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

November 14, 2013

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 NO. 17 REGARDING INSERVICE EXAMINATION OF DISSIMILAR METAL WELDS (TAC NO. MF0697)

Dear Sir or Madam:

By letter dated February 20, 2013, Entergy Nuclear Operations, Inc., the licensee, submitted Relief Request No. 17 (IP2-ISI-RR-17) as an alternative to certain requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g)(6)(ii)(F) and the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) associated with inspection of reactor pressure vessel inlet cold leg nozzle to safe-end dissimilar metal butt welds at Indian Point Nuclear Generating Unit No. 2 (IP2).

The Nuclear Regulatory Commission staff concludes that compliance with the requirements of 10 CFR 50.55a(g)(6)(ii)(F) and the ASME Code would cause an unnecessary burden on the licensee without a compensating increase in the level of quality and safety. Accordingly, in the enclosed safety evaluation, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(ii) and that the proposed alternative provides reasonable assurance of structural integrity and leak tightness Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the staff authorizes the use of the licensee's proposed alternative at IP2 until the spring 2016 refueling outage.

Sincerely,

Robert H. Beall, Acting 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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NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST 17 EXAMINATION OF DISSIMILAR METAL WELDS ON COLD LEG

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NO. 2

DOCKET NO. 50-247

1.0 Introduction

By letter dated February 20, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML13064A299), Entergy Nuclear Operations, Inc. (Entergy or the licensee) submitted Relief Request 17 (IP2-ISI-RR-17) as an alternative to certain requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g)(6)(ii)(F) and the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) associated with inspection of reactor pressure vessel (RPV) inlet cold leg nozzle to safe-end dissimilar metal (DM) butt welds at Indian Point Nuclear Generating Unit No. 2 (IP2). The licensee requested authorization to use the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(ii) 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.

2.0 Regulatory Evaluation

The inservice inspection (ISI) of ASME Code Class 1, 2 and 3 components is to be performed in accordance with Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the ASME Code and applicable editions and addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission.

Paragraph 10 CFR 50.55a(g)(6)(ii) states that the Commission may require the licensee to follow an augmented ISI program for systems and components for which the Commission deems that added assurance of structural reliability is necessary. Paragraph 10 CFR 50.55a(g)(6)(ii)(F) requires, in part, augmented inservice volumetric inspection of class 1 piping and nozzle DM butt welds of pressurized water reactors in accordance with ASME Code Case N-770-1, subject to the conditions specified in paragraphs (2) through (10) of 10 CFR 50.55a(g)(6)(ii)(F).

Alternatives to requirements under 10 CFR 50.55a(g) may be authorized by the Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(a)(3)(i) or 10 CFR 50.55a(a)(3)(ii). In proposing alternatives or requests for relief, the licensee must demonstrate 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 analysis of the regulatory requirements, the NRC staff finds that the regulatory authority exists to authorize the licensee's proposed alternative 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. Accordingly, the NRC staff has reviewed and evaluated the licensee's request pursuant to 10 CFR 50.55a(a)(3)(ii).

3.0 Technical Evaluation

3.1 Licensee Relief Request

The affected components are as follows:

Weld 21-14A-Loop 21 cold leg nozzle to safe-end weld
Weld 22-14A-Loop 22 cold leg nozzle to safe-end weld
Weld 23-14A-Loop 23 cold leg nozzle to safe-end weld
Weld 24-14A-Loop 24 cold leg nozzle to safe-end weld

Paragraph 10 CFR 50.55a(g)(6)(ii)(F) requires, in part, a volumetric inspection of RPV inlet cold leg nozzle to safe-end DM welds of pressurized water reactors in accordance with ASME Code Case N-770-1, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities", subject to the conditions specified in paragraphs (2) through (10) of 10 CFR 50.55a(g)(6)(ii)(F). The ASME Code Case N-770-1, Table 1, Inspection Item B requires volumetric examination of essentially 100 percent of each weld once every second inspection period not to exceed 7 years.

The licensee proposes a onetime extension to the Code Case N-770-1, Table 1, Inspection Item B, volumetric examinations from a period of "not to exceed 7 years" to a period of "not to exceed 10 years."

The licensee requests relief from the regulatory requirement which would require inspection during the scheduled spring 2014 refueling outage and allow the inspection to be performed during the scheduled spring 2016 refueling outage at IP2. This is a one-time extension inspection frequency request.

