



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

July 21, 2025

ANO Site Vice President
Arkansas Nuclear One
Entergy Operations, Inc.
N-ADM-8
1448 S.R. 333
Russellville, AR 72802

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 2 – AUTHORIZATION OF REQUEST FOR
ALTERNATIVE ANO2-ISI-24-02 REGARDING EXTENSION OF REACTOR
VESSEL INSERVICE INSPECTION INTERVAL (EPID L-2024-LLR-0048)

Dear Sir or Madam:

By letter dated July 19, 2024 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML24201A052), Entergy Operations, Inc. (Entergy, the licensee), submitted proposed Alternative ANO2-ISI-24-02 to the U.S. Nuclear Regulatory Commission (NRC), requesting the use of an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) to extend the inservice inspection (ISI) interval for the Arkansas Nuclear One, Unit 2 (ANO-2) reactor pressure vessel weld examinations from 2027 to the end of the current renewed operating license in 2038.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed Alternative ANO2-ISI-24-02 for the fifth and sixth 10 year ISI intervals at ANO-2 for ASME Code, Section XI, "Inservice Inspection of Nuclear Power Plant Components," table IWB-2500-1, Examination Categories B-A and B-D, on the basis that the alternative provides an acceptable level of quality and safety. The item numbers in scope of Examination Categories B-A and B-D are in the reactor vessel (RV) and RV welded nozzles at ANO-2.

As set forth in the enclosed safety evaluation, the NRC staff has determined that the licensee's proposed alternative would provide an acceptable level of quality and safety in lieu of complying with the ASME Code, Section XI requirements and inspection items specified and referenced in Alternative ANO2-ISI-24-02. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of the proposed Alternative ANO2-ISI-24-02 at ANO-2 for the fifth and sixth 10-year ISI intervals.

All other ASME Code, Section XI, requirements for which an alternative was not specifically requested and authorized remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the ANO-2 Project Manager, Hannah McLatchie, at 301-415-8507 or via email at Hannah.McLatchie@nrc.gov.

Sincerely,

Tony Nakanishi, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-368

Enclosure:
Safety Evaluation

cc: Listserv



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

REQUEST FOR ALTERNATIVE ANO2-ISI-24-02

REGARDING EXTENSION OF REACTOR VESSEL INSERVICE INSPECTION INTERVAL

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 2

DOCKET NO. 50-368

1.0 INTRODUCTION

By letter dated July 19, 2024 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML24201A052), Entergy Operations, Inc. (Entergy, the licensee), submitted proposed Alternative ANO2-ISI-24-02 to the U.S. Nuclear Regulatory Commission (NRC), requesting the use of an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) to extend the inservice inspection (ISI) interval for the Arkansas Nuclear One, Unit 2 (ANO-2) reactor pressure vessel (RPV) weld examinations from 2027 to the end of the current renewed operating license (NPF-6) in 2038.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed Alternative ANO2-ISI-24-02 for the fifth and sixth 10 year ISI intervals at ANO-2 for ASME Code, Section XI, "Inservice Inspection of Nuclear Power Plant Components," table IWB-2500-1, Examination Categories B-A and B-D, on the basis that the alternative provides an acceptable level of quality and safety. The item numbers in scope of Examination Categories B-A and B-D are in the reactor vessel (RV) and RV welded nozzles at ANO-2.

2.0 REGULATORY EVALUATION

Regulatory Requirements

Adherence to Section XI of the ASME Code is mandated by 10 CFR 50.55a(g)(4), "Inservice inspection standards requirement for operating plants," which states, in part, that ASME Code Class 1, 2, and 3 components will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI.

The regulations in 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," states, in part, that alternatives to the requirements of 10 CFR 50.55a(b) through (h) may be

Enclosure

used, when authorized by the Director, Office of Nuclear Reactor Regulation, if (1) the proposed alternatives would provide an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The regulation in 10 CFR 50.61, "Fracture toughness requirements for protection against pressurized thermal shock events," requires that the reference temperature of the RV materials be within specific values to protect RPV materials against pressurized thermal shock (PTS) events.

The regulation in 10 CFR 50.61a, "Alternate fracture toughness requirements for protection against pressurized thermal shock events," specifies alternate rules for protection against PTS events.

