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

July 30, 2009

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. 3 - RELIEF REQUEST RR-3-48 FOR REACTOR VESSEL BOTTOM PENETRATIONS EXAMINATION (TAC NO. ME0414)

Dear Sir or Madam:

By letter dated January 22, 2009, as supplemented by letters dated February 6, March 9, and March 23, 2009, Entergy Nuclear Operations, Inc. (the licensee) submitted relief request (RR) 3-48 to the Nuclear Regulatory Commission (NRC) on the examination of the reactor vessel bottom penetrations at Indian Point Nuclear Generating Unit No. 3 (IP3). RR 3-48 would permit use of ultrasonic and eddy current examinations of reactor vessel bottom mounted instrumentation nozzles as an alternative to the bare metal visual examination requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g)(6)(ii)(E).

The NRC staff has reviewed the licensee's submittal and determined that the proposed alternative will provide an acceptable level of quality and safety. To support the licensee's outage schedule, verbal authorization of this alternative was granted on March 30, 2009. Pursuant to paragraph 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the use of RR 3-48 during the third 10-year inservice inspection interval for IP3, which ended on July 21, 2009. The NRC safety evaluation is provided in the enclosure.

Please contact the Indian Point Project Manager, John Boska, at (301) 415-2901 if you have any questions on this issue.

Sincerely,

Nancy L. Salgado

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

Docket No. 50-286

Enclosure:
As stated

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. RR-3-48

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NO. 3

DOCKET NO. 50-286

1.0 INTRODUCTION

By letter dated January 22, 2009, as supplemented by letters dated February 6, March 9, and March 23, 2009, Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML090420062, ML090570517, ML090930321, and ML090890187, Entergy Nuclear Operations, Inc. (Entergy), the licensee for Indian Point Nuclear Generating Unit No. 3 (IP3), submitted a request to the Nuclear Regulatory Commission (NRC) for authorization of an alternative to the bare metal visual examination requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g)(6)(ii)(E) for the plant's third 10-year inservice inspection (ISI) interval, which ended on July 21, 2009. The request for authorization of the alternative was made pursuant to the provisions of 10 CFR 50.55a(a)(3)(i). The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) of record for IP3's third 10-year ISI interval is the 1989 Edition with no Addenda.

2.0 REGULATORY REQUIREMENTS

Pursuant to 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 (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

Pursuant to 10 CFR 50.55a(a)(3) alternatives to requirements may be authorized by the NRC if the licensee demonstrates that: (i) the proposed alternatives provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The licensee submitted the subject request for authorization of an alternative, pursuant to

10 CFR 50.55a(a)(3)(i), which proposed an alternative inspection method to the bare metal visual examination requirements of 10 CFR 50.55a(g)(6)(ii)(E).

3.0 LICENSEE'S PROPOSED ALTERNATIVE

3.1 ASME Code Component Affected

The ASME Code components affected by the licensee's proposed alternative are the 58 instrument nozzles at IP3 as the nozzles penetrate the reactor vessel bottom head.

3.2 ASME Code Requirements

ASME Code Case N-722, "Additional Examinations for PWR [Pressurized-Water Reactor] Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials, Section XI, Division 1," was mandated by NRC as an augmented ISI requirement in 10 CFR 50.55a(g)(6)(ii)(E) on September 8, 2008. ASME Code Case N-722 requires, in part, that bare metal visual inspection of bottom mounted instrument (BMI) nozzles be performed every other refueling outage.

3.3 Duration of the Alternative

Entergy requested approval of this alternative for the third ten-year interval of the IP3 inservice inspection program which began July 21, 2000, and ended July 21, 2009.

3.4 Licensee's Proposed Alternatives to ASME Code Case N-722

The licensee's proposed alternative is to perform volumetric and surface inspections of the inside of the 58 IP3 BMI nozzles. The proposed volumetric and surface inspection is in lieu of bare metal visual examination of the nozzles from outside the reactor vessel. The proposed alternative will consist of ultrasonic and eddy current inspection of each BMI nozzle above, over, and below the partial penetration weld between the penetration nozzle and the reactor vessel.

3.5 Licensee's Basis for Alternatives to ASME Code Case N-722

Entergy proposes to use ultrasonic (UT) and eddy current (ET) techniques to perform volumetric and surface examinations of the BMI nozzles. These techniques were demonstrated by the examination vendor (WesDyne) at the Electric Power Research Institute (EPRI) Nondestructive Examination (NDE) Center in Charlotte, NC. The demonstration of these techniques was documented in MRP-166, "Materials Reliability Program: Demonstration of Equipment and Procedures for the Inspection of Alloy 600 Bottom Mounted Instrumentation (BMI) Head Penetrations." The demonstration was supplemented by a WesDyne technical justification report, "BMI Examination of Indian Point Penetrations," Report Number WDI-TJ-1014. The demonstration took place in 2004 and used BMI nozzle mockups located at the EPRI NDE Center. The UT technique was demonstrated to effectively detect BMI tube inside and outside surface initiated axial and circumferential flaws as well as to establish the location and orientation of those flaws with respect to the weld profile. The ET technique was used in the demonstration for examination of the nozzle inside surface to supplement the volumetric examination technique. Technical justification WDI-TJ-1014 concludes that the equipment, techniques, and procedures to be used on the IP3 BMI tube geometry will result in examinations equivalent to those demonstrated in MRP-166.

