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

May 1, 2026

PALISADES NUCLEAR PLANT - APPROVAL OF RELIEF REQUEST RR-5-13, HALF-NOZZLE REPAIR OF REACTOR VESSEL CLOSURE HEAD CONTROL ROD DRIVE MECHANISM PENETRATION NUMBER 5 - ONE-CYCLE JUSTIFICATION (EPID L-2026-LLR-0010)

LICENSEE INFORMATION

Licensee:	Holtec Palisades, LLC
Licensee Address:	Site Vice President Palisades Energy, LLC Palisades Nuclear Plant 27780 Blue Star Memorial Highway Covert, MI 49043-9530
Plant Name and Unit:	Palisades Nuclear Plant (PNP)
Docket No.:	50-255

1. APPLICATION INFORMATION

Submittal Date: February 20, 2026.

Submittal Agencywide Documents Access and Management System (ADAMS) Accession No.: ML26051A073.

Licensee Proposed Alternative No. or Identifier: Relief Request RR-5-13.

Applicable Provision: Title 10 of the *Code of Federal Regulations* (10 CFR), paragraph 50.55a(z)(1), "Acceptable level of quality and safety."

Applicable Code Edition and Addenda: American Society of Mechanical Engineers (ASME) Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2007 Edition through 2008 Addenda; ASME Code, Section XI, Code Case N-729-6, as amended in 10 CFR 50.55a(g)(6)(ii)(D); ASME Code, Section XI, Code Case N-638-11; ASME Code, Section III, "Nuclear Vessels," 1965 Edition through Winter 1965 Addenda (Original Construction Code); ASME Code, Section III, "Nuclear Power Plant Components," Division 1, 2019 Edition, Subsection NB, Class 1 Components.

Applicable Code Requirements; Requesting an Alternative to:

ASME Code, Section XI, 2007 Edition through 2008 Addenda

IWB-3132.3 states:

> A component whose volumetric or surface examination detects flaws that exceed the acceptance standards of Table IWB-3410-1 is acceptable for continued service without a repair/replacement activity if an analytical evaluation, as described in IWB-3600, meets the acceptance criteria of IWB-3600. The area containing the flaw shall be subsequently reexamined in accordance with IWB-2420(b) and (c).

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.

ASME Code, Section III, 2019 Edition

NB-5245, “Partial Penetration Welded Joints,” specifies progressive surface examination of partial penetration welds.

NB-5331(b), states:

> Indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

ASME Code Case N-638-11, Similar and Dissimilar Metal Welding Using Ambient Temperature Machine Gas Tungsten Arc Welding (GTAW) Temper Bead Technique

This Code Case provides requirements for automatic or machine GTAW of Class 1 components without the use of preheat or post-weld heat treatment.

Paragraph 1(a) states in part:

> This Case shall not be used to repair SA-302, Grade B material, unless the material has been modified to include 0.4% to 1.0% nickel, quenching and tempering, and application of a fine gain practice.

Paragraph 2(b) permits the use of existing welding procedures qualified in accordance with previous revisions of the Code Case. When the licensee’s existing welding procedure was qualified in accordance with N-638-4, the test coupon base material was post-weld heat treated to comply with paragraph 2.1(a) of the Code Case (N-638-4), which states in part: The materials shall be post-weld heat treated to at least the time and temperature that was applied to the materials being welded.

Paragraph 4(a)(2) states:

> When ferritic materials are used, the weld shall be nondestructively examined after the completed weld has been at ambient temperature for at least 48 hours. When austenitic materials are used, the completed weld shall be nondestructively examined after the three tempering layers (i.e., layers 1, 2, and 3) have been in place for at least 48 hours. Examination of the welded region shall include both volumetric and surface examination methods.

Brief Description of the Proposed Alternative and Basis:

By letter dated February 20, 2026 (ML26051A073), Holtec Palisades. LLC (the licensee, Holtec) submitted Relief Request RR-5-13 for PNP. PNP permanently ceased operations in 2022. Holtec is now performing modifications to support restarting operations. The reactor vessel closure head (RVCH) vessel head penetration (VHP) nozzles are constructed of materials susceptible to primary water stress corrosion cracking (PWSCC).

