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

September 19, 2019

Mr. Keith Jury
Vice President, Regulatory Assurance
Entergy Services, LLC
M-ECH-61
1340 Echelon Parkway
Jackson, MS 39213

SUBJECT: ARKANSAS NUCLEAR ONE, UNITS 1 AND 2; GRAND GULF NUCLEAR STATION, UNIT 1; INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3; PALISADES NUCLEAR PLANT; RIVER BEND STATION, UNIT 1; AND WATERFORD STEAM ELECTRIC STATION, UNIT 3 – RELIEF REQUEST NO. EN-19-RR-1, USE OF ASME CODE CASE N-831-1 (EPID L-2019-LLR-0009)

Dear Mr. Jury:

By application dated January 31, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19031C888), Entergy Operations, Inc. and Entergy Nuclear Operations, Inc. (Entergy, the licensee), submitted Relief Request No. EN-19-RR-1 in accordance with paragraph 50.55a(z)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR) for use of a proposed alternative to the requirements of Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) at Arkansas Nuclear One, Units 1 and 2; Grand Gulf Nuclear Station, Unit 1; Indian Point Nuclear Generating Unit Nos 2 and 3; Palisades Nuclear Plant; River Bend Station, Unit 1; and Waterford Steam Electric Station, Unit 3. The proposed alternative would allow the licensee to use ASME Code Case N-831-1, "Ultrasonic Examination in Lieu of Radiography for Welds in Ferritic Pipe, Section XI, Division 1," in lieu of specified ASME Code requirements.

Specifically, pursuant to 10 CFR 50.55a(z)(1), Entergy requested to use an alternative on the basis that the alternative would provide an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the proposed alternative and concludes, as set forth in the enclosed safety evaluation, that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of the proposed alternative described in the licensee's application for the remainder of the applicable 10-year inservice inspection interval listed in Section 3.1.2 of the enclosed safety evaluation, or until such time as the NRC approves ASME Code Case N-831-1 for general use through the revision of NRC Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," or other document.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested and authorized by NRC staff remain applicable, including a third party review by the Authorized Nuclear Inservice Inspector. The NRC staff notes that approval of this alternative does not imply NRC approval of ASME Code Case N-831-1 for generic use.

If you have any questions, please contact the Entergy fleet Project Manager, Margaret O'Banion, at 301-415-1233 or via e-mail at Margaret.O'Banion@nrc.gov.

Sincerely,

/RA/

Robert J. Pascarelli, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-313, 50-368, 50-416,
50-247, 50-286, 50-255,
50-458, and 50-382

Enclosure:
Safety Evaluation

cc: Listserv

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. EN-19-RR-1

PROPOSED ALTERNATIVE TO USE ASME CODE CASE N-831-1

ENTERGY OPERATIONS, INC.

ENTERGY NUCLEAR OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNITS 1 AND 2

GRAND GULF NUCLEAR STATION, UNIT 1

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3

PALISADES NUCLEAR PLANT

RIVER BEND STATION, UNIT 1

WATERFORD STEAM ELECTRIC STATION, UNIT 3

DOCKET NOS. 50-313, 50-368, 50-416, 50-247,

50-286, 50-255, 50-458, AND 50-382

1.0 INTRODUCTION

By application dated January 31, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19031C888), Entergy Operations, Inc. and Entergy Nuclear Operations, Inc. (Entergy, the licensee), submitted Relief Request No. EN-19-RR-1 in accordance with paragraph 50.55a(z)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR) for use of a proposed alternative to the requirements of Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) at Arkansas Nuclear One (ANO), Units 1 and 2; Grand Gulf Nuclear Station, Unit 1 (Grand Gulf); Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point, Units 1 and 2); Palisades Nuclear Plant (Palisades); River Bend Station, Unit 1 (River Bend); and Waterford Steam Electric Station, Unit 3 (Waterford 3). The proposed alternative would allow the licensee to use ASME Code Case N-831-1 "Ultrasonic Examination in Lieu of Radiography for Welds in Ferritic Pipe, Section XI, Division 1," in lieu of specified ASME Code requirements.

Specifically, pursuant to 10 CFR 50.55a(z)(1), Entergy requested to use an alternative on the basis that the alternative would provide an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

The U.S. Nuclear Regulatory Commission (NRC) staff considered the following regulatory requirements and guidance in its evaluation.

