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

July 15, 2022

Mr. Eric Carr
President and Chief Nuclear Officer
PSEG Nuclear LLC – N09
Hope Creek Generating Station
P.O. Box 236
Hancocks Bridge, NJ 08038

SUBJECT: HOPE CREEK GENERATING STATION − CORRECTION LETTER OF RELIEF REQUEST NO. HR-I4R-220 RE: REACTOR PRESSURE VESSEL WATER LEVEL INSTRUMENTATION PARTIAL PENETRATION NOZZLE REPAIRS (EPID L-2022-LLR-0003)

Dear Mr. Carr:

By letter dated July 5, 2022 (Agencywide Documents and Access Management System Accession No. ML22181A125), the U.S. Nuclear Regulatory Commission (NRC, the Commission) approved the alternative in Relief Request HC-I4R-220 associated with the repair of water level instrumentation (WLI) partial penetration nozzles on the reactor pressure vessel (RPV) on the basis that performing the repair in accordance with the ASME Code, Section XI would result in hardship without a compensating increase in quality and safety.

The licensee reviewed the NRC's safety evaluation (SE) approving the relief request and identified inaccuracy in the specification of the nozzle alloy in the SE section on page 4 titled "Half-Nozzle Repair and Examination Process." Please replace the entire paragraph titled "Half-Nozzle Repair and Examination Process" with the following to address the inaccuracy:

Half-Nozzle Repair and Examination Process

To restore the pressure boundary, the licensee will utilize a "half-nozzle" repair method where a portion of the existing degraded SA-541 nozzle assembly at or near the OD surface of the RPV will be replaced with a nozzle penetration resistant to IGSCC. The repair entails a temper bead weld buildup (i.e., weld pad) on the OD of the RPV using Alloy 52M filler metal in accordance with ASME Code Case N-638-x and a final partial penetration manual welding between the IGSCC resistant nozzle and Alloy 52M weld pad using Alloy 52M filler metal. Materials such as Alloy 690/52M are known to be resistant to IGSCC. The remnants of the original SA-541 nozzle and Alloy 182 partial penetration attachment weld that contained the flaw are intended to be left in place. The NRC staff finds that the licensee's half-nozzle repair method is acceptable because 1) it will relocate the pressure boundary from the inside diameter to OD surface of the RPV shell which includes Alloy 52M partial penetration J-groove weld joining the IGSCC resistant nozzle to Alloy 52M weld pad, and 2) the welding and design analysis comply with the ASME Code requirements. In addition, the NRC staff noted that the licensee will perform NDE as a part of the half-nozzle repair to ensure compliance with the ASME Code, Sections III and XI, and ASME Code Case

N-638-x with conditions in the latest RG 1.147, currently Revision 19. The staff finds it acceptable because the conditioned code case will be approved for use in the latest RG 1.147.

The licensee also recommended the text within the SE section on page 5 titled “Corrosion Evaluation of RPV LAS Base Material” in its entirety be changed with the following to accurately align with the wording in the Relief Request:

Corrosion Evaluation of RPV LAS Base Material

In its review, the NRC staff notes that the licensee will perform a corrosion evaluation on the portion of the RPV LAS base metal exposed to BWR environment as a result of the half-nozzle repair. The possible corrosion mechanisms for LAS in BWR environment are known to be general corrosion, galvanic corrosion, crevice corrosion and SCC. For one operating cycle following nozzle repair, the licensee will consider various corrosion mechanisms and use conservative corrosion rates based on established industry experience and testing. The corrosion evaluation will include the geometry of the repair, the material properties of new and existing components, the water chemistry of wetted components, and operating conditions. The licensee will also address crevice corrosion, galvanic corrosion, and SCC susceptibly of LAS, and will ensure that corrosion rates are not significant for one operating cycle following the nozzle repair. The NRC staff finds the licensee’s proposed corrosion evaluation acceptable for one operating cycle because of its implementation of industry standard corrosion mitigate program at Hope Creek and because it will ensure a low corrosion rate of the affected LAS base metal.

The NRC staff has concluded that the inaccuracy on page 4 of the SE was introduced during the preparation of the SE. The NRC also agrees with the licensee’s recommended rewording on page 5 of the SE. The corrections do not change any of the conclusions in the SE associated with the Relief Request HC-I4R-220.

The revised SE is enclosed. If you have any questions, please contact me at 301-415-4125 or James.Kim @nrc.gov.