To mitigate this susceptibility, the licensee proposed to implement preemptive modifications to the majority of the nozzles associated with the control rod drive mechanism (CRDM) under Relief Request RR-5-9 (ML25212A024), as supplemented by letters dated January 19, 2026 (ML26019A041), and February 27, 2026 (ML26058A172). The alternative proposed in Relief Request RR-5-9 was approved by the NRC staff on April 8, 2026 (ML26096A153). This relief request, RR-5-13, applies specifically to CRDM penetration number 5.

The modification technique for CRDM penetration 5, referred to as the half-nozzle modification, was intended to be the same as that implemented previously at PNP, and involves removing the lower portion of the nozzle to above the J-groove weld, then welding the remaining portion of the nozzle and a replacement Alloy 690 lower nozzle to the RVCH to form the new pressure boundary. The welding is performed using inside diameter temper bead (IDTB) welding with Alloy 52M filler metal in accordance with ASME Code Case N-638-11.

As part of this process, the licensee performs roll expansion of the remaining nozzle section to stabilize the component during separation from the original J-groove weld. To address residual tensile stresses introduced by roll expansion, the licensee applies rotary peening to the inside diameter surface of the repaired region. Rotary peening is a surface stress improvement technique that introduces compressive residual stress and mitigates PWSCC initiation.

Because post-weld heat treatment (PWHT) of the RVCH is impractical, the use of the ambient temperature IDTB welding process, combined with Alloy 690/52M materials and rotary peening, constitutes the proposed alternative. The licensee requests authorization of this alternative pursuant to 10 CFR 50.55a(z)(1), on the basis that the modification will provide an acceptable level of quality and safety for one cycle of operation.

The NRC staff notes that, during implementation of the modification for CRDM penetration number 5, fabrication anomalies were identified that differ from the standard half-nozzle configuration. These include conditions associated with roll expansion and an outer diameter (OD) indication that could not be fully characterized by nondestructive examination. The licensee provided additional evaluations, including fracture mechanics analyses and a one-cycle justification, to demonstrate the acceptability of these conditions. These nozzle-specific conditions are evaluated in this safety evaluation.

2. REGULATORY EVALUATION

Regulatory Basis: 10 CFR 50.55a(z)(1)

The NRC regulations in 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," state that alternatives to the requirements of paragraphs (b) through (h) of this section, or portions thereof, may be used when authorized by the Director of the NRC's Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that: (1) the proposed alternative would provide an acceptable level of quality and safety; or (2) 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.

The licensee submitted the request on the basis that the proposed alternative would provide an acceptable level of quality and safety in accordance with 10 CFR 50.55a(z)(1). Based on the above regulations, the NRC staff finds that regulatory authority exists to authorize an alternative to ASME Code, Section III and Section XI, as requested by the licensee.

This licensing action relates to actions under 10 CFR 50.55a. The NRC staff has determined that a categorical exclusion applies and that special circumstances are not present that would preclude reliance on the categorical exclusion. Accordingly, this action meets the eligibility criteria for categorical exclusion set forth in paragraph (a)(16) of 10 CFR 51.22, "Categorical exclusions." Pursuant to 10 CFR 51.22, no environmental impact statement or environmental assessment need be prepared in connection with the action.

3. TECHNICAL EVALUATION

During the PNP RVCH modification activities to support restart, the licensee identified the need to mitigate the PWSCC susceptible Alloy 600 VHP nozzles by proposing the alternative to perform half-nozzle modifications using the ambient temperature IDTB welding method in accordance with ASME Code Case N-638-11 and Code Case N-729-6. For all other nozzles except for nozzle penetration number 5, the NRC approved the licensee's alternative implementing this half-nozzle modification using the ambient temperature IDTB welding method by safety evaluation dated April 8, 2026 (ML26096A153). The NRC staff notes that, during the modification for CRDM penetration number 5, conditions were identified that differ from the standard half-nozzle configuration. Specifically, the modification included an inadvertent roll expansion above the intended location within the RVCH penetration bore, followed by a second roll expansion at the correct location. In addition, an OD indication was identified during preservice inspection that could not be fully characterized using available nondestructive examination techniques. As a result, additional evaluations were required to assess the acceptability of these conditions.

The licensee requested approval of Relief Request RR-5-13 as an alternative to the ASME Code repair and replacement requirements for the RVCH for CRDM penetration number 5. The modification involves removal of the lower portion of the Alloy 600 nozzle, welding of a replacement Alloy 690 lower nozzle with Alloy 52M filler metal, application of rotary peening to the roll-expanded region, and performance of preservice inspections (PSI) and inservice inspections (ISI) in accordance with ASME Code Case N-729-6.

