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

February 25, 2019

Vice President, Operations
Entergy Nuclear Operations, Inc.
Indian Point Energy Center
450 Broadway, GSB
P.O. Box 249
Buchanan, NY 10511-0249

SUBJECT: INDIAN POINT NUCLEAR GENERATING UNIT NO. 2 – ISSUANCE OF RELIEF REQUEST IP3-ISI-RR-14 RE: ALTERNATIVE EXAMINATION REQUIRED BY ASME CODE CASE N-729-4 (EPID L-2018-LLR-0102)

Dear Sir or Madam:

By letter dated July 23, 2018 (Agencywide Documents Access and Management System Accession No. ML18211A299), Entergy Nuclear Operations, Inc. (Entergy or the licensee) submitted Relief Request IP3-ISI-RR-14 to the U.S. Nuclear Regulatory Commission (NRC) for Indian Point Nuclear Generating Unit No. 3 (Indian Point 3). Entergy requested relief from the augmented inspection in accordance with American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Case N-729-4, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI," as mandated by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g)(6)(ii)(D), with conditions. In Relief Request IP3-ISI-RR-14, the licensee proposed to use the alternative requirements of Appendix I, "Analysis Procedure for Alternative Examination Area or Volume Definition," in Code Case N-729-4, as the use of Appendix I requires NRC prior approval. Specifically, pursuant to 10 CFR 50.55a(z)(2), the licensee proposed alternative volumetric examination requirements in accordance with Appendix I of Code Case N-729-4 on the basis that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the NRC staff authorizes the proposed alternative for the remainder of the fourth 10-year inservice inspection interval at Indian Point 3, which began on June 21, 2009, and is scheduled to end on July 20, 2020.

All other ASME Code requirements for which relief was not specifically requested and approved remain applicable.

If you have any questions concerning this matter, please contact the Indian Point 3 Project Manager, Mr. Richard Guzman, at (301) 415-1030 or Richard.Guzman@nrc.gov.

Sincerely,

James G. Danna, Chief
Plant Licensing Branch 1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-286

Enclosure:
Safety Evaluation

cc: Listserv

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

RELATED TO RELIEF REQUEST IP3-ISI-RR-14

REGARDING ASME CODE CASE N-729-4

ALTERNATIVE EXAMINATION

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NO. 3

DOCKET NO. 50-286

1.0 INTRODUCTION

By letter dated July 23, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18211A299), Entergy Nuclear Operations, Inc. (Entergy or the licensee) requested relief from the augmented inspection in accordance with American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Case N-729-4, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI," as mandated by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g)(6)(ii)(D), with conditions. In Relief Request IP3-ISI-RR-14, the licensee proposed to use the alternative requirements of Appendix I, "Analysis Procedure for Alternative Examination Area or Volume Definition," in Code Case N-729-4, as the use of Appendix I requires U.S. Nuclear Regulatory Commission (NRC) prior approval. This relief request is for Indian Point Nuclear Generating Unit No. 3 (Indian Point 3).

Specifically, pursuant to 10 CFR 50.55a(z)(2), the licensee proposed alternative volumetric examination requirements in accordance with Appendix I of Code Case N-729-4 on the basis that compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

2.0 REGULATORY EVALUATION

Components (including supports) that are classified as ASME Code Class 1, 2, and 3 must meet the requirements in 10 CFR 50.55a(g)(4), "Inservice inspection standards requirement for operating plants," throughout the service life of a boiling or pressurized water-reactor (PWR).

Pursuant to 10 CFR 50.55a(g)(4)(ii), "Applicable ISI 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, "Inservice 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 50.55a), subject to the conditions listed in paragraph (b) of 10 CFR 50.55a.

Pursuant to 10 CFR 50.55a(g)(6)(ii)(D), "Augmented ISI requirements: Reactor vessel head inspections," (1) "Implementation," holders of operating licenses or combined licenses for PWRs as of or after August 17, 2017, shall implement the requirements of ASME Code Case N-729-4.

Pursuant to 10 CFR 50.55a(g)(6)(ii)(D)(2), "Appendix I use," Appendix I of ASME Code Case N-729-4 shall not be implemented without prior NRC approval.

Pursuant to 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," alternatives to the requirements of paragraphs (b) through (h) of 10 CFR 50.55a, or portions thereof, may be used when authorized by the Director, Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. 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 10 CFR 50.55a 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 Background

By letter dated October 1, 2010 (ADAMS Accession No. ML102590213), the NRC approved similar Relief Request IP3-ISI-RR-04 for the fourth 10-year inservice inspection interval (ISI) of Indian Point 3, authorizing the licensee to use the alternative requirements of Appendix I in Code Case N-729-1. The regulations 10 CFR 50.55a(g)(6)(ii)(D) mandated the augmented inspection in accordance with Code Case N-729-1, with conditions.