Sincerely,

/RA/

James S. Kim, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-354

Enclosure:
Revised Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. HC-I4R-220

REACTOR PRESSURE VESSEL WATER LEVEL INSTRUMENTATION

PARTIAL PENETRATION NOZZLE REPAIRS

PSEG NUCLEAR LLC

HOPE CREEK GENERATING STATION

DOCKET NO. 50-354

1.0 INTRODUCTION

By letter dated January 7, 2022 (Agencywide Documents and Access Management System Accession No. ML22007A026), PSEG Nuclear LLC (the licensee) submitted a request for alternative to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Articles IWB-3000 and IWA-4000 for Hope Creek Generating Station (Hope Creek).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(z)(2), the licensee requested for alternative in Relief Request HC-I4R-220 associated with the repair of water level instrumentation (WLI) partial penetration nozzles on the reactor pressure vessel (RPV) on the basis that performing the repair in accordance with the ASME Code, Section XI would result in hardship without a compensating increase in quality and safety. The licensee stated that the proposed alternative provides reasonable assurance of structural integrity and leak tightness for the duration of one operating cycle.

2.0 REGULATORY EVALUATION

The regulation at 10 CFR 50.55a(z) states, in part, that alternatives to the requirements of paragraphs (b) through (h) of 10 CFR 50.55a or portions thereof may be used when authorized by the director, Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that:

(1) *Acceptable level of quality and safety.* The proposed alternative would provide an acceptable level of quality and safety; or

(2) *Hardship without a compensating increase in quality and safety.* Compliance with the specified requirements of this section 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 U.S. Nuclear Regulatory Commission (NRC) staff finds that regulatory authority exists for the licensee to request the use of an alternative and the NRC to authorize the use of the proposed alternative.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Component(s) Affected

The affected components are the RPV WLI partial penetration nozzles identified in table 1 of attachment 2 to the relief request, as seen below.

RPV Material (clad with stainless steel)	Nozzle Number	Nozzle Material	J-Groove Weld Material
SA-533 Gr. B Class 1	N11A, N11B, N11C, N11D, N12A, N12B, N12C, N12D, N16A, N16B, N16C, N16D	SA-541	Alloy 82/182 with Alloy 182 butter

These components are ASME Code, Section XI, Code Class 1, Examination Category: B-P, Item Number: B15.10.

3.2 Applicable Code Edition and Addenda

The code of record for the current fourth 10-year ISI interval at Hope Creek is based on the ASME Code, Section XI, 2007 Edition through the 2008 Addenda. The construction code for the RPV is the 1968 Edition through the Winter 1969 Addenda of the ASME Code, Section III. The fourth 10-year ISI interval began on December 13, 2017, and is scheduled to end on December 31, 2026.

3.3 Applicable Code Requirements

The ASME Code requirements applicable to this request stem from Articles IWB-3000 and IWA-4000 of Section XI, which include:

- Flaw removal requirements of IWA-4412 and IWA-4611. Paragraph IWA-4412 states, "Defect removal shall be accomplished in accordance with the requirements of IWA-4420." Subparagraph IWA-4611.1(a) states “Defects shall be removed in accordance with IWA-4422.1. A defect is considered removed when it has been reduced to an acceptable size.”

- Flaw characterization requirements and analytical flaw evaluation requirements of IWB-3420 and IWB-3610. Subarticle IWB-3420 states, "Each detected flaw or group of flaws shall be characterized by the rules of IWA-3300 to establish the dimensions of the flaws. These dimensions shall be used in conjunction with the acceptance standards of IWB-3500." Subarticle IWB-3610(b) states, in part, "For purposes of evaluation by analysis, the depth of flaws in clad components shall be defined in accordance with Fig. IWB-3610-1...”

In addition, subarticle N-532 of the ASME Code, Section III in the 1968 Edition up to and including the Winter 1970 Addenda, and subarticle NB-4620 of the ASME Code, Section III in the 1971 Edition up to and including the 2019 Edition contain requirements for postweld heat treatment.

3.4 Proposed Alternative

In lieu of the ASME Code requirements, the following alternatives are proposed:

- As an alternative to flaw removal or reduction in size to meet the applicable acceptance standards per Paragraphs IWA-4412 and IWA-4611, the licensee proposed to implement an outside diameter (OD) repair of the RPV WLI partial penetration nozzles utilizing an OD weld pad and a half nozzle.

- As an alternative to performing the nondestructive examination (NDE) requirement to characterize the flaw under Subarticles IWB-3420 and IWB-3610(b) in the WLI partial penetration weld or nozzles, PSEG proposed to use ASME Code Case N-749[-x], “Alternative Acceptance Criteria for Flaws in Ferritic Steel Components Operating in the Upper Shelf Temperature Range Section XI, Division 1.” (The licensee’s submittal uses “-x” to refer to the ASME Code Case revision approved or conditionally approved by the NRC in the latest revision of Regulatory Guide (RG) 1.147, currently Revision 19.). The licensee will analyze a maximum postulated flaw that bounds the range of flaw sizes that could exist in the original J-groove welds and nozzles.