Because the OD indication could not be fully characterized in accordance with ASME Code, Section XI, IWB-3420, the licensee performed a bounding flaw evaluation and fracture mechanics analysis to demonstrate the structural integrity of the modified configuration. The licensee also provided a one-cycle justification to support continued operation for one operating cycle based on the evaluated condition of the nozzle. The NRC staff reviewed these nozzle-specific conditions and associated analyses to determine whether the proposed alternative provides an acceptable level of quality and safety.

This section documents the NRC staff's technical evaluation of the licensee's proposed alternative in Relief Request RR-5-13, including the staff's review of the welding requirements, triple point anomalies, flaw characterization of the remnant J-groove weld, evaluation of the OD anomaly specific to penetration number 5, general corrosion of exposed low-alloy steel, and PWSCC initiation and growth, as well as the PSI and ISI requirements that form the technical basis for the proposed alternative.

3.1 Welding Requirements

The licensee indicated that paragraph 1(a) of ASME Code Case N-638-11 states, in part, that the Case shall not be used to repair SA-302 Grade B material unless the material has been modified to include 0.4 percent to 1.0 percent nickel, quenching and tempering, and application of a fine grain practice. The PNP RVCH material is SA-302 Grade B Modified, quenched and tempered plate. Certified Material Test Reports (CMTRs) from the fabricator confirm that the material chemistry includes 0.4 percent–1.0 percent nickel and that the plates were quenched and tempered. However, the CMTRs do not report aluminum content or otherwise indicate that a fine grain practice was applied during steelmaking, and they do not identify whether carbide formers (e.g., niobium or vanadium) were intentionally added to promote grain refinement. Therefore, it is not known whether aluminum-nitride pinning of prior-austenite grain boundaries occurred, or whether alternative methods were used to achieve a fine grain microstructure.

To address this limitation, the licensee referenced Electric Power Research Institute (EPRI) Report 1014351, which provides a comparison of the chemical and mechanical properties, heat treatment, and grain refinement practices of SA-302 Grade B Modified and SA-533 Grade B Class 1 materials. The report concludes that the chemical composition and mechanical properties of SA-302 Grade B Modified plate are essentially identical to SA-533 Grade B Class 1 plate when both materials are quenched and tempered, as is the case for PNP. Prior to 1987, the principal distinction between the two specifications was that SA-533 explicitly required quench and temper heat treatment, while SA-302 Grade B did not. The ASME Code, Section II specification for SA-533 Grade B Class 1 did not require a fine grain practice until 1987. ASME Code Case N-638-11 does not prohibit its use on SA-533 Grade B Class 1 plate manufactured before 1987.

The GTAW ambient temperature temper bead (ATTB) welding process used in the ambient temperature IDTB welding method is designed to develop a ductile and notch-tough microstructure in the weld heat-affected zone (HAZ) that is equivalent or superior to the surrounding base material. When performing GTAW ATTB welding in accordance with ASME Code Case N-638-11, the cooling rates are sufficiently high to produce a predominantly martensitic HAZ microstructure. Subsequent passes provide localized tempering of the HAZ, producing improved toughness. Adequacy of toughness is demonstrated through Charpy V-notch impact testing of the HAZ in accordance with Section 2.1 of the Code Case. The Framatome welding procedure qualified for PNP satisfies these requirements, with Charpy V-notch lateral expansion values for the HAZ meeting the acceptance criteria.

The licensee's ATTB welding procedure was originally qualified to ASME Code Case N-638-4, which included simulated PWHT provisions for the test assembly. The licensee requested that the simulated PWHT requirements of ASME Code Case N-638-11, paragraph 2.1(a) apply when using the previously qualified procedure for the PNP modification. ASME Code Case N-638-11 clarifies that simulated PWHT of the test assembly is neither required nor prohibited, and if used, shall not exceed the time/temperature already applied to the base material. The licensee stated that this change addresses non-conservatism recognized in earlier revisions of the Code Case, and that the PNP Welding Procedure Specification, as applied, complies with ASME Code Case N-638-11. The NRC staff reviewed this basis and found it acceptable for use at PNP.