The latest regulations in 10 CFR 50.55a(g)(6)(ii)(D) require the augmented inspection in accordance with Code Case N-729-4, instead of Code Case N-729-1, with conditions. Thus, the licensee submitted IP3-ISI-RR-14 requesting to use the alternative requirements of Appendix I in Code Case N-729-4 for the remainder of the fourth 10-year ISI interval of Indian Point 3.

3.2 Components Affected

ASME Code Class 1 reactor pressure vessel (RPV) closure head penetration nozzles and their partial penetration (J-groove) dissimilar metal attachment welds are affected. In accordance with ASME Code Case N-729-4 (Table 1), these dissimilar metal welds are classified as Item No. B4.20. Below, the licensee identified the RPV closure head penetration nozzles that are affected by this relief request.

- Penetration Nos. 1 through 37
- Penetration Nos. 38, 41, 42, 43, 44, 46, 47, 48, 52, 55, 56, 61, 62, 65, 67, 68, 70, 71, 72, 73, 74, 75, 76, 77, and 78
- Penetration Nos. 40, 49, 50, 53, 54, 57, 58, 60, 64, and 66

The licensee stated that the RPV closure head penetration nozzles and associated J-groove welds at Indian Point 3 are made of Alloy 600/82/182 and known to be susceptible to primary water stress corrosion cracking.

3.3 Applicable Code Edition and Addenda

The code of record for the fourth 10-year ISI interval is the 2001 Edition through 2003 Addenda of the ASME Code.

3.4 Duration of Relief Request

The licensee submitted this request for remainder of the fourth 10-year ISI interval, which began on June 21, 2009, and is scheduled to end on July 20, 2020.

3.5 ASME Code Requirement

ASME Code Case N-729-4 (Table 1, Item No. B4.20) requires that all RPV closure head penetration nozzles and their associated DM welds be subjected to volumetric and surface examinations every 8 calendar years, or before reinspection years (RIY = 2.25), whichever is less.

- Code Case N-729-4, Figure 2, "Examination Volume for Nozzle Base Metal and Examination Area for Weld and Nozzle Base Metal," identifies the required examination volume or area of tube to be inspected, including a distance "a" above the highest point of the root of the J-groove weld to a distance "a" below the lowest point of the toe of the J-groove weld. Distance "a" is equal to 1.5 inches for incidence angle less than or equal to 30 degrees to the horizontal plane, or 1.0 inch for incidence angle greater than 30 degrees to the horizontal plane.

- Code Case N-729-4 (Table 1, Note 6) requires the volumetric or surface examinations of essentially 100 percent of the required volume or equivalent surfaces of the nozzle tube, as identified by Code Case N-729-4 (Figure 2).

- Code Case N-729-4 (Table 1, Note 5) requires that if the examination area or volume requirements of Figure 2 cannot be met, the alternative requirements of Mandatory Appendix I in Code Case N-729-4 shall be used, and the evaluation shall be submitted to the NRC.

3.6 Proposed Alternative

In lieu of examining the required nozzle volume in accordance with Code Case N-729-4, as discussed above, the licensee proposed to use the analysis procedure of Appendix I in Code Case N-729-4 to define the alternative examination volume, since the impediments prevented the examinations of the required volume below the toe of downhill side of the J-groove weld, as

defined by Code Case N-729-4 (Figure 2). The analysis of Appendix I is also used to demonstrate the adequacy of the alternative examination volume of each nozzle.

Based on the analysis of Appendix I, the licensee proposed minimum examination volume for each nozzle. The proposed alternative examination volume for the ultrasonic test (UT) is from a distance "a" above the root of the J-groove weld to a distance "Minimum Required UT Coverage" below the toe of downhill side of the J-groove weld, as defined in IP3-ISI-RR-14 (Table 1) below.

IP3-ISI-RR-14 (Table 1): Minimum Inspection Coverage Requirement

Nozzle Penetration No.	Nozzle Angle of Incidence (Degrees)	(1)Minimum Required UT Coverage Below J-groove Weld with > 2 Effective Full Power Years (EFPY) by Crack Growth Evaluation (Inches)	Time (EFPY) to Reach the Lowest Point of the Toe of J-groove Weld (Years)
01 through 29	0.0 to 24.8	0.4	3.0
30 through 37	26.2	0.4	2.7
38 through 69	30.2 to 38.6	0.4	2.7
70 through 73	44.3	0.3	3.0
74 through 78	48.7	0.3	4.2

Note (1): Length below the lowest point at the toe of the J-groove weld (downhill side) that has an operating stress level of 20 kilo-pound per square inch (ksi): 0.86 inch at nozzles 1 through 29; 0.50 inch at nozzles 30 through 69; 0.35 inch at nozzles 70 through 73; and 0.35 inch at nozzles 74 through 78.