Regulatory Guidance

Regulatory Guide (RG) 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," dated May 1988 (ML003740284), specifies guidance on determination of embrittlement shift of RV materials due to irradiation.

RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 1, dated November 2002 (ML023240437), specifies guidance on assessment of risk-informed decisions on changes to the plant-specific current licensing basis.

NUREG-1874, "Recommended Screening Limits for Pressurized Thermal Shock (PTS)," dated March 2010 (ML15222A848), specifies recommended PTS screening limits for RV materials.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Affected

The affected components are the ANO-2 RV shell welds and nozzles associated with the following ASME Code, Section XI examination categories and item numbers. These examination categories and item numbers are from subarticle IWB-2500 and table IWB-2500-1 of the ASME Code, Section XI.

Examination Category	Item No.	Description
B-A	B1.10	Shell Welds
B-A	B1.11	Circumferential Shell Welds
B-A	B1.12	Longitudinal Shell Welds
B-A	B1.20	Head Welds
B-A	B1.21	Circumferential Head Welds
B-A	B1.22	Meridional Head Welds
B-A	B1.30	Shell-to-Flange Weld
B-A	B1.40	Head-to-Flange Weld
B-D	B3.90	Nozzle-to-Vessel Welds
B-D	B3.100	Nozzle Inside Radius Section

Note: Examination Category B-A welds are defined as “Pressure Retaining Welds in Reactor Vessel.” Examination Category B-D welds are defined as “Full Penetration Welded Nozzles in Vessels.”

3.2 Applicable ASME Code Edition and Addenda

The fifth 10-year ISI interval for ANO-2 is scheduled to end on March 25, 2030. The Code of record for the fifth 10-year ISI interval is ASME Code, Section XI, 2007 Edition through 2008 Addenda. The applicable Code for the sixth 10-year ISI interval will be selected in accordance with the requirements of 10 CFR 50.55a, “Codes and standards.”

3.3 Applicable ASME Code Requirement

Paragraph IWB-2411, Inspection Program, requires volumetric examination of essentially 100 percent of RV pressure-retaining welds identified in table IWB-2500-1 once each 10-year ISI interval.

3.4 Reason for Request

The licensee is requesting an alternative from the IWB-2411 Inspection Program that requires volumetric examination of essentially 100 percent of RV pressure-retaining Examination Categories BA and B-D welds once each 10-year ISI interval. The licensee stated that extension of the interval between examinations of Categories B-A and B-D welds from 10 years to up to 20 years will result in a reduction in radiation exposure and examination costs.

3.5 Proposed Alternative and Basis for Use

In section 5, “Proposed Alternative and Basis for Use,” of the enclosure to the submittal dated July 19, 2024 (“the submittal”), the licensee proposed to not perform the ASME Code required volumetric examination of the ANO-2 RV full penetration pressure-retaining Examination Categories B-A and B-D welds for the fifth 10-year ISI interval, currently scheduled for 2027. Instead, the licensee proposes to perform these volumetric examinations in 2038, during the third period of the sixth 10-year ISI interval, which will end on July 17, 2038.

The licensee stated that the proposed inspection date is within plus or minus one refueling outage of the latest revised implementation plan, OG-10-238, “Revision to the Revised Plan for Plant Specific Implementation of Extended Inservice Inspection Interval per WCAP-16168-NP, Revision 1, ‘Risk-Informed Extension of the Reactor Vessel In-Service Inspection Interval.’ PA-MS-0120” (ML11153A033). This implementation plan is used in conjunction with the use of the methodology in WCAP-16168-NP-A, “Risk-Informed Extension of the Reactor Vessel Inservice Inspection Interval,” Revision 3 (ML11306A084), hereafter referred to as “WCAP-A” in this safety evaluation (SE).

In accordance with 10 CFR 50.55a(z)(1), the licensee proposed an alternate (i.e., extended) ISI interval on the basis that the current interval can be revised with negligible change in risk by satisfying the risk criteria specified in RG 1.174. The licensee stated that the methodology used to conduct this analysis is based on that defined in WCAP-A. The licensee stated that the results of the calculations for ANO-2 were compared to those obtained from the Combustion Engineering (CE) pilot plant evaluated in WCAP-A. The licensee stated that the parameters for ANO-2 are bounded by the results of the CE pilot plant evaluation.