Based on the information provided by the licensee, the NRC staff finds that the proposed welding procedure for the PNP RVCH half-nozzle modification for CRDM penetration number 5 complies with the requirements of ASME Code Case N-638-11. Although the CMTRs do not document a fine grain practice, EPRI Report 1014351 provides a technical basis that SA-302 Grade B Modified plate in the quenched and tempered condition is metallurgically equivalent to SA-533 Grade B Class 1 material, which is permitted by the ASME Code Case. In addition, the Framatome welding procedure demonstrates acceptable HAZ toughness in accordance with the ASME Code Case. Therefore, the NRC staff concludes that the proposed welding procedure provides reasonable assurance of the structural integrity of the repaired configuration.

3.2 Elimination of 48-Hour Hold Time

The NRC staff reviewed the licensee's technical justification to eliminate the 48-hour hold time when using austenitic filler materials in the temper bead welding process on P-1 and P-3 ferritic materials. The licensee's technical basis included a white paper that provided detailed technical justification for eliminating the 48-hour hold time, as well as industry operating experience from similar repairs, in support of ASME Code Case N-888-1.

The NRC staff found the licensee's basis for the proposed alternative to be consistent with previous NRC approvals for elimination of the 48-hour hold time. Specifically, when austenitic weld metal is used, the level of diffusible hydrogen in the ferritic base metal HAZ is sufficiently low such that hydrogen-induced cracking is not a concern.

The NRC staff's conclusion is further supported by extensive nuclear industry operating experience using various revisions of ASME Code Case N-638, with no documented instances of delayed hydrogen-induced cracking in similar applications using austenitic filler metals with the machine GTAW temper bead process. Based on this information, the NRC staff finds that elimination of the 48-hour hold time requirement of ASME Code Case N-638-11 is acceptable.

3.3 Acceptance Examination of IDTB Weld Repair

The licensee stated that the acceptance examination of the IDTB weld repair is performed in accordance with ASME Code, Section III, 2019 Edition. Specifically, NB-5245 of ASME Code, Section III prescribes a progressive surface examination for partial penetration welds in lieu of volumetric examination, based on the impracticality of volumetric methods for conventional partial penetration weld configurations. The licensee requests relief from the progressive surface examination requirements of NB-5245 for the partial penetration weld associated with CRDM penetration number 5.

The modified VHP geometry of this partial penetration weld at PNP is suitable for UT, and the structural portion of the weld is accessible from both the top and bottom surfaces. Accordingly, the licensee proposed a combination of UT and penetrant testing (PT) examinations.

The licensee stated that volumetric UT will be performed in accordance with ASME Code Case N-638-11, paragraphs 4(a)(2) and 4(a)(3). The acceptance criteria of ASME Code, Section III, 2019 Edition, NB-5331, will apply to all flaws identified within the examined volume. The UT system is capable of scanning cylindrical surfaces with inside diameters of approximately 2.79 inches. The scanning process employs multiple search angles, including:

- a 0° longitudinal-wave (L-wave) transducer,
- a 45° shear-wave (S-wave) transducer aimed axially downward,
- 45° L-wave transducers in two opposed axial directions,
- 70° L-wave transducers in two opposed axial directions, and
- 45° L-wave transducers in two opposed circumferential directions.

In addition, the low-alloy steel extending 0.25 inches beneath the weld into the base material will be examined using a 0° longitudinal-wave transducer to detect potential under-bead cracking and lack of fusion in the heat-affected zone. The licensee reported that the UT configuration provides essentially full volumetric coverage of the structural weld volume.

In addition to UT, the licensee committed to perform a surface PT examination of the entire completed weld and the adjacent ferritic low-alloy steel RVCH material. The acceptance criteria for this PT examination are specified in ASME Code, Section III, 2019 Edition, NB-5350.

The NRC staff finds that the proposed combination of UT and PT examinations is acceptable because the examinations are performed in accordance with ASME Code Case N-638-11. The examination volume is sufficient to identify lack of fusion or under-bead cracking, and the acceptance criteria are consistent with ASME Code, Section III construction code requirements. The NRC staff concludes that the licensee’s proposed approach provides reasonable assurance of the structural integrity and acceptability of the modified VHP weld for CRDM penetration number 5, consistent with NRC staff approvals for similar half-nozzle repair activities.