3.7 Basis for Use of Alternative

The licensee stated that the design of RPV closure head penetration nozzles includes an approximately 0.75 inch long threaded section at the bottom of the nozzles tube, as shown in Figure 1 (Attachment to NL-18-052) of IP3-ISI-RR-14. There is no qualified volumetric inspection technique available to interrogate the threaded region at the nozzle end and provide meaningful results. Furthermore, the dimensional configuration at some nozzles is such that the inspectable distance from the lowest point of the toe of the J-groove weld to the bottom of the scanned region is less than the 1 inch and 1.5 inch lower boundary limits defined by Code Case N-729-4 (Figure 2).

The licensee stated that the inspection by the surface examination techniques is an option to meet the surface area requirement as defined by Code Case N-729-4 (Figure 2). However, the radiation dose rates under the RPV head near the J-groove weld areas are expected to be within 3 to 5 rem/hour. Additionally, the area under the RPV head is posted as a locked high radiation and contamination area. Therefore, performance of the required surface examinations is considered a hardship.

The licensee stated that the proposed alternative will be used for the RPV closure head penetration nozzles as described below:

- Penetration Nos. 1 through 37 do not meet the 1.5 inch examination volume criterion specified in Code Case N-729-4 (Figure 2) for an incident angle of less than or equal to 30 degrees.

- Penetration Nos. 38, 41, 42, 43, 44, 46, 47, 48, 52, 55, 56, 61, 62, 65, 67, 68, 70, 71, 72, 73, 74, 75, 76, 77, and 78 do not meet the 1 inch examination volume criterion specified in Code Case N-729-4 (Figure 2) for an incident angle of greater than 30 degrees.

- During previous Refueling Outages 3R14 to 3R19, the examination volume for Penetration Nos. 40, 49, 50, 53, 54, 57, 58, 60, 64, and 66 was measured to be within 0.080 inch of the examination volume criterion specified in Code Case N-729-4 (Figure 2). The licensee also requested relief for these penetrations due to the potential that the examination volume criterion cannot be met.

The licensee stated that its justification for the adequacy of the proposed alternative examination volume is based on: (1) a finite element stress analysis of the nozzle and its attachment J-groove weld; (2) a postulation of an initial flaw size and crack growth rate based on the stress analysis; and (3) a demonstration that a postulated crack in the unexamined volume is not expected to grow to the toe of the J-groove weld prior to the next inspection, which is scheduled for the next refueling outage in approximately 2 years. The NRC previously reviewed and approved the licensee's supporting stress and flaw analyses used in developing the above Table 1.[1]

The licensee stated that it will perform the volumetric examination by the UT procedure and personnel qualified in accordance with Section 2500 requirements of Code Case N-729-4 for the flaw detection from the inside surface of the RPV head penetration nozzle. The scanning area extends from 1 inch and 1.5 inches above the J-groove weld (i.e., the upper boundary limits defined in Code Case N-729-4 (Figure 2)) and continues down the nozzle to at least the top of the threaded region. IP3-ISI-RR-14 (Table 1) provides the minimum inspection coverage required to ensure that a postulated axial through-wall flaw in the uninspected area of the RPV penetration nozzle will not propagate into the pressure boundary formed by the J-groove weld prior to a subsequent inspection or in 2 effective full power years (EFPY).

The licensee stated that, for all RPV penetration nozzles, the requirements of Code Case N-729-4 (Figure 2) for the inspection of the examination volume above the J-groove weld will be met. The proposed alternative is applicable for the examination volume of the nozzles below the J-groove weld.

3.8 NRC Staff Evaluation

The NRC staff has evaluated IP3-ISI-RR-14 pursuant to 10 CFR 50.55a(z)(2). The NRC staff focuses on: (1) whether compliance with the specified requirements of 10 CFR 50.55a(g), or portions thereof, would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety; and (2) that the licensee's proposed alternative (accepting Code Case N-729-4 (Appendix I) analysis procedure to define a reduced examination volume in this case) provides reasonable assurance of structural integrity and leaktightness of the RPV penetration nozzles.

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[1] See Entergy Relaxation Requests for Inspection of RPV Heads dated May 19, 2004 (ADAMS Accession No. ML041460199); Relief Request IP3-ISI-RR-04 dated December 23, 2009 (ADAMS Accession Nos. ML100050207); and NRC letter dated October 1, 2010 (ADAMS Accession No. ML102590213).