Pursuant to 10 CFR 50.55a(g)(4), "Inservice inspection standards requirement for operating plants," components (including supports) that are classified as ASME Code Class 1, Class 2, and Class 3 must meet the requirements in 10 CFR 50.55a throughout the service life of a boiling or pressurized water reactor. The exception is the design and access provisions and preservice examination requirements set forth in Section XI of editions and addenda of the ASME Code that become effective subsequent to editions specified in paragraphs (g)(2) and (3) of 10 CFR 50.55a, which are incorporated by reference in 10 CFR 50.55a(a)(1)(ii) to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(g)(4)(ii), "Applicable ISI [inservice inspection] Code: Successive 120-month intervals," inservice examination of components and system pressure tests conducted during successive 120-month inspection intervals must comply with the requirements of the latest edition and addenda of the ASME Code incorporated by reference in paragraph (a) of 10 CFR 50.55a 12 months before the start of the 120-month inspection interval (or the optional ASME Code Cases listed in NRC Regulatory Guide (RG) 1.147, "lnservice Inspection Code Case Acceptability, ASME Section XI, Division 1," when using ASME Code, Section XI, as incorporated by reference in paragraph (a)(3)(ii) of 10 CFR 50.55a, subject to the conditions listed in paragraph (b) of 10 CFR 50.55a.

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

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request and the NRC to authorize the alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 The Licensee's Request for Alternative

3.1.1 ASME Code Components Affected

ASME Code, Section XI, piping welds made of the ferritic steel or austenitic stainless steel that require radiography as part of a repair/replacement activity are affected.

3.1.2 Applicable Code Edition and Addenda – Duration of Relief Request

The licensee provided the Code of record, and the duration of this relief request for each plant in the table below.

Plant	10-Year ISI Interval	ASME Code of Record	Duration of Relief Request	
			Interval Started	Interval is Scheduled to End
ANO, Unit 1	5th	2007 Edition through 2008 Addenda	May 31, 2017	May 30, 2027
ANO, Unit 2	4th	2001 Edition through 2003 Addenda	March 26, 2010	March 25, 2020
ANO, Unit 2	5th	2007 Edition and 2008 Addenda	March 26, 2020	March 25, 2030
Grand Gulf	4th	2007 Edition through 2008 Addenda	December 1, 2017	November 30, 2026
Indian Point, Unit 2	5th	2007 Edition through 2008 Addenda	June 1, 2016	May 31, 2026
Indian Point, Unit 3	4th	2001 Edition through 2003 Addenda	July 21, 2009	July 20, 2021
Palisades	5th	2007 Edition through 2008 Addenda	December 13, 2015	December 12, 2025
River Bend	4th	2007 Edition through 2008 Addenda	December 1, 2017	November 30, 2027
Waterford 3	4th	2007 Edition through 2008 Addenda	December 1, 2017	November 30, 2027

The licensee stated in a letter dated July 12, 2017 (ADAMS Accession No. ML17174B144), that the NRC authorized ANO, Unit 2, and Indian Point, Unit 3, to perform their nondestructive examinations, pressure testing, and repair/replacement activities in accordance with the 2007 Edition through 2008 Addenda of Section XI during the fourth 10-year ISI interval.

The licensee stated in a letter dated July 18, 2018 (ADAMS Accession No. ML18193B030), that the NRC authorized Indian Point, Unit 3, to extend its fourth 10-year ISI interval to July 20, 2021.

The licensee stated that the fifth 10-year ISI interval at ANO, Unit 2, is presently scheduled to begin on March 26, 2020, at which time ANO, Unit 2, plans to update its Code of record to the 2007 Edition and 2008 Addenda of ASME Code, Section XI. By letter dated September 6, 2018 (ADAMS Accession No. ML18249A293), the licensee submitted Relief Request ANO2-ISI-021 for NRC review and approval. By letter dated June 11, 2019 (ADAMS Accession No. ML19156A400), the NRC authorized use of the 2007 Edition and 2008 Addenda of ASME Code, Section XI, for the fifth 10-year ISI interval of ANO, Unit 2.

3.1.3 ASME Code Requirement

The ASME Code requirements applicable to repair/replacement activities originate in IWA-4000 of Section XI. Paragraph IWA-4221, “Construction Code and Owner’s Requirements,” of the ASME Code, Section XI, 2001 Edition through 2003 Addenda and 2007 Edition through 2008 Addenda, requires that items used for repair/replacement activities meet the applicable

construction code requirements when performing repair/replacement activities. Paragraph IWA-4520, "Examination," requires that welded joints made for fabrication or installation of items be examined in accordance with the construction code.

3.1.4 Licensee's Proposed Alternative

The licensee proposed to utilize ASME Code Case N-831-1 requirements to perform the volumetric examination of the ferritic steel or austenitic stainless steel piping welds during repair/replacement activity. This code case requires use of the encoded phased array ultrasonic testing (UT) technique as an alternative to the Code-required radiographic testing (RT). ASME Code Case N-831-1 has not been incorporated by reference into 10 CFR 50.55a via inclusion in RG 1.147, Revision 18.