- As an alternative to the requirements of postweld heat treatment required by the Construction Code, the licensee proposed to install a welded pad in accordance with ASME Code Case N-638-x, “Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW (Gas Tungsten Arc Welding) Temper Bead Technique, Section XI,” and N-839-x, "Similar and Dissimilar Metal Welding Using Ambient Temperature SMAW (Shielded Metal Arc Welding) Temper Bead Technique, Section XI, Division 1."

3.5 Basis for Use

For the examination of the J-groove welds, the licensee will perform ultrasonic testing examinations on the existing J-groove welds in accordance with BWRVIP-03, Revision 20, or later, “BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines.” The current RPV OD volumetric examination technique has been demonstrated to only interrogate the partial penetration J-groove welds and the surrounding RPV LAS material. As an alternative to performing the NDE required by Subarticles IWB-3420 and IWB-3610(b) to characterize the flaw in the WLI partial penetration weld or nozzle, the licensee proposed to analyze a maximum postulated flaw that bounds the range of flaw sizes that could exist in the original J-groove weld and nozzle.

Regarding the nozzle repair, the licensee will replace the existing nozzle assembly with a nozzle penetration that is resistant to intergranular stress corrosion cracking (IGSCC) using ASME Code Case N-638-x, N-839-x, or similar code case, as approved or conditionally approved by the NRC in the latest revision of RG 1.147, and in accordance with the applicable construction code. A weld pad will be applied to the OD of the RPV using IGSCC-resistant nickel alloy filler metal and will be welded using the machine GTAW or manual SMAW welding processes. The IGSCC-resistant nozzle will be attached to the new weld pad with a partial penetration weld

using a non-temper bead manual welding process and IGSCC-resistant filler metal. The original partial penetration J-groove welds and remnants of the original nozzles will remain in place. In addition, the new weld pads will be examined as required by ASME Code Case N-638-x, N-839-x or similar code case, as approved or conditionally approved by the NRC in the latest revision of RG 1.147. These examinations will verify there are no unacceptable indications in the newly installed weld pads or the original base metal material.

Regarding post-repair flaw analytical evaluation, the licensee will perform flaw evaluations for one cycle of operation in accordance with subarticle IWB-3610, as well as per ASME Code Case N-749-x. ASME Code Case N-749-x or similar code case will be used with all applicable conditions stated in the latest revision of RG 1.147.

The licensee also stated that a corrosion evaluation will be performed to consider potential material degradation due to the repair of the RPV WLI partial penetration nozzles. Given the original WLI partial penetration nozzles are not intended to be entirely removed, the licensee will also complete a loose parts evaluation to assess the potential for nozzle segments to enter the RPV during power operation.

3.6 Duration of Proposed Alternative

Relief is requested for the duration of the subsequent operating cycle following the outage in which any indication is identified. A separate relief request will be submitted to justify continued use of the nozzle repair beyond the first cycle. Such a relief request, which will contain the appropriate analyses and justification for the remainder of the plant operating life, will be submitted prior to the end of the subsequent operating cycle following the repair.

3.7 NRC Staff Evaluation

The NRC staff evaluated Relief Request HC-I4R-220 pursuant to 10 CFR 50.55a(z)(2). The NRC staff focused on whether compliance with the specified requirements of 10 CFR 50.55a(g), or portions thereof, would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

Structural Integrity

In its evaluation, the NRC staff focused on two aspects of the licensee's technical basis which include the half-nozzle repair and examination process to restore the pressure boundary, and the plant-specific analysis (i.e., evaluation of potential flaws left in service in the original J-groove welds) and corrosion assessment of RPV LAS to demonstrate that structural integrity of the repaired RPV instrument penetration nozzles will be maintained for the duration of one operating cycle.

Half-Nozzle Repair and Examination Process

To restore the pressure boundary, the licensee will utilize a "half-nozzle" repair method where a portion of the existing degraded SA-541 nozzle assembly at or near the OD surface of the RPV will be replaced with a nozzle penetration resistant to IGSCC. The repair entails a temper bead weld buildup (i.e., weld pad) on the OD of the RPV using Alloy 52M filler metal in accordance with ASME Code Case N-638-x and a final partial penetration manual welding between the IGSCC resistant nozzle and Alloy 52M weld pad using Alloy 52M filler metal. Materials such as Alloy 690/52M are known to be resistant to IGSCC. The remnants of the original SA-541 nozzle

and Alloy 182 partial penetration attachment weld that contained the flaw are intended to be left in place. The NRC staff finds that the licensee's half-nozzle repair method is acceptable because 1) it will relocate the pressure boundary from the inside diameter to OD surface of the RPV shell which includes Alloy 52M partial penetration J-groove weld joining the IGSCC resistant nozzle to Alloy 52M weld pad, and 2) the welding and design analysis comply with the ASME Code requirements. In addition, the NRC staff noted that the licensee will perform NDE as a part of the half-nozzle repair to ensure compliance with the ASME Code, Sections III and XI, and ASME Code Case N-638-x with conditions in the latest RG 1.147, currently Revision 19. The staff finds it acceptable because the conditioned code case will be approved for use in the latest RG 1.147.