3.4 Triple Point Anomaly

ASME Code, Section III, 2019 Edition, NB-5331(b) states that indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length. With respect to this requirement, the proposed alternative addresses a material anomaly associated with the ambient temperature IDTB welding process.

The licensee explained that an artifact of the IDTB welding process is the formation of an anomaly at the triple point, which is the intersection of three dissimilar materials. In the PNP modification, two such triple points exist. The upper triple point is where the low-alloy steel RVCH base material, the original Alloy 600 nozzle, and the Alloy 52M weld intersect. The lower triple point is where the RVCH base material, the replacement Alloy 690 nozzle, and the Alloy 52M weld intersect.

The licensee characterized the triple point anomaly as a fabrication-induced discontinuity inherent to the IDTB process at the interface of the base metal, nozzle, and weld filler which does not exceed 0.10 inches in through-wall extent. For analysis purposes, the licensee conservatively assumed that anomalies of this size could exist around the entire circumference at both triple point elevations.

To evaluate the acceptability of this condition, the licensee performed fracture mechanics analysis of limiting nozzle configurations. The analyses postulated a 0.10-inch-deep crack-like defect initiating at the triple point and considered circumferential and axial flaw orientations as well as a cylindrical flaw along the interface between the upper and lower triple points. Bounding fatigue crack growth rates were applied at twice the in-air crack growth rate of austenitic stainless-steel to ensure conservatism for Alloy 600/690 and Alloy 52M materials.

The results demonstrated that the triple point anomaly remains acceptable for the remainder of the 60-year licensed operational life until 2031. Specifically, the analysis showed:

- a minimum fracture toughness margin of 2.5 for cylindrical flaw propagation, compared to the required 1.41 margin per ASME Code, Section XI, IWB-3613,
- negligible fatigue crack growth for all flaw paths, and
- a limit load margin of 1.11 under normal operating conditions, compared to the required 1.0 margin in ASME Code, Section XI, C-5320 and C-5410.

The licensee further noted that the postulated anomaly at the upper triple point is not exposed to primary coolant and is therefore not subject to PWSCC. At the lower triple point, the materials in contact with primary coolant are Alloy 52M, Alloy 690, and low-alloy steel, which are highly resistant to PWSCC and are only subject to fatigue crack growth.

Based on these analyses, the NRC staff finds that the licensee has adequately demonstrated that postulated triple point anomalies of up to 0.10 inches in depth will remain stable and within ASME Code, Section XI acceptance criteria for the full licensed period of operation until 2031. The NRC staff's acceptance is further based on the fact that the Alloy 52M weld material possesses high fracture toughness, which significantly reduces the likelihood of unstable crack propagation from these small fabrication-induced discontinuities. Therefore, the NRC staff concludes that the proposed alternative provides reasonable assurance of the structural integrity of the modified configuration with respect to the triple point anomaly.

3.5 Preservice and Inservice Inspections

The licensee described the PSI and ISI plans for the modified CRDM penetration number 5. The proposed examinations will be conducted in accordance with ASME Code Case N-729-6, as incorporated by reference in 10 CFR 50.55a, with appropriate consideration of the IDTB weld geometry.

The licensee stated that PSI will be performed following completion of the modification and prior to plant restart. The PSI will include surface examination of the repaired region and a volumetric UT leak path examination to confirm the integrity of the pressure boundary.

Following plant restart, ISI examinations will be performed in accordance with the requirements of ASME Code Case N-729-6, Table 1. The licensee stated that the inspection region will be adjusted, as necessary, to account for the IDTB weld configuration and will include the repaired region and adjacent areas susceptible to PWSCC. The examination methods will include UT and surface examinations, as applicable.

The licensee stated that the materials used in the repair, including Alloy 52M weld metal and Alloy 690 replacement nozzle material, are highly resistant to PWSCC. In addition, rotary peening is applied to the repaired region to introduce compressive residual stresses and further mitigate the potential for crack initiation.

The NRC staff finds that the proposed PSI and ISI approach, which includes examinations of the repaired region using qualified volumetric and surface examination methods in accordance with ASME Code Case N-729-6, provides reasonable assurance of the structural integrity and leak-tightness of the modified configuration for CRDM penetration number 5.