3.1.5 Basis for Use of Alternative

The licensee stated that the use of proposed encoded phased array ultrasonic testing (PAUT) for the volumetric examinations of the ferritic or austenitic piping repair/replacement welds would eliminate the safety risk associated with the use of Code-required RT, which includes both planned and unplanned radiation exposure to plant workers. In addition, the use of proposed encoded PAUT significantly minimizes the impact on other refueling outage activities as compared to the use of Code-required RT.

The licensee stated that the technical basis for the proposed alternative was developed from numerous codes and code cases, associated industry experience, research articles, and the results of welds examinations by the ultrasonic and radiography techniques. The encoded PAUT has been known to be equivalent or superior to the Code-required RT for detecting and sizing critical (planar) flaws such as cracks and lack of fusion. The encoded PAUT provides sizing capabilities for both depth and length dimensions of the flaw, which is required to apply the applicable acceptance criteria of the ASME Code, Section XI. However, RT does not have the flaw depth sizing capabilities.

The licensee stated that ASME Code Case N-831-1 requires the proposed encoded PAUT procedures, equipment, and personnel be qualified by the performance demonstration using representative piping conditions and flaws. Such an approach will demonstrate the ability of the encoded PAUT to detect and accurately size flaws that are both acceptable and unacceptable to the defined acceptance standards.

3.2 NRC Staff Evaluation

The NRC staff has evaluated this relief request pursuant to 10 CFR 50.55a(z)(1) to ensure the proposed alternative provides an acceptable level of quality and safety. In evaluating the licensee's proposed alternative, the NRC staff focused on the following two aspects of the licensee's basis: (1) effectiveness of encoded PAUT on the repair/replacement weld inspection; and (2) assurance of detection of structurally-significant fabrication flaws in ferritic steel or austenitic stainless steel piping welds by encoded PAUT. The NRC staff finds that if these two criteria are met, the proposed alternative will provide an acceptable level of quality and safety.

For its review, the NRC staff utilized guidance from NUREG/CR-7204, "Applying Ultrasonic Testing In Lieu of Radiography for Volumetric Examination of Carbon Steel Piping," dated September 2015 (ADAMS Accession No. ML15253A674), and ASME Code Case N-831. ASME Code Case N-831 has been incorporated by reference into the NRC proposed rule

published in *Federal Register* on August 16, 2018 (83 FR 40685), by inclusion in draft RG 1.147 DG-1342 (proposed revision to RG 1.147) with a condition that prohibits its use on new reactor construction.

Effectiveness of Encoded PAUT in lieu of RT for Repair/Replacement Weld Inspection

While both PAUT and RT techniques are capable to detect a spectrum of flaws resulting from fabrication welding processes, the differences in physical/material interactions can make one technique more sensitive to certain fabrication flaw types than the other technique. In NUREG/CR-7204, the NRC concluded that the encoded PAUT technique as compared to RT provides an equally effective examination for identifying the presence of fabrication flaws in the ferritic steel piping welds; however, the encoded PAUT is more effective for detection of planar flaws than small volumetric flaws (i.e., volumetric flaws with less than 0.15 inch in diameter, which are acceptable by the construction code). Based on this assessment, the NRC staff finds that there is a sufficient technical basis for use of PAUT technique in lieu of RT for the repair/replacement weld inspection.

Electric Power Research Institute (EPRI) published Technical Report No. 3002010297, "Technical Basis for Substituting Ultrasonic Testing for Radiographic Testing for New, Repaired, and Replacement Welds for ASME Section XI, Division 1, Stainless Steel Piping," dated June 2017. The report summarizes EPRI's performance-based approach based on ASME Code, Section XI, Appendix VIII, to demonstrate the effectiveness of the encoded PAUT for detection and sizing the fabrication flaws in the austenitic stainless steel piping welds. For the performance demonstration, EPRI designed and fabricated mockups containing representative welding fabrication flaws. The flaw distribution included both unacceptable and acceptable sized flaws in accordance with the acceptance standards of IWB-3514 and flaw characterization figures of IWA-3300 of the ASME Code, Section XI. The performance demonstration initiative (PDI) generic procedures PDI-UT-2 and PDI-UT-3 were utilized for examination and flaw sizing. EPRI showed that (1) the encoded PAUT is an effective technique as compared to RT for detection and sizing fabrication flaws within the ferritic steel or austenitic stainless steel welds, and (2) the ASME Code, Section XI, Appendix VIII, root mean square error (RMSE) criteria for flaw length and depth sizing was met.

The NRC staff notes that the RMSE equation in ASME Code Case N-831-1 has a typographical error as compared to the equation in ASME Code, Section XI, Appendix VIII, Subparagraph VIII-3120. Therefore, the licensee shall use the Appendix VIII-3120 equation for calculating RMSE because the equation in Appendix VIII-3120 is accurate.

Based on the above studies, the NRC staff finds that there is a sufficient technical basis for the use of encoded PAUT in lieu of RT for repair/replacement inspection of the ferritic steel or austenitic stainless steel piping welds. The encoded PAUT as compared to RT was shown to be an effective technique for both detection and characterization of fabrication flaws in the repaired/replaced ferritic steel or austenitic stainless steel piping welds.

