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NUCLEAR REGULATORY COMMISSION
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PALISADES NUCLEAR PLANT - APPROVAL OF RELIEF REQUEST RR-5-9, HALF-NOZZLE REPAIR OF REACTOR VESSEL CLOSURE HEAD PENETRATIONS - LIFE OF PLANT JUSTIFICATION (EPID L-2025-LLR-0074)

LICENSEE INFORMATION

Licensee: Holtec Palisades, LLC

Licensee Address: Site Vice President
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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: July 31, 2025; supplemented January 19, 2026, and February 27, 2026.

Submittal Agencywide Documents Access and Management System (ADAMS) Accession Nos.: ML25212A024, ML26019A041, and ML26058A172, respectively.

Licensee Proposed Alternative No. or Identifier: Relief Request RR-5-9.

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 grain 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 3(c) states that a maximum interpass temperature shall be used and monitored during welding.

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 July 31, 2025, Holtec Palisades, LLC (the licensee) submitted Relief Request RR-5-9 for PNP, as supplemented by letters dated January 19, 2026, and February 27, 2026. PNP permanently ceased operations in May 2022. The licensee 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 proposes to implement preemptive modifications to 45 nozzles associated with the control rod drive mechanism (CRDM) (Identification numbers 1-4, 6-16, 18-24, 26-28, 31, 32, 35 and 37-53) and in-core instrument (ICI) penetrations. This relief request excludes RVCH VHP nozzle No. 5, which is addressed in Relief Request 5-13 (ML26051A072).

The modification technique, referred to as the half-nozzle repair, has been previously applied at PNP during prior outages (2004, 2018, and 2020) 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 will perform 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 will apply rotary peening to the inside diameter surface of the repaired region. Rotary peening has previously been applied at PNP during the 2018 half-nozzle repairs (nozzles 25, 33, and 36) and is recognized by the NRC staff as a surface stress improvement technique that introduces compressive residual stresses and mitigates PWSCC initiation. Rotary peening will also be applied retroactively to previously repaired nozzles (17, 29, 30, and 34) to ensure consistent stress mitigation across the reactor vessel closure head.

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 the life of the plant. The licensee requested that the duration of the alternative be the remainder of the 60-year licensed operational life of PNP (until 2031) plus an additional 20-year operational life extension. However, because no additional license extension has been granted for PNP at this time, the NRC staff is evaluating the alternative for approval through the end of PNP's current 60-year licensed operational life until 2031.

The staff notes that the January 19, 2026, and February 27, 2026, supplements included additional information and addenda associated with CRDM nozzles 4 and 8. These describe

nozzle-specific repair conditions and proposed alternatives that are evaluated separately 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.

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 an 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. The NRC staff notes that, during the modification, additional repair activities (weld buildup) were required for CRDM nozzles 4 and 8 and these repairs resulted in conditions that differ from the standard half-nozzle modification. Nozzles 4 and 8 are evaluated separately below to confirm that these nozzle-specific conditions remain bounded by, or are otherwise acceptable relative to, the general analyses supporting this relief request. The licensee clarified that any additional repairs performed to address fabrication defects, including localized excavation and rewelding, will also remain bounded by the existing fracture mechanics, fatigue, corrosion, and PWSCC evaluations, or was evaluated to ensure that the most limiting conditions are addressed.

The licensee requested approval of Relief Request RR-5-9 as an alternative to the ASME Code repair and replacement requirements for the RVCH. The modification involves removal of the lower portion of each Alloy 600 nozzle, welding of a replacement Alloy 690 lower nozzle with Alloy 52M filler metal, rotary peening of the roll-expanded regions, and preservice inspections (PSI) and inservice inspections (ISI) in accordance with Code Case N-729-6.

The licensee's supplements dated January 19, 2026, and February 27, 2026, provided additional technical justification specific to nozzles 4 and 8 due to out-of-tolerance conditions identified during the modification and repair process. Following the initial IDTB machining, the licensee identified that the inner diameters (IDs) of these nozzles (2.891 inches for nozzle 4 and 2.884 inches for nozzle 8) exceeded the 2.877-inch maximum diameter qualified for the ASME Code Section III ultrasonic (UT) acceptance examination. To restore the IDs to a value within the qualified UT range, the licensee performed an Alloy 52M weld buildup over the Alloy 600 nozzle ID. The NRC staff reviewed these nozzle-specific deviations and the associated

analyses to determine whether the proposed alternative continues to provide 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-5-9, including the staff's review of the welding requirements, acceptance examinations, triple point anomalies, flaw characterization of remnant J-groove welds, general corrosion of exposed low-alloy steel, and PWSCC initiation and growth in the modified nozzles, 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% to 1.0% 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.

In order 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 modifications. 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 modifications 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 Code Case. In addition, the Framatome welding procedure demonstrates acceptable HAZ toughness in accordance with the Code Case. Therefore, the NRC staff concludes that the proposed welding procedure provides reasonable assurance of structural integrity and safety of the repair for the remainder of PNP's 60-year licensed operational life until 2031.