3.6 Flaw Characterization and Successive Examination - As-left J-Groove Weld Flaw Evaluation

The licensee performed a flaw evaluation of the remnant J-groove weld in accordance with the analytical procedures of ASME Code, Section XI, IWB-3600. Because qualified volumetric examination techniques are not available to characterize flaws in the original nozzle-to-RVCH J-groove weld, the licensee conservatively postulated a bounding radial-axial corner flaw extending through the entire J-groove weld and buttering. Crack growth was assumed to propagate into the adjacent low-alloy steel (LAS) RVCH material by fatigue crack growth under cyclic loading conditions.

The licensee evaluated fatigue crack growth using the crack growth rates for ferritic materials in a primary water environment specified in ASME Code, Section XI, Nonmandatory Appendix A, Subarticle A-4300. The evaluation considered a bounding CRDM nozzle configuration, including postulated flaws on the uphill and downhill sides of the J-groove weld, and included additional conservatism by accounting for potential general corrosion of the exposed LAS base metal. The results of the linear elastic fracture mechanics (LEFM) analysis, performed in accordance with IWB-3612, demonstrated that the postulated flaw remains acceptable through the end of the 60-year licensed operating life until 2031. The licensee's analysis showed that the safety margin on the applied stress intensity factor was 2.39 compared to the required safety margin of $\sqrt{2}$ (1.41).

Additionally, a limit load analysis performed in accordance with IWB-3610(d)(2) confirmed that the modified configuration satisfies the primary stress limits of NB-3000, assuming a local membrane area reduction equal to the area of the flaw. Due to the impracticality of characterizing flaw geometry in accordance with IWB-3420, the licensee requested relief from flaw characterization specified in IWB-3420 and from the subsequent examination requirements specified in IWB-2420(b) and IWB-2420(c). The licensee also stated that successive examinations required by IWB-3132.3 will not be performed on the modified nozzle for the life of the modification. The licensee's basis for this request is the bounding nature of the analysis, which assumes a worst-case flaw at the outset and demonstrates acceptability for continued operation.

Finally, the licensee evaluated the potential for debris generation from a cracked J-groove weld remnant. Radial cracks were postulated due to dominant hoop stresses, while transverse cracking was considered remote because of minimal driving forces. The licensee further stated that radial cracks would relieve the driving forces for potential transverse cracks, that there are no known service conditions that would cause the cracks to intersect and produce a loose part, and that extensive operating experience with remnant J-groove welds has identified no known cases of debris generation due to PWSCC.

Based on the information provided, the NRC staff finds that the licensee's use of a bounding flaw evaluation, which conservatively postulates a flaw extending through the full J-groove weld and buttering, provides a technically acceptable basis for ensuring the structural integrity of the RVCH. The staff further finds that, because qualified volumetric examination techniques are not available to characterize flaws in the remnant nozzle-to-RVCH J-groove weld, the licensee's detailed LEFM analysis in accordance with IWB-3612 and limit load analysis in accordance with IWB-3610(d)(2) provide an adequate basis to demonstrate that the postulated worst-case flaw remains acceptable for the remainder of the 60-year licensed operating life until 2031.

Therefore, the NRC staff finds that the requested relief from flaw characterization specified in IWB-3420 and from the subsequent examination requirements specified in IWB-2420(b) and IWB-2420(c) is justified, and that the licensee's analysis provides reasonable assurance of the structural integrity of the component for the remainder of the licensed operating period until 2031.

3.7 PWSCC Evaluation

The licensee performed an evaluation of PWSCC initiation and growth for the CRDM penetration number 5 modification. The evaluation assumed that the compressive stress layer produced by rotary peening could only be removed by general corrosion of the peened surface. Crack initiation and growth were postulated to begin only after complete loss of the compressive stress layer. The results showed that the time required to remove the compressive stress layer by general corrosion greatly exceeds the duration of one operating cycle. Accordingly, PWSCC initiation and growth are not expected to challenge structural integrity during this period.

The NRC staff notes that the analysis used for MRP-335, Revision 3-A, considers the potential for minor surface flaws that may not be detected by nondestructive examination. The prescribed follow-up examinations during the first and second refueling outages following application of rotary peening provide reasonable assurance that any such flaws would be detected prior to challenging the structural integrity of the component.