Assurance of Detection of Structurally-Significant Fabrication Flaws

In evaluating the licensee's proposed alternative requirements as specified in ASME Code Case N-831-1, the NRC staff assessed the adequacy of the following aspects of the licensee's technical basis, which include the performance demonstration and qualification of the encoded

PAUT, achieving 100 percent coverage of the examination volume, and flaw acceptance criteria. The NRC staff verified that:

- The licensee will examine 100 percent of the weld volume and the weld-to-base-metal interface.

- The licensee will perform the encoded PAUT using the procedures, equipment, and personnel qualified by performance demonstration as outlined below.

    - The procedures will be demonstrated by using either a blind test or a nonblind test. The demonstration specimen set will include a minimum of 30 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws. The demonstration set will include specimens to represent the minimum and maximum diameter and thickness covered by the procedure.

    - Personnel will be qualified for detection and sizing fabrication flaws by performance demonstration using the qualified procedure. The personnel performance demonstration will be conducted using a blind test (i.e., the flaw information is not provided). The demonstration specimen set will contain at least 10 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws.

    - The demonstration specimens will include both planar and volumetric fabrication flaws (e.g., lack of fusion, crack, incomplete penetration, slag inclusions) representative of welding process. The flaws will be distributed throughout the examination volume. The flaw through-wall heights for the performance demonstration will be based on the preservice acceptance standards for volumetric examination in accordance with ASME Code, Section XI, IWB-3400, IWC-3400, or IWD-3400, as applicable. At least 30 percent of the flaws will be classified as acceptable planar flaws, with the smallest flaws being at least 50 percent of the maximum allowable size based on the applicable aspect ratio for the flaw.

    - Personnel will be qualified for flaw length sizing when the RMSE of the flaw lengths estimated by ultrasonic examinations, as compared with the true lengths, do not exceed 0.25 inch for nominal pipe size 6 inches and smaller, and 0.75 inch for larger than nominal pipe size 6 inches.

    - Personnel will be qualified for flaw through-wall height sizing when the RMSE of the flaw through-wall heights estimated by ultrasonic examinations, as compared with the true through-wall heights, does not exceed 0.125 inch.

- The licensee will treat all flaws detected using angle-beam ultrasonic inspections as planar flaws and will evaluate the flaws against the preservice acceptance standards in ASME Code, Section XI, IWB-3400, IWC-3400, or IWD-3400, as applicable.

- The licensee will store the electronic data files for the encoded PAUT as archival-quality records permitting off-line analysis of images built from the data.

Therefore, the NRC staff finds that licensee's proposed performance demonstration for the encoded PAUT, which includes procedures demonstration and personnel qualification are

adequate because the use of encoded data provide assurance that the PAUT will be sufficiently rigorous to detect and size flaws in the welds.

In addition, the NRC staff notes that while IWB-3400, IWC-3400, and IWD-3400 of Section XI, the ASME Code allows larger flaws to remain inservice than that of NB-5330, NC-5330, and ND-5330 of Section III, the use of Section XI acceptance standards has proven to be effective for the ISI of piping welds. The NRC staff finds that the use of the ASME Code, Section XI, acceptance standards is appropriate for the proposed alternative, as the alternative is for the repair/replacement activities, and not for new plant construction. Therefore, the NRC staff determines that the licensee's proposed encoded PAUT for the repair/replacement weld inspection is acceptable because it provides reasonable assurance that any structurally-significant fabrication defects in repaired/replaced welds be detected.

4.0 CONCLUSION

As set forth above, the NRC staff has determined that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1).

Therefore, the NRC staff authorizes the use of the proposed alternative described in the licensee's application for the remainder of the applicable 10-year ISI interval listed in Section 3.1.2 of this safety evaluation, or until such time as the NRC approves ASME Code Case N-831-1 for general use through revision of RG 1.147 or other document.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested and authorized by NRC staff remain applicable, including a third party review by the Authorized Nuclear Inservice Inspector. The NRC staff notes that approval of this alternative does not imply NRC approval of ASME Code Case N-831-1 for generic use.

Principal Contributor: A. Rezai

Date: September 19, 2019

SUBJECT: ARKANSAS NUCLEAR ONE, UNITS 1 AND 2; GRAND GULF NUCLEAR STATION, UNIT 1; INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3; PALISADES NUCLEAR PLANT; RIVER BEND STATION, UNIT 1; AND WATERFORD STEAM ELECTRIC STATION, UNIT 3 – RELIEF REQUEST NO. EN-19-RR-1, USE OF ASME CODE CASE N-831-1 (EPID L-2019-LLR-0009) DATED SEPTEMBER 19, 2019

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