3.6 Duration of Proposed Alternative

The licensee stated that the requested alternative is applicable to the ANO-2 ISI program for the fifth and sixth 10-year ISI intervals.

3.7 NRC Staff Evaluation

The licensee's proposed extended ISI interval in ANO2-ISI-24-02 is based on a risk-informed RV fracture mechanics analysis that was performed in accordance with the NRC staff-approved, risk-informed flaw analysis methods in WCAP-A. The methodology in WCAP-A was developed by the Pressurized Water Reactor Owners Group (PWROG) to satisfy through-wall cracking frequency (TWCF) criteria, specifically the 95th percentile total TWCF (TWCF_{95-TOTAL}), for pressurized water reactors (PWRs) established in NUREG-1874 and the delta large early release frequency (Δ LERF) criteria specified in RG 1.174.

In section 3.4, "Submit Proposed Change," of the NRC staff's SE, dated July 26, 2011 (Package ML111610242), for WCAP-A (hereafter referred as "WCAP-A SE"), the staff specified plant-specific information that licensees must submit for alternative requests that are based on the methodology of WCAP-A. Tables A-1, A-2, and A-3 in appendix A of WCAP-A show the format used for providing the plant-specific information. The licensee provided the plant-specific information for ANO-2 in tables 1, 2, and 3 of section 5 "Proposed Alternative and Basis for Use," of the enclosure to the submittal. The staff evaluated the plant-specific information in the following subsections.

3.7.1 Identification of Limiting Design Basis Transients and Cladding Layers

Regarding the PTS transients, the licensee identified in table 1 of section 5 of the enclosure to the submittal, that the transients are defined in NRC Letter Report, "Generalization of Plant-Specific Pressurized Thermal Shock (PTS) Risk Results to Additional Plants" (ML042880482), hereafter referred as "PTS Generalization Study," and that those transients serve as the limiting design basis transients for the RV welds that were assessed in ANO2-ISI-24-02. The NRC staff verified that for CE-designed- PWRs, such as ANO-2, the PWROG's methodology in WCAP-A uses the PTS transients that were defined in NUREG-1874 and clarified in the PTS Generalization Study as the limiting PTS transients for the PWROG's risk-informed flaw analysis that was included in WCAP-A. Therefore, the staff finds the licensee's transient basis to be acceptable based on the information in NUREG-1874 and the PTS Generalization Study, and the staff's conclusions in the WCAP-A SE that the PTS transient characteristics for a given nuclear steam supply system (NSSS) design of U.S. PWR facilities are generically applicable for all PWRs designed by the same reactor NSSS vendor (i.e., CE for ANO-2).

Regarding the cladding layers, the licensee reported in table 1 of section 5 of the enclosure to the submittal that the cladding for the RV at ANO-2 was deposited using a single layer. The NRC staff confirmed that the RV cladding at the CE plant analyzed in WCAP-A was deposited using a single layer. Thus, for the proposed alternative, the staff concludes that the licensee did not need to evaluate the impacts that multiple pass layers would have on the design of the RV cladding at ANO-2 because: (1) the cladding layer at ANO-2 was deposited as a single layer, and (2) the design of the cladding layer at ANO-2 is consistent with and bounded by the staff's evaluation of the cladding layer in the WCAP-A SE.

3.7.2 Frequency and Severity of Design Basis Transients

In section 3.3, "Implementation and Monitoring," of the WCAP-A SE, the NRC staff stated, in part, that:

The number of transient cycles that were utilized in the fatigue crack growth analysis was discussed in Section 3.2.1 of this revised final SE. The PWROG used... 13 heat-up and cool-down cycles per year for CE-designed plants... Since the PWROG fatigue crack growth analysis of CE NSSS designed plants determined that the amount of crack growth from 13 cool-down transients bounds the expected crack growth from both cool-down and loss of secondary pressure transients, CE plants should monitor the number of cool-down transients.

In table 1 of section 5 of the enclosure to the submittal, the licensee indicated that the plant-specific basis for frequency and severity of design basis transients is bounded by the 13 cycles/reactor year of plant heatup and cooldown transients of the associated pilot plant assessed in WCAP-A.