Regarding the qualification of the rotary peening process in accordance with MRP-335, Revision 3-A, the licensee confirmed that an application-specific qualification report was developed demonstrating that the rotary peening process meets the performance criteria specified in Section 4.3.8 of MRP-335, Revision 3-A. These criteria include the magnitude and depth of compressive residual stress, sustainability of stress improvement, ultrasonic testing inspectability, and the absence of adverse effects on the material or nondestructive examination capability. The NRC staff finds that compliance with MRP-335, Revision 3-A provides reasonable assurance that the rotary peening process will achieve the intended stress mitigation and will not adversely affect the structural integrity of the nozzle.

Based on the licensee's evaluation, the materials used in the modification (Alloy 52M weld metal and Alloy 690 replacement nozzle), and the application of rotary peening, the NRC staff finds that the potential for PWSCC initiation and growth does not challenge the structural integrity of the modified configuration during one operating cycle. This conclusion is consistent with, and supports, the one-cycle justification associated with the OD anomaly condition.

3.8 One-Cycle Justification, Outer Diameter Anomaly

During preservice ultrasonic testing of CRDM penetration number 5, the licensee identified an OD indication located approximately 2.2 inches above the upper triple point. The indication was detected circumferentially around the nozzle and could not be fully characterized using nondestructive examination techniques in accordance with ASME Code, Section XI, IWB-3420. Specifically, ultrasonic testing did not identify definitive tip signals, and the indication did not exhibit characteristics consistent with a clearly defined planar flaw.

Because the indication could not be fully characterized, the licensee conservatively postulated a bounding flaw for evaluation purposes. The postulated flaw was assumed to be a 0.110-inch-deep flaw extending circumferentially around the nozzle OD at the axial location of the indication. The licensee stated that this bounding assumption is consistent with the demonstrated capability of the ultrasonic examination techniques and provides a conservative basis for structural integrity evaluation.

The licensee performed a fracture mechanics evaluation in accordance with ASME Code, Section XI, IWB-3600 to assess the acceptability of the postulated flaw. The analysis considered the effects of residual stresses associated with the roll expansion process, operating loads, and potential crack growth mechanisms, including both fatigue crack growth and PWSCC. The licensee's evaluation applied PWSCC crack growth rates consistent with ASME Code guidance and included an environmental factor to account for potential exposure to primary coolant.

The results of the licensee's fracture mechanics evaluation demonstrate that the postulated flaw will not grow to an unacceptable size and will not challenge the structural integrity of the nozzle for at least one operating cycle (18 months). The evaluation shows that the structural margins remain within the acceptance criteria of ASME Code, Section XI for the duration of the one-cycle period. The licensee's analysis concluded that the anomaly would not challenge the structural integrity of the penetration nozzle for the duration of the proposed alternative.

The NRC staff notes that the OD anomaly is not expected to be exposed to primary coolant under normal operating conditions and that PWSCC growth would require the presence of a leak path through the pressure boundary. Therefore, PWSCC growth at the location of the anomaly is conditional upon the occurrence of leakage. The staff further notes that, in the absence of a leak path, the environmental conditions necessary to support PWSCC initiation and growth are not present, and fatigue crack growth remains the controlling degradation mechanism. Therefore, the NRC staff finds the licensee's evaluation methodology conservative for the anomaly.

The NRC staff reviewed the licensee's fracture mechanics evaluation, including bounding flaw assumptions and applied crack growth rates, and finds that the evaluation appropriately accounts for the uncertainties associated with the inability to fully characterize the indication. The NRC staff further confirmed that the evaluation was conducted using appropriate technical rigor, consistent with ASME Code methodologies. The NRC staff also performed confirmatory evaluations of key assumptions, including consideration of the sensitivity of the results to variations in flaw size, crack growth behavior, and residual stress conditions, thereby providing additional assurance that the analysis conservatively bounds potential flaw behavior. The NRC staff's evaluation concurs with the licensee's assessment that the anomaly would not challenge the structural integrity of the penetration nozzle for the duration of the proposed alternative.

Because the flaw cannot be fully characterized, the licensee requested relief from the flaw characterization requirements of IWB-3420. In addition, the licensee requested relief from the successive examination requirements of IWB-2420(b), IWB-2420(c), and IWB-3132.3 for the duration of the one-cycle justification. The licensee committed to perform future evaluations and inspections, as necessary, to support continued operation beyond the initial operating cycle.

