March 5, 2019

Mr. Peter P. Sena, III
President and Chief Nuclear Officer
PSEG Nuclear LLC - N09
P.O. Box 236
Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNIT NO. 1 – ALTERNATIVE TO REACTOR VESSEL NOZZLE WELDS EXAMINATIONS INSPECTION INTERVAL (EPID L-2018-LLR-0110)

Dear Mr. Sena:

By letter dated August 6, 2018 (Agencywide Documents Access and Management System Accession No. ML18218A481), PSEG Nuclear LLC (the licensee) submitted a request for a proposed alternative to certain American Society of Mechanical Engineers Boiler & Pressure Vessel Code (ASME Code), Section XI, requirements for reactor vessel inspections at the Salem Nuclear Generating Station (Salem), Unit No. 1. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee requested to use the proposed alternative in Relief Request S1-I4R-160, Revision 1, on the basis that the ASME Code requirements present an undue hardship, without a compensating increase in the level of quality or safety.

The licensee requested use of an alternative to the examination frequency requirements of 10 CFR 50.55a(g)(6)(ii)(F) for reactor pressure vessel inlet nozzle dissimilar metal butt welds mitigated with the Mechanical Stress Improvement Process™ at Salem, Unit No. 1. The duration of the proposed alternative is requested through the fall 2020 refueling outage (S1R27).

The U.S. Nuclear Regulatory Commission (NRC) staff determines that the licensee has demonstrated the proposed alternative in Relief Request No. S1-I4R-160, Revision 1, provides reasonable assurance of structural integrity of the subject components, and that complying with the specified ASME Code requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the NRC staff authorizes the use of Relief Request No. S1-I4R-160, Revision 1, at Salem, Unit No. 1, up to and including refueling outage S1R27, currently scheduled to start in fall 2020.

If you have any questions, please contact the Salem Project Manager, James Kim, at 301-415-4125 or James.Kim@nrc.gov.

Sincerely,

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-272

Enclosure:
Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PROPOSED ALTERNATIVE TO REACTOR VESSEL NOZZLE WELD

EXAMINATIONS INSPECTION INTERVAL

PSEG NUCLEAR LLC

EXELON GENERATION COMPANY, LLC

SALEM NUCLEAR GENERATING STATION, UNIT NO. 1

DOCKET NO. 50-272

1.0 INTRODUCTION

By letter dated August 6, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18218A481), PSEG Nuclear LLC (the licensee) submitted Relief Request S1-I4R-160, Revision 1, for a proposed alternative for the Salem Nuclear Generating Station, Unit No. 1 (Salem 1). The licensee requested the U.S. Nuclear Regulatory Commission (NRC or the Commission) to authorize the use of an alternative to the examination frequency requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 55a(g)(6)(ii)(F) for reactor pressure vessel (RPV) inlet nozzle dissimilar metal butt welds (DMBW) mitigated with the Mechanical Stress Improvement Process™ (MSIP) at Salem 1.

Specifically, pursuant to 10 CFR 50.55a(z)(2), the licensee requested to use a proposed alternative on the basis that compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(4), "Inservice inspection standards requirement for operating plants," American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code (Code or BPV Code) Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(g)(6)(ii), "Augmented ISI program," the NRC may require licensees to follow an augmented inservice inspection (ISI) program for systems and components for which the Commission deems that added assurance of structural reliability is necessary.

Enclosure

Pursuant to 10 CFR 50.55a(g)(6)(ii)(F)(1), "Augmented ISI requirements: Examination requirements for Class 1 piping and nozzle dissimilar-metal butt welds – (1) Implementation," licensees shall implement the requirements of ASME BPV Code Case N-770-2 instead of ASME BPV Code Case N-770-1, subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (13).

The regulation in 10 CFR 50.55a(z) states, in part, that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if the licensee demonstrates that (1) the proposed alternative provides an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the NRC to authorize the licensee's proposed alternative for Salem 1. Accordingly, the NRC staff reviewed and evaluated the licensee's request pursuant to 10 CFR 50.55a(z)(2).

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Affected by the Proposed Alternative

The licensee's request is applicable to the following RPV inlet nozzle-to-safe end DMBW for Salem 1: Loop 11 - 27.5-RC-1110-5, Loop 12 - 27.5-RC-1120-5, Loop 13 - 27.5-RC-1130-5, and Loop 14 - 27.5-RC-1140-5.