The NRC staff confirmed that the PWROG established 13 cycles/reactor year as the maximum bounding number of heatup and cooldowns that could occur for CE-designed PWRs. Based on the discussion above, the staff finds that the plant-specific frequency and severity of design basis transients is bounded by the established 13 cycles/reactor year for CE-designed PWR units in WCAP-A.

3.7.3 Scope and Schedule for Inspecting the RV Welds During the 20-Year ISI Interval

In section 3.4 of the WCAP-A SE, the NRC staff stated that licensees should identify the ISI schedule for RV weld examinations that will be performed during the proposed 20-year ISI interval. The WCAP-A SE also established the staff's position that the dates for the weld inspections must be within one refueling cycle of the revised dates identified for inspection in the implementation plan in PWROG Letter No. OG-10-238 (ML11153A033).

In section 5 and in table 2 of the enclosure to the submittal, the licensee proposes not to perform required ASME Code volumetric examinations of the applicable RV weld components of ANO-2 for the fifth 10-year ISI interval currently scheduled for 2027. The licensee proposes instead to perform these volumetric examinations during the third period of the sixth 10-year ISI interval in 2038. The licensee stated that this proposed inspection date is in accordance with the implementation plan in PWROG Letter No. OG-10-238 since the plan reflects the next inspection for ANO-2 to be performed in 2038. The NRC staff confirmed that the 2038 inspection date is listed as the "Subsequent ISI Date" in PWROG Letter No. OG-10-238.

Based on the discussion above, the NRC staff finds that the licensee's proposed scope and schedule for inspecting the subject RV welds are acceptable because it aligns with the staff position in section 3.4 of the WCAP-A SE that inspections fall within one refueling cycle of the revised dates in PWROG Letter No. OG-10-238.

3.7.4 Relevant Operating Experience - Summary of ISI Results

In section 3.4 of the WCAP-A SE, the NRC staff established its position that a licensee submitting risk-informed ISI extension(s) for its RVs should report the results of its prior ISI inspections of the applicable RV weld locations.

In table 2 of the enclosure to the submittal, the licensee identified that it performed three 10-year ISIs. The licensee reported that four subsurface indications were noted during the most recent 10-year ISI but were originally identified during the second 10-year ISI interval. These subsurface indications are located in the intermediate shell-to-lower shell circumferential weld seam, the upper shell longitudinal weld seam, and the intermediate shell longitudinal weld seam. The licensee stated that the indications are acceptable per table IWB-3510-1 of Section XI of the ASME Code. One of the indications is not within the inner 1/10th or 1 inch of the RV thickness. The licensee reported that the three indications that are within the inner 1/10th or 1 inch of the RV thickness are acceptable per the requirements of the Alternate PTS Rule in 10 CFR 50.61a. The NRC staff reviewed the reported number of flaws compared to the scaled plant-specific total weld length (1,590 inches) in the inspection volume and the scaled plant-specific inside surface area in the inspection volume that are greater than the through wall extent (TWE) minimum and less than the TWE maximum and confirmed that they are bounded by table 2 and table 3 of 10 CFR 50.61a, as discussed in 10 CFR 50.61a(e)(1).

Based on the discussion above, the NRC staff finds the licensee's ISI results for the subject RV welds acceptable because the one subsurface indication that was detected outside the inner 1/10th or 1 inch of the RV thickness was acceptable per ASME Code, Section XI, and the three subsurface indications within 1/10th of 1 inch of the RV thickness were acceptable per ASME Code, Section XI and within the bounds specified in table 2 and table 3 of 10 CFR 50.61a.

3.7.5 Susceptibility to Underclad Cracking of RV Forgings

In section 3.4 of the WCAP-A SE, the NRC staff determined that licensees with RVs containing forgings that are susceptible to underclad cracking and have RT_{MAX-FO} values exceeding 240 degrees Fahrenheit (699.67 degrees Rankine) must submit a plant-specific evaluation because the analyses performed in the WCAP-A are not applicable (i.e., the scope of analyses in WCAP-A do not cover the evaluation of RV underclad cracks for forgings with high RT_{MAX-FO} values).

In table 3 of the enclosure to the submittal, the licensee lists the region and component description of the pieces which make up the RV. Item Nos. 1 through 9 are all plate material and item nos. 10 through 20 are fabrication welds. Based on the discussion above, the NRC staff finds that no further information was required to be submitted by the licensee to meet this condition of the WCAP-A SE.