Based on the information provided, the NRC staff finds that the licensee's use of a bounding flaw evaluation provides a technically acceptable basis for addressing the OD anomaly. The staff further finds that the fracture mechanics evaluation, including consideration of conservative assumptions and potential variability in flaw behavior, demonstrates that the postulated flaw will remain stable and will not challenge structural integrity for one operating cycle. Therefore, the NRC staff concludes that the requested relief from flaw characterization and successive examination requirements is justified for the duration of one operating cycle, and that the licensee has provided reasonable assurance of structural integrity for CRDM penetration number 5 under the proposed alternative.

3.9 Corrosion Evaluation

The licensee explained that the IDTB nozzle modification leaves an annular crevice between the RVCH and the replacement lower nozzle, which exposes a small area of the RVCH low-alloy steel base material to primary coolant. The licensee performed an evaluation to assess potential corrosion mechanisms for the wetted low-alloy steel surface.

The licensee determined that galvanic corrosion, hydrogen embrittlement, stress corrosion cracking (SCC), and crevice corrosion are not expected to be of concern for the modified configuration. With respect to galvanic corrosion, results from the NRC's boric acid corrosion program, as well as supporting studies, demonstrate that the galvanic potential differences among SA-533 Grade B Class 1, Alloy 600, and stainless-steel cladding materials are not significant contributors to corrosion. Hydrogen embrittlement is not expected because high-strength steels are most susceptible, whereas low-alloy steels with high toughness are not prone to hydrogen-induced cracking under normal pressurized water reactor (PWR) conditions. SCC of RVCH low-alloy steels has not been observed in decades of PWR operating experience, and no ASME Code or NRC requirements exist for this degradation mechanism in RVCH steels. Crevice corrosion is also not expected due to the low oxygen content of PWR environments; in addition, the exposed low-alloy steel surfaces will passivate, further reducing susceptibility.

The licensee indicated that general corrosion of the exposed low-alloy steel may occur within the crevice between the IDTB weld and the original J-groove weld. However, the rate of corrosion is expected to decrease over time as corrosion products accumulate, restricting reactor coolant flow into the crevice. A conservative sustained corrosion rate was applied in the ASME Code, Section III analysis, and the resulting increase in bore diameter was accounted for in reinforcement calculations in accordance with NB-3330. The lack of oxygen, combined with the tight geometry and the passivation of the exposed surface, is expected to further reduce long-term corrosion rates.

Based on the above evaluation, the NRC staff finds that the licensee has provided adequate justification that general corrosion of the exposed RVCH low-alloy steel will not compromise the structural integrity of the vessel head penetration modification for CRDM penetration number 5. The evaluation demonstrates that corrosion mechanisms other than general corrosion are not applicable, and that general corrosion will be self-limiting over time. Therefore, the staff concludes that the effect of corrosion on the modified configuration is negligible for the life of the modification.

4. CONCLUSION

As set forth above, the NRC staff determined that the proposed alternative, as described in the licensee's Relief Request RR-5-13, for the use of the IDTB welding process with rotary peening stress improvement for CRDM penetration number 5 at PNP, provides an acceptable level of quality and safety. The NRC staff finds that, for the general half-nozzle modification, including the welding process, triple point anomaly, remnant J-groove weld evaluation, and corrosion considerations, the proposed alternative provides reasonable assurance of structural integrity and leak-tightness for the remainder of the licensed operating period ending in 2031. However, with respect to the OD anomaly identified for CRDM penetration number 5, the NRC staff finds that the licensee's flaw evaluation and associated fracture mechanics analysis provide reasonable assurance that the condition will not challenge structural integrity for one operating cycle (18 months). Therefore, the NRC staff concludes that the requested relief from flaw characterization and successive examination requirements are acceptable for the duration of one operating cycle.

Accordingly, the NRC staff concludes that the licensee has adequately addressed the regulatory requirements in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of the proposed alternative, RR 5-13, for CRDM penetration number 5 at PNP, for one cycle of operation (18 months).

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

Date: May 1, 2026

ILKA BERRIOS

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Ilka Berrios, Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

cc: Listserv

PALISADES NUCLEAR PLANT – APPROVAL OF RELIEF REQUEST RR-5-13, HALF-NOZZLE REPAIR OF REACTOR VESSEL CLOSURE HEAD CONTROL ROD DRIVE MECHANISM PENETRATION NUMBER 5 - ONE-CYCLE JUSTIFICATION (EPID L-2026-LLR-0010) DATED MAY 1, 2026

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