Plant-Specific Analysis

To demonstrate reasonable assurance of RPV structural integrity for one operating cycle following the nozzle repair, the licensee will use a plant-specific analytical evaluation based on combination of linear elastic fracture mechanics (LEFM) and elastic-plastic fracture mechanics (EPFM) in accordance with the ASME Code, Section XI requirements, with the assumption that the crack will potentially propagate into the RPV LAS base material. The NRC staff notes that the licensee's assumption is conservative on the basis that any "as-left" flaws in the Alloy 182 J-groove weld cannot be characterized with reasonable confidence by the currently available NDE techniques, and this postulated initial flaw bounds any actual indications that have existed in the attachment weld. The staff also notes that the licensee will utilize the screening criteria in ASME Code Case N-749-x with conditions in RG 1.147, Revision 19, to determine acceptability of the flaw in the RPV LAS when the metal temperature is in the upper shelf range. The screening criteria are: (a) use EPFM method of analysis if the metal temperature exceeds the NRC-defined temperature T_c, (b) use LEFM method of analysis if the metal temperature drops below the NRC-defined temperature T_{c1}, and (c) for metal temperature between T_c and T_{c1}, assess suitability of using EPFM since the fracture mode is in transition from LEFM to EPFM. The NRC staff finds that the ASME Code-required acceptance criteria for LEFM and EPFM are satisfied.

Corrosion Evaluation of RPV LAS Base Material

In its review, the NRC staff notes that the licensee will perform a corrosion evaluation on the portion of the RPV LAS base metal exposed to BWR environment as a result of the half-nozzle repair. The possible corrosion mechanisms for LAS in BWR environment are known to be general corrosion, galvanic corrosion, crevice corrosion and SCC. For one operating cycle following nozzle repair, the licensee will consider various corrosion mechanisms and use conservative corrosion rates based on established industry experience and testing. The corrosion evaluation will include the geometry of the repair, the material properties of new and existing components, the water chemistry of wetted components, and operating conditions. The licensee will also address crevice corrosion, galvanic corrosion, and SCC susceptibly of LAS, and will ensure that corrosion rates are not significant for one operating cycle following the nozzle repair. The NRC staff finds the licensee's proposed corrosion evaluation acceptable for one operating cycle because of its implementation of industry standard corrosion mitigate program at Hope Creek and because it will ensure a low corrosion rate of the affected LAS base metal.

Loose Parts Evaluation

The proposed repair will only replace a portion of the existing nozzle; therefore, the licensee proposed to perform a loose parts evaluation to assess any potential for remnant nozzle segments or existing J-groove weld to enter the RPV during normal power operations. The NRC staff finds the proposed loose parts evaluation acceptable because it will address any potential impact on the fuel and on the RPV internal components.

Hardship Justification

The NRC staff finds the licensee's hardship justification is acceptable because performing the repair in accordance with the ASME Code, Section XI, would result in an increased radiological exposure, and because there exists a potential risk of loose parts or foreign materials accidentally getting into the RPV during the ASME Code repair. Therefore, the NRC staff determines that concerns from the foreign material falling into the RPV and an as low as reasonably achievable criteria for radiological exposure support the licensee's hardship justification.

The NRC staff finds the licensee's plant-specific analysis acceptable because a conservative initial flaw is assumed, and the flaw evaluation will demonstrate that the initial flaw will not grow to an unacceptable depth into the RPV LAS base metal over one operating cycle. Furthermore, the impact on RPV LAS from exposure to BWR water environment is low. The staff finds that the licensee's proposed alternative provides reasonable assurance of the RPV structural integrity and leak tightness for the duration of one operating cycle.

4.0 CONCLUSION

As set forth above, the NRC staff determined that complying with the specified requirements described in the licensee's relief request would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The proposed alternative provides reasonable assurance of structural integrity and leak tightness of the RPV instrument penetration nozzles. The NRC staff concludes that the licensee has adequately addressed the regulatory requirements set forth in 10 CFR 50.55a(z)(2); therefore, the NRC staff authorizes use of the proposed alternative in Relief Request HC-I4R-220 at Hope Creek, for the duration of one operating cycle.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Bart Fu, NRR

Date: July 15, 2022

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