The licensee stated relief was requested due to the need to examine the RPV inlet cold leg nozzle to safe-end welds from the inside surface of the weld. This examination would require access to the lower portion of the reactor vessel to insert automated volumetric inspection equipment. As such, it would be necessary to remove the core barrel and other RPV internals. At IP2, the core barrel is scheduled to be removed during the spring 2016 refueling outage for inspection of the vessel shell welds and vessel internal inspection as required by Electric Power Research Institute report MRP-227. Requiring the additional removal of the core barrel and other internals during the spring 2014 refueling outage would result in an additional radiological dose of approximately 1.5 (roentgen equivalent man [rem]).

Additionally, the licensee stated that volumetric inspection of the RPV inlet cold leg nozzle to safe-end welds from the outside surface would be undesirable due to the welds being located inside a sandbox and covered with asbestos insulation. The licensee estimated that approximately 11 [rem] would be accumulated to perform the inspection from the outside surface, including the personnel hazard of dealing with asbestos materials.

The licensee's technical basis for the relief request is based on the temperature dependence on the susceptibility of these welds to primary water stress corrosion cracking (PWSCC) and the previous inspection history at IP2. The licensee notes that the susceptibility to PWSCC of alloy 82/182 welds, such as those that are the subject of this relief request, is largely a function of time at temperature. The RPV inlet cold leg nozzle to safe-end welds operate at a temperature of less than 535 °F for a significant portion of their operating lifetime. Additionally, the licensee claims that the welds would be ranked as moderately susceptible to PWSCC based on the susceptibility formula provided in previously required NRC Order EA-03-009 for the upper RPV head penetration nozzles and welds.

The licensee also stated that since PWSCC is temperature dependent, it would be expected that hot leg temperature welds would show evidence of crack initiation before cold leg temperature welds, and no evidence of cracking has been identified in either hot leg and cold leg welds at IP2. Hot leg temperature welds were inspected most recently in 2012, as core barrel removal is not required to gain inspection access for these welds. Furthermore, the cold leg temperature welds that are the subject of this relief request were inspected in May of 2006 with both volumetric and eddy current techniques which verified no indications in the weld.

The licensee noted that in response to a previous NRC request for additional information, by letter dated November 8, 2011 (ADAMS ML11319A216), the licensee provided a crack growth calculation for a hypothetical flaw that would have initiated just after the May 2006 inspection of a RPV inlet cold leg nozzle to safe-end weld at IP2. The licensee applied the recently created guidelines of Electric Power Research Institute report, MRP-287, "Primary Water Stress Corrosion Cracking (PWSCC) Flaw Evaluation Guidance," in their evaluation. The licensee stated that their analysis showed significant margin to ensure that ASME Section XI flaw size limits would not be exceeded during the extended period of inspection frequency. As such, the licensee found the technical basis sufficient to ensure public health and safety by extending the inspection frequency of the RPV inlet cold leg nozzle to safe-end DM welds at IP2 from a maximum of 7 years to a new maximum of 10 years.

3.2 NRC Staff Evaluation

The NRC staff notes that the generic rules for the frequency of volumetric examination of DM butt welds were established to provide reasonable assurance of the structural integrity of the reactor coolant pressure boundary. As such, the staff finds that plant-specific analysis could be used to provide a basis for inspection relief if the inspection requirement presents a significant hardship. The staff reviewed the licensee's proposed alternative under the requirements of 10 CFR 50.55a(a)(3)(ii), which states;

> 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.

As the RPV inlet cold leg DM welds are in sandboxes, and inspection of the welds would require the licensee to remove the RPV core barrel just for these examinations in the spring 2014 refueling outage, the NRC staff found the licensee had a sufficient basis for a radiological dose hardship. Therefore, the staff reviewed licensee's deterministic assessment and supporting inspection results to access the authorization of RR-17.

The NRC staff reviewed the licensee's previous inspection results and found they provided a strong basis for the initial flaw size used in the deterministic crack growth analysis. The initial flaw size is a critical component of a flaw analysis. The staff found the licensee's data and supporting eddy current inspection results provided a reasonable basis for the initial flaw size assumptions.

The NRC staff reviewed the licensee's stress analysis and found it followed the recommendations of MRP-287 and numerous NRC public meeting discussions with industry on effective weld residual stress calculations to address PWSCC flaw analysis. Of note, for significant conservatism, a 50 percent inside surface weld repair 360° around the circumference was simulated in the licensee's analysis. The fabrication sequence was simulated based on information provided in the plant specific drawings. The staff also found that the use of the maximum stress path through the weld that compared the three stress paths calculated for hoop stresses, was effective and consistent with NRC staff expectations. The staff reviewed the stress analysis through the thickness of the weld and found both the hoop and axial residual stress curve contours were consistent with analyses using similar geometries and fabrication methods. As such, the staff's review found the licensee's plant specific stress analysis for these welds to have conservative inputs and assumptions and, therefore, was adequate to be used in the flaw evaluation.