3.2 Interpass Temperature

The licensee requested relief from the interpass temperature monitoring requirements of ASME Code Case N-638-11, paragraph 3C, specifically for the weld buildup applied to the Alloy 600 nozzle for nozzles 4 and 8 only. The NRC staff reviewed the licensee's basis that this buildup consists of a P-No. 43-to-P-No. 43 weld using austenitic materials. Per ASME Code, Section IX, interpass temperature is a supplementary essential variable only when the construction code requires impact testing, such as ferritic material. Since ASME Code, Section III, NB-2300, does not require impact testing for austenitic or nonferrous materials, the NRC staff finds that omitting interpass temperature monitoring for this specific non-ferritic weld buildup for nozzles 4 and 8 provides an acceptable level of quality.

3.3 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 was a white paper that provided detailed technical information for not performing 48-hour hold times, as well as industry's operational experience on similar repairs in support of ASME Code Case N-888-1. The NRC staff found the licensee's basis for the proposed repair to be consistent with previous NRC approvals for the elimination of the 48-hour hold time since when austenitic weld metal is used, the level of diffusible hydrogen content in the ferritic base metal HAZ is too low to promote hydrogen induced cracking. The NRC staff's conclusion is 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. Given this basis, the NRC staff finds the elimination of the 48-hour hold time requirements of ASME Code Case N-638-11 to be acceptable.

3.4 Acceptance Examination of IDTB Weld Repair

The licensee stated that the acceptance examination of the IDTB weld repair follows the requirements in 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 these partial penetration welds.

The modified VHP geometry of the partial penetration welds at PNP that are the subject of Relief Request RR 5-9 is suitable for ultrasonic testing (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° L-wave transducer to detect potential under-bead cracking and lack of fusion in the HAZ. The licensee reported that the UT configuration provides essentially 100 percent 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: (1) the examinations use the provisions of ASME Code Case N-638-11; (2) the examination volume, including the 0.25-inch low-alloy steel region beneath the weld, is sufficient to identify lack of fusion or under-bead cracking; and (3) the acceptance criteria are consistent with ASME Code, Section III construction code requirements. The staff finds that these examination methods are also applicable to the repaired regions associated with nozzles 4 and 8, as the same inspection techniques and acceptance criteria are applied to ensure weld integrity. The licensee's proposed approach provides reasonable assurance of the structural integrity and acceptability of the modified VHP welds for the remainder of PNP's 60-year licensed operational life until 2031, consistent with NRC staff approvals for similar half-nozzle repair activities.

3.5 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 the 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 the most limiting nozzle configurations, including the outermost CRDM penetration and ICI penetration. The analyses postulated a 0.10-inch-deep crack-like defect initiating at the triple point and considered both 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.

The results demonstrated that the triple point anomaly remains acceptable for the remainder of PNP's 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 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.

During the volumetric UT examination of Nozzle 8, a rejectable lower triple point indication was identified at 0.106 inches. Consequently, the licensee updated the flaw evaluation to bound a 0.15-inch anomaly for nozzle 8, increased from the original 0.10-inch assumption used for the rest of the nozzles. The NRC staff reviewed the updated fracture mechanics analysis and determined that with the 0.15-inch postulated flaw, the configuration maintains acceptable fracture toughness and limit load margins per ASME Code, Section XI for the remainder of PNP's 60-year licensed operational life until 2031.

Based on these analyses, the NRC staff finds that the licensee has adequately demonstrated that postulated triple point anomalies of up to 0.15 inches in depth will remain stable and within ASME Code, Section XI acceptance criteria for PNP's 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 structural integrity with respect to the triple point anomaly.

3.6 Preservice and Inservice Inspections

The licensee described the PSI and ISI plans for the modified CRDM and ICI nozzles, including those nozzles previously repaired in 2004, 2018, and 2020. The proposed examinations will be conducted in accordance with ASME Code Case N-729-6, as approved by the NRC in 10 CFR 50.55a, with modifications for the IDTB weld geometries.

The licensee stated that nozzles 25, 33, and 36 underwent rotary peening mitigation in 2018, with PSI liquid penetrant examinations performed prior to peening and visual examinations performed after peening, as recommended by EPRI MRP-335, Revision 3-A (ML131260010). Successive ISI volumetric examinations using UT were performed in 2020 on these nozzles, with no flaws detected. As part of the current modification activities, all remaining RVCH VHPs will be mitigated by rotary peening, and PSI will be performed prior to peening, as required by MRP-335, Revision 3-A. The licensee stated that ISI examinations will be performed during both the first and second refueling outage after rotary peening, consistent with the MRP-335, Revision 3-A requirements.