3.2 Applicable Code Edition, Addenda, and Requirement

The regulation in 10 CFR 50.55a(g)(6)(ii)(F) requires licensees of pressurized-water reactors to implement the requirements of ASME Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities Section XI, Division 1," subject to conditions specified in 10 CFR 50.55a(g)(6)(ii)(F)(2) through (13). Code Case N-770-2, Inspection Item D, requires uncracked DMBW mitigated with stress improvement to be volumetrically inspected no sooner than the third refueling outage and no later than 10 years following stress improvement application.

The applicable Code edition and addenda is the 2007 Edition with Addenda through 2008 of ASME Code Section XI.

3.3 Licensee's Proposed Alternative

The licensee is requesting a one-time 24-month extension to the 10-year inspection interval required by Table 1 of Code Case N-770-2 for Item D uncracked DMBW mitigated with stress improvement.

3.4 Licensee's Bases for Use

The licensee is seeking NRC authorization of the proposed alternative in accordance with 10 CFR 50.55a(z)(2) on the basis that compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and

safety. The licensee is requesting the deferral of the volumetric examination of the subject DMBW to limit the number of core barrel removals to facilitate inspection of the subject DMBW and align the single core barrel removal with the required Reactor Vessel Internals Materials Reliability Program and ASME Section XI RPV examinations of other components during refueling outage S1R27, which is currently scheduled in fall 2020. The licensee notes that this extension would allow the examinations to be performed from the inside surface of the subject DMBW using automated remote equipment rather than performing the examinations from the outside surface, as would be necessary without relief. The licensee estimates the hardship associated with performing the DMBW examinations during the spring 2019 outage, without the relief, would result in an estimated 3.5 rem radiological dose, based on previous operating experience.

Additionally, the licensee indicated that during the fall 2008 refueling outage for Salem 1, the licensee performed MSIP of both the RPV hot leg and cold leg nozzle to safe-end Alloy 600 DMBW, which included the subject DMBW. pre-MSIP volumetric examinations of the subject four RPV cold leg nozzle to safe-end DMBW, and post-MSIP volumetric examinations were performed. The volumetric ultrasonic examination met ASME Section XI, Appendix VIII requirements, including examination volume of essentially 100 percent. The pre-MSIP and post-MSIP examinations identified no flaws in the four RPV cold leg nozzle to safe-end DMBW. The post-MSIP DMBW examinations were the preservice baseline examinations for Code Case N-770-2 Inspection Item D DMBW.

The licensee explains that since the Salem 1 RPV cold leg nozzle to safe-end DMBW have been mitigated by the application of MSIP and were ultrasonically examined without the detection of any flaws, the subsequent ultrasonic examination of these DMBW is considered as defense-in-depth monitoring and not for the management of primary water stress-corrosion cracking (PWSCC) degradation. Extending the inspection interval 24 months will continue to provide an adequate level of quality and safety.

Therefore, the licensee believes that imposition of the 10-year inspection interval would create a hardship in that personnel would unnecessarily receive additional radiation exposure, in the order of 3.5 rem, if the examinations were performed during the spring 2019 refueling outage, without an increase in quality or safety.

3.6 Duration of Proposed Alternative

The licensee requested that the NRC authorize this alternative through the fall 2020 refueling outage (S1R27).

3.7 NRC Staff Evaluation

The NRC staff has reviewed and evaluated the licensee's request on the basis that compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety. The applicable regulatory requirement of 10 CFR 50.55a(g)(6)(ii)(F) is that the first qualified volumetric inspection of the subject DMBW will be within 10 years of the installation of the MSIP mitigation. This requirement is based on a general assessment of the necessary, qualified volumetric inspection frequency for all MSIP-mitigated cold leg temperature DMBW of any size in the reactor coolant system to maintain structural integrity. Under this inspection requirement, the DMBW are expected to have no previous indications of PWSCC. The licensee stated in its submittal that no PWSCC has been found in these DMBW. The NRC staff verified this information and confirms that the

licensee-identified DMBW that are the subject of this proposed alternative are applicable to this inspection category and technical basis for qualified volumetric inspection frequency.

The licensee identified a hardship associated with the performance of the qualified volumetric inspection frequency within the current requirements. The licensee noted that the current required volumetric inspection frequency would require either an additional core barrel removal or examination from the outside diameter to facilitate inspection of the subject DMBW. Since the licensee is planning on performing a core barrel lift for the planned inspection of vessel internals on the subsequent outage, the NRC accepts the licensee's position that an additional core barrel lift to meet the existing examination requirement would cause hardship due to increased safety risk and radiological dose exposure. The licensee also estimates the hardship associated with performing the volumetric examination from the outside diameter of the DMBW will be approximately 3.5 rem of radiological dose. The NRC staff finds the licensee's estimate of radiological dose is reasonable compared to the inspection of similar DMBW at other facilities near the reactor vessel. The NRC staff finds the licensee has provided sufficient information to demonstrate a hardship associated with the current required volumetric inspection frequency of the subject DMBW. Therefore, the NRC staff finds the licensee meets the hardship requirement of 10 CFR 50.55a(z)(2).

