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

July 14, 2016

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 – SAFETY EVALUATION FOR RELIEF REQUEST IP2-ISI-RR-02 ALTERNATIVE EXAMINATION VOLUME REQUIRED BY CODE CASE N-729-1 (TAC NO. MF7151)

Dear Sir or Madam:

By letter dated December 9, 2015, as supplemented by letter dated May 6, 2016, Entergy Nuclear Operations, Inc., the licensee, submitted Relief Request (RR) IP2-ISI-RR-02 for Nuclear Regulatory Commission (NRC) review and approval. The licensee requested to implement a proposed alternative to the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g)(6)(ii)(D)(3), which mandates the use of ASME Code Case N-729-1, with conditions. The request pertains to the volumetric and/or surface examinations of reactor vessel upper head nozzles, most of which are used to house control rod drive mechanisms at Indian Point Nuclear Generating Unit No. 2 (IP2).

The NRC staff has determined that the proposed alternative provides reasonable assurance of structural and leak tightness of the subject component and that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality or safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, pursuant to 10 CFR 50.55a(z)(2), the staff authorizes the use of RR IP2-ISI-RR-02 at IP2 for the fifth 10-year inservice inspection interval, which started on June 1, 2016, and is scheduled to end on May 31, 2026.

The NRC staff's safety evaluation is enclosed. Please feel free to contact Douglas V. Pickett at (301) 415-1364 if you have any questions on this issue.

Sincerely,

N. Wanchu for

Travis L. Tate, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-247

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. IP2-ISI-RR-02

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NO. 2

DOCKET NO. 50-247

1. INTRODUCTION

By letter dated December 9, 2015, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15349B009), as supplemented by letter dated May 6, 2016 (ADAMS Accession No. ML16133A036), Entergy Nuclear Operations, Inc., the licensee, submitted Relief Request (RR) IP2-ISI-RR-02 for Nuclear Regulatory Commission (NRC) review and approval. The licensee requested to implement a proposed alternative to the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g)(6)(ii)(D)(3), which mandates the use of the American Society of Mechanical Engineers (ASME) Code Case N-729-1, "Alternative Examination Requirements for Pressurized-Water Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds," with conditions. The request pertains to the volumetric and/or surface examinations of reactor vessel (RV) upper head nozzles, most of which are used to house control rod drive mechanisms (CRDMs), of the pressurized-water reactor (PWR) vessel at Indian Point Nuclear Generating Unit No. 2 (IP2).

Pursuant to 10 CFR 50.55a(z)(2), the licensee requested to use the proposed alternative in RR IP2-ISI-RR-02 on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Specifically, the licensee proposed an alternative to the ASME Code Case N-729-1, Figure 2, "Examination Volume for Nozzle Base Metal and Examination Area for Weld and Nozzle Base Metal."

2. REGULATORY REQUIREMENTS

In accordance with 10 CFR 50.55a(z)(2), the licensee proposed to use an alternative to the requirements of 10 CFR, 50.55a(g)(6)(ii)(D)(3), which mandates the use of Code Case N-729-1, with conditions.

In accordance with 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components, including supports, must meet the requirements, except the design and access provisions and the preservice examination requirements set forth in the ASME Code, Section XI, "Rules for

Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry and materials of construction of the components.

As stated in 10 CFR 50.55a(z), 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 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.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that it has the regulatory authority to authorize an alternative proposed by the licensee.

3. TECHNICAL PROPOSAL

3.1. Components for Which Relief is Requested

Component:	RV Upper Head CRDM Nozzles Having Pressure Retaining Partial Penetration Welds
Code Class:	Class 1
Examination Category:	PWR RV Upper Head in Table 1 of ASME Code Case N-729-1
Code Item No.:	B4.20 in Table 1 of ASME Code Case N-729-1

The licensee stated that relief is being requested for reactor head penetration nozzles 1 and 3 through 37 because they fail to meet the 1.5-inch acceptance criterion specified in ASME Code Case N-729-1 for incident angles less than or equal to 30 degrees. Relief is also being requested for reactor head penetration nozzles 38, 39, 40, 41, 47, 52, 53, 58, 62, 64, 65, 67, 68, 70, 71, 74, 75, 77, 78, 79, 80, 81, 82, 84, 88, 89, 90, 93, 94, and 97 because they fail to meet the 1-inch acceptance criterion for incident angles greater than 30 degrees. In addition, the licensee preemptively requested relief for penetration nozzles 2, 42, 48, 50, 54, 56, 59, 60, 63, 66, 72, 76, 83, 85, 86, 87, 91, 92, and 96. The licensee stated that when measured, these penetration nozzles were within 0.08 inch of the acceptance criteria. The NRC staff finds this preemptive request acceptable because slight variations in the manner in which the nozzles are measured could cause these nozzles to fail to meet the acceptance criteria which would necessitate an exigent relief request. The preemptive request for relief for these components on the part of the licensee ensures their orderly inspection without a loss of safety.