Post-modification, the nozzles will fall under the requirements of Code Case N-729-6, Table 1, Item B4.60. This item permits either volumetric or surface examinations, and the licensee stated that the inspection region will be modified for the IDTB weld configuration. For newly repaired nozzles (1-4, 6-16, 18-24, 26-28, 31, 32, 35, and 37-53), PSI and ISI examination surfaces will extend up to 0.81 inches above the roll transition (greater than 1.5 inches above the modification weld), and 1.5 inches below the structural weld. For previously repaired nozzles (17, 25, 29, 30, 33, 34, and 36), the PSI and ISI examination surfaces will extend up to 0.81 inches above the roll transition and 1.0 inch below the structural weld. In all cases, the examination coverage includes the rotary peened surfaces.

The licensee justified examination coverage of 1.0 to 1.5 inches below the structural weld as sufficient because (1) the modification weld material (Alloy 52M) is highly resistant to PWSCC; (2) the replacement nozzle material (Alloy 690) is highly resistant to PWSCC; and (3) the replacement nozzle is not pressure-retaining.

Prior to restart of plant operations at PNP, PSI of all modified VHPs and ISI of nozzles 25, 33, and 36 will be performed using a surface examination followed by a UT leak path examination, as shown in Figures 9 and 10 of the initial submittal. Future ISI examinations of all CRDM and ICI nozzles will be performed using the same methods and in compliance with Code Case N-729-6, as modified by 10 CFR 50.55a(g)(6)(ii)(D).

For the nozzles 4 and 8 configurations, the licensee clarified that PSI and ISI examination surfaces, as well as rotary peening mitigation, will extend at least 2.0 inches above the uppermost weld buildup extent. This expanded coverage (exceeding the 0.81-inch extent used for other VHPs) ensures that the entire weld buildup and the transition into the unconstrained portion of the nozzle are fully mitigated and examined. The NRC staff finds that these nozzle-specific modifications and the associated updated flaw evaluations for nozzles 4 and 8 provide reasonable assurance of structural integrity and leak-tightness, consistent with the requirements of 10 CFR 50.55a(z)(1).

The NRC staff finds that the proposed PSI and ISI approach, which includes examinations of the rotary peened regions and extends above the roll transition, provides adequate assurance of the structural integrity and leak-tightness of the modified nozzles.

3.7 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 the worst-case CRDM outermost nozzle penetration and the ICI 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 PNP's 60-year licensed operating life until 2031. The licensee's analysis showed that the safety margins on the applied stress intensity factor were 1.52 for the ICI location and 2.39 for the CRDM location, 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 the 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 the successive examinations required by IWB-3132.3 will not be performed on the modified nozzles for the life of the modifications. 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 PNP's 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 its intended use for the remainder of the operating license window for PNP until 2031.

3.8 PWSCC Evaluation

The licensee performed an evaluation of PWSCC initiation and growth for the VHP modifications. The licensee stated that the analysis assumed that the compressive stress layer produced by 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 remaining licensed life of the plant. Accordingly, no PWSCC flaw could propagate to the 75 percent through-wall acceptance limit during the intended service life of the modification.

The NRC staff notes that the analysis used for MRP-335, Revision 3-A, included PWSCC minor surface flaws that may be missed by nondestructive examination. The technical basis for the follow-up examinations during the first and second refueling outages following application of peening, as well as the first ISI interval examination after peening are sufficient to address any hypothetical flaws prior to challenging the structural integrity of the RVCH and VHP nozzles.

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, lack of adverse effects on the material and nondestructive examination qualification.

The NRC staff finds 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 nozzles.

Based on these results, the NRC staff finds that the licensee has adequately demonstrated that rotary peening remediation provides effective mitigation of PWSCC initiation and growth in the modified VHPs. The analysis supports the conclusion that, with peening, the repaired nozzles will maintain structural integrity and remain acceptable for the remainder of PNP's 60-year licensed operational life until 2031.

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. An evaluation was performed for similar prior repairs 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 VHP modifications. 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 remainder of PNP's 60-year licensed operational life until 2031..

4. CONCLUSION

As set forth above, the NRC staff determined that the proposed alternative, as described in the licensee's Relief Request RR-5-9, as supplemented, for the use of the IDTB welding process with rotary peening stress improvement on the Palisades RVCH penetration nozzles, is acceptable on the basis that the proposed alternative provides an acceptable level of quality and safety. The NRC staff finds that the proposed alternative provides reasonable assurance of the structural integrity and leak-tightness of the modified nozzles for the remainder of the licensed operating period of PNP, which ends in 2031.

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 for the PNP RVCH VHP modifications, covering the 45 nozzles identified in Relief Request RR-5-9.

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: April 8, 2026

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-5-9, HALF-NOZZLE REPAIR OF REACTOR VESSEL CLOSURE HEAD PENETRATIONS - LIFE OF PLANT JUSTIFICATION (EPID L-2025-LLR-0074) DATED APRIL 8, 2026

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