The NRC staff reviewed the level of quality and safety of the licensee's proposed alternative to allow a 2-year delay in the qualified volumetric examination beyond the original regulatory requirement of, at most, 10 years. As part of this analysis, the NRC staff reviewed the licensee's previous inspection findings, technical basis regarding the mitigation, and the operating conditions of the subject DMBW.

The NRC staff reviewed the effect of the licensee's previous inspection findings. The licensee provided the results of the most recent volumetric examinations of these DMBW, which resulted in no reportable PWSCC indications. The NRC staff notes that this information is necessary to ensure the correct classification of the inspection category of the DMBW, Inspection Item D of Table 1 of ASME Code Case N-770-2, such that the first post-MSIP-required volumetric inspection should be performed within at least 10 years. However, since Inspection Item D DMBW, by definition in Table 1 of ASME Code Case N-770-2, require no previous indications of PWSCC, the NRC staff finds that this factor, although favorable, alone does not provide sufficient basis to support the proposed alternative.

The NRC staff analyzed the technical basis of the MSIP mitigation process and the required timing of the first post-MSIP mitigation examination for the cold leg temperature DMBW at Salem 1. The licensee mitigated each of the subject DMBW with MSIP as a stress improvement process to prevent any future PWSCC in these DMBW. The MSIP mitigation process utilizes compressive stresses generated in the DMBW by the mechanical squeezing of the pipe wall near the DMBW to prevent flaw initiation or growth in at least the inner one-third of the DMBW wall thickness. The desired stress improvement effect is determined by the amount the pipe wall is squeezed by calculation. The NRC staff notes that the initial followup examination for MSIP-mitigated DMBW is a defense-in-depth measure to provide reasonable assurance that no new cracking has formed and any existing cracks have not grown in depth. Operating experience has shown, in hundreds of applications, that if performed properly, the MSIP process has prevented new flaw initiation. The NRC staff notes that there have been a few rare cases where existing flaws may have grown in DMBW after MSIP has been performed in other nuclear plants, but these issues are not a primary concern for the Salem 1 DMBW, as no previous indications of cracking were found in these DMBW. Therefore, the NRC staff finds

that the first followup examination would be just as effective from a safety perspective as verifying no new crack initiations at 10 years vs.12 years for the subject DMBW at Salem 1.

The NRC staff thus finds the remaining concern is the possible impact of any initiating crack or growth of a potentially missed crack during the previous examination, in the 2-year period of extension for the inspection under the licensee's proposed alternative. In considering this case, the NRC staff notes that since the subject DMBW at Salem 1 are at cold leg operating temperatures, any potential growth of hypothetical cracks missed by the last inspection would grow at approximately a factor of 5 times slower than cracks growing under hot leg temperature conditions. Since the inspection requirement applies the same timeline for both hot leg and cold leg operating temperature DMBW mitigated by MSIP, the NRC staff finds for the issue of crack growth, cold leg temperature DMBW as those subject to the licensee's proposed alternative, have sufficient safety margin. Therefore, the NRC staff finds that extending the volumetric inspection by an additional 2 years would have limited overall safety impact for the subject DMBW at Salem 1.

Therefore, the NRC staff's technical assessment finds that the licensee's proposed volumetric inspection frequency extension provides reasonable assurance of structural integrity of the subject DMBW. Hence, given the licensee's identified hardship, the NRC staff finds the licensee's proposed alternative is acceptable on the basis that compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the licensee has demonstrated the proposed alternative in Relief Request No. S1-I4R-160, Revision 1, provides reasonable assurance of structural integrity of the subject components, and that complying with the specified ASME Code requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the NRC staff authorizes the use of Relief Request No. S1-I4R-160, Revision 1, at Salem 1 up to and including refueling outage S1R27, currently scheduled to start in fall 2020.

All other 10 CFR 50.55a(g)(iii)(F) and ASME Code, Section XI requirements for which relief was not specifically requested and approved in the subject request for relief remains applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: J. Collins

Date: March 5, 2019

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNIT NO. 1 – ALTERNATIVE TO REACTOR VESSEL NOZZLE WELDS EXAMINATIONS INSPECTION INTERVAL (EPID L-2018-LLR-0110) DATED MARCH 5, 2019

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