.2 of EPRI report 3002015905, EPRI stated that the flaw distribution derived from flaw data from the Pressure Vessel Research User's Facility (PVRUF) vessel was applied to the PZR vessel in the analyses. NUREG-6471 “Characterization of Flaws in U.S. Reactor Pressure Vessels,” (ADAMS Accession No. ML112510316, Reference 89 of EPRI report 3002015905) states that the PVRUF vessel is from an unused pressurized water reactor (PWR) vessel and that the PVRUF data are from fabrication flaws in the PVRUF vessel weldment. The nominal thickness of PWR vessels is 8 inches. Figure 4-4 of EPRI report 3002015905 shows the PZR vessel lower head model used in the analyses referenced for the Salem Units 1 and 2 SHWs in the PZR lower head; the figure shows that the PZR vessel cylindrical shell (vertical

portion) is relatively thick, but the PZR lower head is only 2.55 inches thick. The staff noted that the PVRUF flaw data may not be appropriate for vessels much thinner than 8 inches since welding thinner vessels is different from welding thick vessels. Furthermore, Table A-1 in Attachment 1 to the submittal states that the upper and lower head of the Salem Units 1 and 2 PZRs are made of SA-216 Grade WCC, which is different from SA-533 and SA-508 Class 2 materials typically used for reactor pressure vessels. Section 8.3.2.2 of EPRI report 3002015905 included only a general discussion of the applicability of PVRUF to a PZR vessel, stating that "even though the PVRUF data were based on a reactor pressure vessel, they can be applied to a pressurizer vessel because both are large-diameter vessels fabricated from similar plate and forging process and from the same materials (SA-533 and SA-508 Class 2)." This discussion does not provide the staff sufficient information to determine that the PVRUF flaw data is appropriate for the Salem Units 1 and 2 PZR vessel lower SHWs, given that the modeled PZR lower heads are much thinner than reactor pressure vessels, and given the difference in materials of the Salem Units 1 and 2 PZR vessel lower heads from the materials of reactor pressure vessels.

Request

Justify that the flaw distribution based on the PVRUF flaw data from a reactor pressure vessel is appropriate for the Salem Units 1 and 2 PZR vessel lower SHWs.

RAI 5

Regulatory Basis

The regulatory basis for the following requests has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the requested PZR SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per 10 CFR 50.55a(z)(1) for these welds.

Issue

Page 5 of Attachment 1 to the submittal describes a sensitivity run performed for Salem with an examination coverage of 37% to address the 37.2% examination coverage achieved for weld 2-PZR-CIRC DUH during the 2nd 10-year ISI interval. It further states that this sensitivity run was made with preservice inspection (PSI) with five ISI inspections at 10, 20, 30, 40, and 70 years (PSI + 10 + 20 + 30 + 40 +70). The staff noted that the table of coverage on the same page of Attachment 1 to the submittal indicates that the fourth examination for weld 2-PZR-CIRC DUH has not yet been performed; therefore, the sensitivity run should be performed with PSI + 10 + 20 + 30 + 60. The staff also noted that only the probability of leakage (1.34x10-6) was reported and that it is not clear whether this probability of leakage is the value per year at 80 years. The staff noted the comparable probability of leakage value of 1.13x10-6 per year in Table 8-33 of EPRI report 3002015905, but it is not clear whether the Table 8-33 results are at 80 years. The staff also noted that only the probability of leakage values are reported in Table 8-33 of EPRI report 3002015905. In order to determine whether the low examination coverage achieved for weld 2-PZR-CIRC DUH during the 2nd 10-year ISI interval would result in a probability of rupture value below the criterion, the staff needs probability of rupture values per year at 80 years with the lower examination coverage.

Request

Either;

(a) Perform the 37% examination coverage run described on page 5 of Attachment 1 to the submittal except with PSI + 10 + 20 + 30 + 60, and report the resulting probability of rupture value per year at 80 years.

or

(b) For the limiting case (PRSHC-BW-2C) in Table 8-33 of EPRI report 3002015905, report the resulting probability of rupture value per year at 80 years for the base case with 50% examination coverage.

RAI 6

Regulatory Basis

The regulatory basis for the following requests has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the requested PZR SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per10 CFR 50.55a(z)(1) for these welds.

Issue

Section 7.0 of Attachment 1 to the submittal states that the proposed alternative for Salem Unit 1 and 2 is requested for the remainder of the 4th inspection intervals through the 5th inspection intervals, currently scheduled to end on December 31, 2030. The Salem Unit 1 renewed operating license (ADAMS Accession No. ML052990140) states that the Salem Unit 1 renewed license shall expire on August 13, 2036. The Salem Unit 2 renewed operating license (ADAMS Accession No. ML052990143) states that the Salem Unit 2 renewed license shall expire on April 18, 2040. With these expiration dates of the renewed licenses, the 5th inspection interval for Salem Unit 1 should end on August 13, 2026; and the 5th inspection interval for Salem Unit 2 should end on April 18, 2030. The staff needs clarification on the end dates of the 5th inspection intervals for both units.

Request

Clarify if the 5th inspection interval for Salem Unit 1 ends on August 13, 2026; and if the 5th inspection interval for Salem Unit 2 ends on April 18, 2030, such that the proposed alternative would be requested up to August 13, 2026 for Salem Unit 1 and April 18, 2030 for Salem Unit 2.

RAI 7

Regulatory Basis

The NRC has established requirements in 10 CFR Part 50 to protect the structural integrity of structures and components in nuclear power plants. Among these requirements are the ISI requirements of Section XI of the ASME Code incorporated by reference in 10 CFR Part 50.55a

to ensure that adequate structural integrity of the PZR vessel is maintained through the service life of the vessel. Therefore, the regulatory basis for the following RAI has to do with demonstrating that the proposed alternative ISI requirements would ensure adequate structural integrity of the PZR SHWs of Salem Units 1 and 2 for which EPRI report 3002015905 is referenced, and thereby providing an acceptable level of quality and safety per 10 CFR 50.55a(z)(1) for these components.

Issue

The NRC staff noted that the probabilistic fracture mechanics (PFM) software used in EPRI report 3002015905 is PROMISE Version 2.0. The NRC staff audited PROMISE Version 1.0 and issued the audit report by letter dated December 10, 2020 (ADAMS Accession No. ML20258A002). One of the objectives of the NRC staff's audit was to ensure that PROMISE Version 1.0 received adequate verification and validation (V&V). The NRC staff has not audited PROMISE Version 2.0. In Section 8.0 of Attachment 1 to the submittal, the licensee summarized the difference between PROMISE Version 2.0 and PROMISE Version 1.0; "The main difference between the two versions is that in PROMISE Version 1.0, the user-specified examination coverage is applied to all inspections, whereas in PROMISE Version 2.0, examination coverage can be specified by the user uniquely for each inspection."

Request

To ensure that PROMISE Version 2.0 received adequate V&V for use in the referenced analyses for the PZR SHWs of Salem Units 1 and 2, describe the V&V performed for PROMISE Version 2.0 to ensure that (1) cases intended for the difference between PROMISE Version 2.0 and PROMISE Version 1.0 reflected the change; and (2) that cases not intended for the difference were not affected.