3.2. Applicable Code Edition and Addenda

The Code of Record for the fifth 10-year inservice inspection (ISI) interval for IP2 is the 2007 edition/2008 addenda. For the components under consideration, ISI is governed by 10 CFR 50.55a(g)(6)(ii)(D), which mandates the use of Code Case N-729-1, with conditions.

3.3. Inspection Requirements for the Component Under Consideration

The requirements of 10 CFR 50.55a(g)(6)(ii)(D)(*3*) stipulate that the licensee perform a volumetric and/or surface examination of essentially 100 percent of the required volume or equivalent surfaces of the nozzle tube as identified by Figure 2 of ASME Code Case N-729-1. Figure 2 identifies the required volume of tube to be inspected, 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.

3.4. Proposed Alternative

The licensee stated that the design of its RV head penetration nozzles includes a threaded section which is approximately ¾ inch in length and is located at the bottom of the nozzles. The licensee also stated that due to the presence of this threaded region, the inspectable distance below the toe of the J-groove weld was less than that required by Figure 2 of the Code Case for some nozzles.

The licensee proposed to perform a volumetric inspection of each penetration nozzle from a distance "a" above the J-groove weld and the minimum required ultrasonic test (UT) coverage below the J-groove weld as defined in Table 1.

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 EFPY by Crack Growth Evaluation (inches)**	**Time, Effective Full Power Years (EFPY), to Reach the Lowest Point of the Toe of the J-groove Weld (year)**
1 through 25	0 to 23.3	0.55	4.6
26 through 69	24.8 to 38.6	0.45	4.4
70 through 81	44.3	0.25	8.4
82 through 89	45.4	0.25	6.8
90 through 97	48.7	0.18	5.0
(1) Length below the lowest point at the toe of the J-groove weld (downhill side) that has an operating stress level of 20 ksi: 0.86 inches at nozzles 1 through 25; 0.40 inches at nozzles 26 through 69; 0.32 inches at nozzles 70 through 81; 0.34 inches at nozzles 82 through 89 and 0.32 inches at nozzles 90 through 97.			

3.5. Licensee's Technical Basis

The licensee provided a basis for the adequacy of the proposed alternative based on three components: (1) a finite element stress analysis of the nozzles near the J-groove weld; (2) a postulation of an initial flaw size and crack growth rate based on the stress analysis; and (3) a proposal for an alternate inspection area such that the postulated crack is not expected to grow sufficiently to reach the toe of the J-groove weld prior to the next inspection which is scheduled for the next refueling outage in 2 years.

As indicated by the licensee, surface examination techniques are an available option to meet the current regulatory requirements. However, radiation dose rates under the head near the J-groove weld areas are expected to be in the 3 to 5 rem/hour range. Additionally, the area

under the head is posted as a locked high radiation area and high concentration area. Performance of a surface exam is considered a hardship as result of the high radiation exposure.

The licensee stated that, in all cases, the inspection requirements of Figure 2 of the Code Case for inspection above the J-groove could be met. Based on the stress analysis and crack growth rate predictions, the licensee proposed minimum UT inspection coverage requirements. These values are contained in Table 1 above. The licensee also confirmed that the proposed UT inspection area for each of the nozzles was at least as large as the required inspection area as listed in Table 1.

4. NRC STAFF EVALUATION

The NRC staff finds that the inspection requirements found in 10 CFR 50.55a(g)(6)(ii)(D)(3) are the appropriate inspection requirements for the components identified in the licensee's RR.

The NRC staff reviewed the licensee's basis for requesting relief from the inspection requirements for these components. The staff finds that satisfactory UT inspection of the threaded regions at the lower ends of the penetration nozzles is unlikely. The staff also finds that 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 Figure 2 of Code Case N-729-1. As stated by the licensee, the NRC staff also finds that, although surface examination of the components is an acceptable option, the length of time required to perform the inspection in combination with the projected dose rate (3 to 5 rem/hr) would result in a significant radiation exposure to the individuals performing the inspection.

The NRC staff reviewed the basis upon which the licensee's proposed alternative inspection area is based (See Reference 1.) This basis relies upon stress analyses and crack growth projections to predict that a crack, which lies outside the proposed inspection area in one inspection, cannot reasonably be expected to grow to the toe of the J-groove weld prior to the next scheduled inspection. Cracks which do not affect the J-groove weld are not part of the pressure boundary of the reactor coolant system and do not constitute a safety hazard. The staff agrees with the licensee that this approach will prevent a crack from reaching the J-groove weld and will, therefore, provide an adequate level of safety to allow the staff to authorize the proposed alternative under 10 CFR 50.55a(z)(2).

The NRC staff reviewed the method used by the licensee to demonstrate that its proposed inspection area will be sufficient to preclude cracks from reaching the toe of the J-groove weld between inspections. The staff considered the method used to produce the stress analysis; the method used to postulate the initial crack length; the method used to predict crack growth rate; the minimum inspection coverage requirement; and the proposed inspection coverage. The staff found that the licensee employed commonly used techniques. The staff finds that the techniques employed, and the predictions derived from these methods and techniques, are acceptable.