3.7.6 Submittal of Information Required by 10 CFR 50.61a(e)

In section 3.4 of the WCAP-A SE, the NRC staff stated, in part, that "... [l]icensees seeking second or additional interval extensions shall provide the information and analyses requested in Section (e) of 10 CFR 50.61a [10 CFR 50.61a(e)]." The licensee states in the submittal that alternative request ANO2-ISI-24-02 is the second interval extension for ANO-2. The licensee has provided the information requested by 10 CFR 50.61a(e) in table 2 of the enclosure to the submittal and verified the information against ASME Code, Section XI or against table 2 and 3 of 10 CFR 50.61(a) as appropriate. The staff reviewed the information and analyses provided against the applicable sections of 10 CFR 50.61a(e) sections (1) through (3) and tables 2 and 3 and determined that the condition in section 3.4 of the WCAP-A SE is satisfied. The staff also reviewed the information provided in the submittal and determined that none of the conditions of 10 CFR 50.61a(e)(4) are applicable to the ANO-2 RV and therefore, the staff determined that the licensee does not need to include the information required by 10 CFR 50.61a(e)(4)-(6).

3.7.7 TWCF Evaluation

In section 3.4 of the WCAP-A SE, the NRC staff established its position that the maximum adjusted reference temperatures and 30 foot-pounds Charpy V-notch energy shifts in reference temperature values (i.e., RT_{MAX-X} and ΔT_{30} values, as defined in 10 CFR 50.61a) may be calculated using the methods documented in RG 1.99, Revision 2, or in an alternate NRC-approved methodology using these types of parameters. The WCAP-A SE also stated that licensees' submittals should include the material property and fluence information related to these parameters and that appendix A of WCAP-A (table A-3) identifies the information needed to be submitted.

In table 3 of the enclosure to the submittal, the licensee included the material property and neutron fluence data, ΔT_{30} values, and RT_{MAX-XX} values for the RV base metal and weld components of ANO-2 at 54 effective full power years. The licensee stated that material properties are based on WCAP-18169-NP Revision 1, "Arkansas Nuclear One Unit 2 Heatup and Cooldown Limit Curves for Normal Operation," dated June 2018 (ML18215A178).

The licensee calculated a $TWCF_{95-TOTAL}$ value of 5.99×10^{-13} per year for the RV, as shown in the last line of table 3 of the enclosure to the submittal. This $TWCF_{95-TOTAL}$ value is less than the limiting $TWCF_{95-TOTAL}$ value of 3.16×10^{-7} events per year approved in WCAP-A for CE plants. The NRC staff verified the calculations in the " $TWCF_{95-XX}$ " column of table 3 of the enclosure to the submittal and noted that the licensee's $TWCF_{95-XX}$ values were conservative compared to the staff's calculations. Therefore, the staff finds that the licensee's $TWCF_{95-TOTAL}$ value for the ANO-2 RV is acceptable.

The NRC staff noted that the methodology in WCAP-A conservatively sets the $TWCF_{95-TOTAL}$ equal to the $\Delta LERF$ value for the RV that may result from initiation of the postulated, limiting PTS event at a plant. Thus, based on the staff's independent calculations and verifications discussed above, the staff determined that the $TWCF_{95-TOTAL}$ value for the ANO-2 RV meets the limit of 1×10^{-7} early release events per reactor year that is established for $\Delta LERF$ values in RG 1.174.

3.7.8 Summary

Based on the evaluations in sections 3.7.1 through 3.7.7 of this SE, the NRC staff determined that the licensee has satisfied all plant-specific information items specified in the WCAP-A SE. Therefore, the staff finds that the licensee's proposed risk-informed alternative provides an acceptable level of quality and safety in lieu of complying with the ASME Code, Section XI requirements and inspection items specified and referenced in ANO2-ISI-24-02.

4.0 CONCLUSION

As set forth above, the NRC staff has determined that the proposed alternative in the licensee's request would provide an acceptable level of quality and safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of the proposed Alternative ANO2-ISI-24-02 at ANO-2 for the fifth and sixth 10-year ISI intervals.

All other ASME Code, Section XI, requirements for which an alternative was not specifically requested and authorized remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: S. Levitus, NRR

Date: July 21, 2025

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DATED JULY 21, 2025

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