The NRC staff found that the licensee's flaw evaluation used reasonable inputs and industry methodologies to determine maximum end-of-evaluation period flaw sizes for both axial and circumferential flaws. The staff found the licensee's use of the maximum allowable flaw size of 75 percent of the wall thickness in accordance with the requirements of ASME Code, Section XI, Paragraph IWB-3640, is an adequate approach. The staff found the licensee's use of the MRP-115, "Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 82, 182, and 132 Welds," adequate for the analysis. Further, the staff recognized the licensee's basis of the effect of temperature on the crack growth rates for PWSCC flaws at cold leg operating temperatures. For example, a PWSCC flaw in the same material and same environmental conditions will grow, on average, 7 to 8 times slower at the cold leg operating temperature at IP2 versus a typical operating hot leg temperature at a U.S. pressurized water reactor plant.

The last component of the NRC staff review concerned the licensee's flaw analysis results and conclusions to provide a technical basis to support the relief request. Figures 7-1 and 7-2 of the licensee's letter dated November 8, 2011, provide the PWSCC crack growth curves through the thickness of the welds for both an axial and circumferential flaw, respectively. The flaw analysis shows that only a flaw 1-inch in depth or greater (~45 percent depth of the weld) could grow to the allowable ASME Code flaw size limit (75 percent through wall) in ten years. The long time span is a product of the low or compressive calculated residual stresses and the cold leg temperature effect on the crack growth rate. Therefore, the staff found the licensee's flaw analysis evaluation acceptable. The licensee used the results of the flaw analysis to support the conclusion that since no flaw was identified in the spring 2006 inspection of each weld, the next inspection can be delayed to the spring 2016 refueling outage, while maintaining reasonable assurance of the structural integrity and leak tightness of each weld. The licensee's 2006 examination included an Appendix VIII demonstrated volumetric examination obtaining essentially 100 percent coverage, and an eddy current surface examination that found no indications of surface connected flaws. The staff found the inspection techniques and results provide a reasonable basis for the licensee's conclusion that any flaw connected to the wetted surface with a size of 10 percent in depth or greater should have been identified. Furthermore, the staff finds that there is sufficient margin when comparing the postulated initial flaw size of 1-inch that would be required to grow to an unacceptable flaw size in ten years that was used in the flaw analysis to the maximum flaw size of approximately 10 percent depth or 0.25-inches which could have been reasonably missed during the 2006 inspection at IP2. Therefore, the staff found that the licensee has provided an adequate technical basis to support reasonable assurance of structural integrity and leak tightness for the extended inspection frequency requested in RR-17, which requests to increase the maximum inspection frequency for these welds from a maximum of seven to ten calendar years.

Therefore, given the hardship of the location of the RPV inlet cold leg nozzle to safe-end DM welds being in sandboxes and the flaw analysis demonstrating a sufficient safety margin, the NRC staff concludes that the licensee has provided adequate technical basis to demonstrate that compliance with the requirements of 10 CFR 50.55a(g)(6)(ii)(F) for the volumetric inspection of the RPV inlet cold leg nozzle to safe-end DM welds at IP2, during the spring 2014 refueling outage, would cause an unnecessary hardship or unusual difficulty on the licensee without a compensating increase in the level of quality and safety given that the volumetric inspections will be performed during the spring 2016 refueling outage at IP2.

4.0 Conclusion

As set forth above, the NRC staff concludes that the licensee provided sufficient technical basis to demonstrate that compliance with the requirements of 10 CFR 50.55a(g)(6)(ii)(F) and the ASME Code would cause an unnecessary burden on the licensee without a compensating increase in the 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(a)(3)(ii), the proposed alternative provides reasonable assurance of structural integrity and leak tightness, and is in compliance with the Code of Federal Regulation's requirements. Therefore, in accordance with 10 CFR 50.55a(a)(3)(ii) the staff authorizes the use of the licensee's proposed alternative, RR-17, at Indian Point Unit No. 2, until the spring 2016 refueling outage.

All other ASME Code, Section XI and 10 CFR 50.55a(g)(6)(ii)(F) requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: J. Collins

Date: November 14, 2013

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Vice President, Operations
Entergy Nuclear Operations, Inc.
Indian Point Energy Center
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Sincerely,
/ra/
Robert H. Beall, Acting 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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