The NRC staff reviewed the method used by the licensee to postulate the length of the initial crack. The staff noted the use of two significant assumptions. These assumptions include: (1) the lower tip of the postulated crack is located at the point where circumferential stresses on either the inside surface or the outside surface of the nozzle become compressive, indicating

that a through wall crack below this point is unlikely; and (2) the postulated crack length is such that the stress intensity factor is equal to the stress intensity factor required for crack growth (threshold stress intensity factor of 8.19 ksi$\sqrt{\text{inch}}$). The staff finds these assumptions reasonable because they specify the minimum crack length required for growth, or alternatively, cracks which do not meet these minimum criteria cannot reasonably be expected to grow to the toe of the J-groove weld prior to the next scheduled inspection.

The NRC staff reviewed the minimum inspection coverage. The staff noted that the end of the required inspection area lies at the postulated location of the upper crack tip. Based on the values reported in Table 1, this point is either 0.18, 0.25, 0.45 or 0.55 inches below the toe of the J-groove weld. Through the use of this approach, the licensee has defined both the postulated crack geometry, which defines the potential crack growth rate and the maximum allowable growth between inspections as 0.18, 0.25, 0.45 or 0.55 inches depending on the nozzle penetration. Through the use of the crack growth prediction methodology discussed above, the licensee predicted the length of time required for the postulated crack to grow from the uninspected area to the toe of the J-groove weld. These projections are also reported in Table 1 as the Time, Effective Full-Power Years (EFPY) to Reach the Toe of the J-groove Weld. The staff agrees with the licensee that an inspection area of 0.18, 0.25, 0.45 or 0.55 inches, respectively, is adequate because, in all instances, the time required for the postulated crack to grow the necessary distance to reach the toe of the J-groove weld exceeds the time interval between inspections.

The NRC staff reviewed the proposed inspection coverage. The staff noted that the licensee stated that inspections would be conducted "from the inside surface of each RPV head penetration nozzle from 1 inch or 1 ½ inch (depending on the specific nozzle's incidence angle) above the J-groove weld (i.e., the upper boundary limit defined in Figure 2 of Code Case N-729-1) and extending down the nozzle to at least the top of the threaded region." The licensee also confirmed that in each case for which relief was sought, the distance inspected from the toe of the J-groove weld to the top of the threaded lower section exceeds the minimum required UT coverage as shown in Table 1. The staff finds the licensee's proposed inspection coverage adequate because any crack which lies outside the proposed inspection area will not be able to grow sufficiently before the next inspection to reach the toe of the J-groove weld and thereby create the possibility that the reactor pressure boundary will be breached. Therefore, the staff finds that the licensee's proposed alternative provides reasonable assurance of public health and safety, and requiring compliance with the regulations would impose a radiological hardship on the licensee.

The NRC staff reviewed the licensee's proposal to determine whether it provided a level of safety and quality that was equivalent to the specified requirement. The staff noted that the proposed alternative provides for a smaller inspected area and relies on predicted, as opposed to measured, levels of stress. The staff cannot, therefore, conclude that the proposed alternative will provide an equivalent level of safety to the specified requirement.

The NRC staff reviewed the licensee's proposal to determine whether the specified requirement created a hardship and whether the improvements in safety and quality achieved by the specified requirement were commensurate with the increased difficulty of meeting that requirement as opposed to the proposed alternative. The staff noted that meeting the specified requirement through the use of internal UT inspection is not possible for all penetrations. The

staff also noted that the specified requirement could be met through the use of a manual surface exam but that the length of time required to perform the inspection in combination with the projected dose rate (3 to 5 Rem/hr) would result in a significant radiation exposure to the inspector. The staff considers this to be a hardship. Therefore, the staff finds sufficient basis to authorize relief under 10 CFR 50.55a(z)(2).

5.0 CONCLUSION

As set forth above, the NRC staff determined that the proposed alternative provides reasonable assurance of structural and leak tightness of the subject component and that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality or safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, pursuant to 10 CFR 50.55a(z)(2), the staff authorizes the use of RR IP2-ISI-RR-02 at IP2 for the fifth 10-year ISI interval, which started on June 1, 2016 and is scheduled to end May 31, 2026.

All other requirements for which relief was not specifically requested and approved in this relief request remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

6.0 REFERENCES

1. Dominion Engineering document dated October 14, 2005 (Enclosure to Entergy letter NL-09-130 to NRC, ML092800242), "Dominion Engineering Calculation C-8724-00-01, Rev 0, Indian Point 2 CRDM Stress Analysis – Proprietary," ADAMS Accession No. ML092800243 (Information herein provided addresses both Indian Point 2 and Indian Point 3).

Principal Contributor: D. Becker

Date: July 14, 2016.

The NRC staff's safety evaluation is enclosed. Please feel free to contact Douglas V. Pickett at (301) 415-1364 if you have any questions on this issue.

Sincerely,

/RA RPascarelli for/

Travis L. Tate, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-247

Enclosure:
Safety Evaluation

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