Hardship

Within the context of IP3-ISI-RR-14, the NRC staff has determined that the licensee identified the limitations that prevented the volumetric or surface inspections of the required examination volume or surface of the penetration nozzle tube below the toe of the J-groove weld, as defined by Code Case N-729-4 (Figure 2). The design of penetration nozzles tube has the threaded region of approximately 0.75 inch long at the bottom end of the penetration nozzles. The NRC staff confirms that the volumetric examination of the threaded region is not possible with the current technologies. The distance between the toe of the J-groove welds and the top of the threaded region of the nozzle is, in some cases, less than the inspection distance required by Code Case N-729-4 (Figure 2). The NRC staff confirms that the licensee could not meet the required examination volume criteria. Although the inspection of the required surface area of the nozzle's threaded region by the surface examination techniques is an acceptable option, the length of time needed to perform the surface inspection would expose the involved personnel to unnecessary, high radiation dose rates. Therefore, the NRC staff determines that the nozzle tube design limitations, from an as low as reasonably achievable and safety hazards standpoint, constitute a hardship. The NRC staff finds that the licensee has provided sufficient basis to demonstrate that performing the required examination constitutes a hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

Proposed Alternative – Assurance of Structural Integrity and Leaktightness

In evaluating the licensee's proposed alternative, the NRC staff assessed the licensee's plant-specific stress analysis and crack growth calculation. These analyses serve as a technical basis to demonstrate that the proposed inspection volume/area of nozzle tube below the toe of the J-groove weld is adequate, and any potential cracks that might exist in the uninspected volume/area of the nozzle tube would not grow to the pressure boundary formed by the J-groove weld prior to the next scheduled inspection (i.e., 2 EFPY). The NRC staff verified that:

- The licensee's plant-specific stress analysis was performed according to the ASME Code and industry standards to plot the distributions of the stresses along the length of the penetration nozzles below the J-groove weld. The operating stresses in the penetration nozzles were determined to be the highest at or close to the pressure boundary formed by the J-groove weld and decrease rapidly as the distance below the toe of the J-groove weld increases.

- The lowest point below the toe of the downhill side of the J-groove weld that experiences an operating stress level of 20 ksi was identified in each nozzle tube. This distance is 0.86 inch for nozzles 1 through 29; 0.50 inch for nozzles 30 through 69; 0.35 inch for nozzles 70 through 73; and 0.35 inch for nozzles 74 through 78, as documented in IP3-ISI-RR-14 (Table 1). The NRC staff notes that the crack initiation in the primary water stress corrosion cracking susceptible materials with 20 ksi or lower operational stresses theoretically has a reduced probability compared to areas at or very close to yield stress.

- A plant-specific crack growth calculation was performed according to the ASME Code and industry standards to demonstrate that any crack postulated in the uninspected volume/area below the toe of the J-groove weld would not grow to the pressure boundary formed by the J-groove weld before 2 EFPY.

- The postulated crack upper tip was assumed to lie where the proposed inspection volume/area ends, which is either 0.3 inch or 0.4 inch below the toe of downhill side of the J-groove weld at the applicable nozzle, as documented in IP3-ISI-RR-14 (Table 1).

- The time required for the postulated crack to grow from the uninspected volume/area to reach the pressure boundary at the toe of the J-groove weld was calculated to be within 2.7 EFPY and 4.2-EFPY at the applicable nozzle, as documented in IP3-ISI-RR-14 (Table 1). However, the NRC staff notes that the licensee will inspect these nozzles every refueling outage, which is less than 2 EFPY. The NRC staff finds that the above-calculated time for a postulated axial through-wall flaw in the uninspected area of the RPV penetration nozzle reaching the pressure boundary is greater than 2 EFPY. Therefore, the licensee will be able to detect any unanticipated flaw growth prior to the pressure boundary being challenged. This provides a reasonable assurance of structural integrity and leaktightness of the pressure boundary formed by the subject J-groove welds because the next inspection will be performed in 2 EFPY.

In summary, the NRC staff concludes that the licensee's proposed alternative provides reasonable assurance of structural integrity, public health, and safety of the RPV closure head penetration nozzles. With these considerations, compliance with examination coverage requirements of Code Case N-729-4, as mandated by the regulations in 10 CFR 50.55a(g)(6)(ii)(D), with conditions, would result in hardship, without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the proposed alternative provides reasonable assurance of structural integrity and leaktightness of the subject RPV closure head penetration nozzles and associated J-groove welds, and complying with the specified requirement would result in hardship or unusual difficulty, without a compensating increase in the 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)(2). Therefore, the NRC staff authorizes the use of IP3-ISI-RR-14 at Indian Point 3 for the remainder of the fourth 10-year ISI interval, which is scheduled to end on July 20, 2020.

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

Principal Contributor: A. Rezai

Date: February 25, 2019

SUBJECT: INDIAN POINT NUCLEAR GENERATING UNIT NO. 2 – ISSUANCE OF RELIEF REQUEST IP3-ISI-RR-14 RE: ALTERNATIVE EXAMINATION REQUIRED BY ASME CODE CASE N-729-4 (EPID L-2018-LLR-0102) DATED FEBRUARY 25, 2019

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