3.6 NRC Staff Evaluation of Alternative to ASME Code Case N-722

3.6.1 Demonstration Mockups and Process

The examination techniques the licensee proposes to use to inspect the BMI nozzles were demonstrated on mockups constructed to simulate BMI nozzles in the field. The demonstration was administered by EPRI. WesDyne, the BMI inspection vendor at IP3, was one of the vendors that participated in the demonstration. The demonstration process was broken up into two phases: an open phase and a blind phase. During the open phase of the demonstration, the vendors were allowed access to tubes and a partial-scale mockup with discontinuities in the tube and weld volumes for developing their UT inspection procedures. These open samples included configurations that represented the Westinghouse 3 and 4 loop plant designs as well as the Westinghouse 2 loop plant design. Data collected on the open mockups were reviewed by EPRI to determine if the vendor was prepared to continue with the blind phase of the demonstration.

The BMI head penetration mockups used during the blind phase of demonstration included a full-scale mockup for the Westinghouse 3 and 4 loop design. The mockups have realistic weld geometries and distortion as caused by manufacturing the J-groove weld. The mockups were manufactured at the EPRI NDE Center using a combination of electrical discharge machining (EDM) and cold isostatic processing (CIP), which creates tight cracks. These mockups contain flaws in both the axial and circumferential orientations. The flaws are located in the critical flaw locations from a structural and leakage integrity perspective. Specifically, the flaws are located in the tube above, below, and over the partial penetration weld and flaws. The mockups contain flaws that originate from both the inside diameter (ID) surface and the outside diameter (OD) surface. The flaw lengths do not exceed 70 mm and the flaw depths ranged up to 100% of the wall thickness of the nozzle.

The manufacturing process whereby CIP-squeezed EDM notches are used to fabricate mockups was previously demonstrated to deliver UT and ET responses similar to those of real flaws removed from service. As indicated by generically applicable information in a March 26, 2008, letter to the NRC pertaining to a similar request on Dockets 50-456 and 50-457 and information in EPRI Report 1015143: "Nondestructive Evaluation: Comparison of Field and Manufactured Flaw Data in Austenitic Materials," UT CIP notch responses have been compared to a primary water stress corrosion cracking (PWSCC) flaw in a control rod drive mechanism penetration at the Bugey Nuclear Power Plant in France. Typically, the radius of the CIP-squeezed EDM notch tips used in control rod drive mechanism nozzle mockups and BMI mockups are 10 microns, which is smaller than that required by the ASME Code, Section XI, Appendix VIII. When the UT CIP-squeezed EDM notch responses were compared with the response from a PWSCC flaw from the Bugey plant, they were found to give similar forward scatter time-of-flight diffraction (TOFD) UT responses. The amplitude of the UT tip responses varied only slightly. This was determined to be primarily due to minor variations in surface condition and ultrasonic coupling. The signal-to-noise ratios were also very similar. There was only a small difference observed between the echo-dynamic characteristics of the simulated and field-removed cracks.

Based on this information, the NRC staff concludes that the mockups that were used were sufficiently representative of reactor vessel BMI penetrations with potential PWSCC. The flaws built into the mockups represent the range of critical flaws that could challenge the structural integrity of the penetrations. The types of flaws used produce signals that are sufficiently representative of the response from actual PWSCC for the purpose of demonstrating the TOFD UT method.

3.6.2 TOFD UT and ET Inspection Techniques

During the BMI head penetration performance demonstration, volumetric and surface inspection techniques were demonstrated. Volumetric inspection techniques demonstrated by the inspection vendors were exclusively TOFD UT. The TOFD UT technique was used for length and depth sizing, location of the flaws with respect to the weld profile, and orientation of the flaws. ET was used by the vendors in the demonstration for surface inspection of the tube ID. The ET technique was used for surface flaw detection, length sizing, and axial and circumferential flaw locations and orientations.

TOFD UT utilizes two transducers, a transmitting transducer and a receiving transducer, arranged so that their beams intersect in the region of interest. Unlike conventional, amplitude-based UT that relies on detecting a signal reflected off the flaw, the TOFD method makes use of the diffracted waves that radiate from an insonified flaw tip. Flaw sizes are determined based on measuring the travel time of the diffracted signals from the tips of the flaws. From the known geometry of the probe set up and measured beam path lengths, the location of the flaw tips can be determined by geometrical calculations. The TOFD data is displayed in a two-dimensional grey-scale image in which one axis represents time and the other axis represents the position of the probe. TOFD images are generally interpreted by first identifying those diffracted signals occurring between the surface (lateral) wave and the backwall signals that represent cross-section of the inspection volume. Diffracted signals from flaw tips are then recognized by their location and appearance in the image.

ET is the primary tool for detection, length sizing, flaw location, and orientation of both axial and circumferential ID-connected flaws. UT is the primary tool for flaw characterization information and through-wall sizing. Both ET and UT are used in combination for detection of ID-connected flaws. All base metal ID detection and sizing is a result of the two complementary exams used in this demonstration.

The NRC staff considers the TOFD UT and ET inspection techniques to be appropriate for detecting potential ID or OD initiated flaws in BMI nozzles. These techniques have been successfully used for inspection of control rod drive mechanism nozzles for a number of years.

3.6.3 Demonstration Results

The Westinghouse 3 and 4 loop blind demonstration using an inspection system called the WesDyne Paragon system resulted in all flaws greater than 10% of the wall thickness being detected. This included ID-connected and OD-connected flaws ranging to 100% through-wall extent. The Paragon system was demonstrated to be successful in determining the orientation of all flaws longer than 0.4 inch, but was inconsistent in determining the orientation of short flaws. The Westinghouse 2 loop blind demonstrations with the Paragon system resulted in flaws greater than 5% of the wall thickness being detected. This included ID-connected and OD-connected flaws ranging to 100% through-wall extent. One OD-connected flaw with between 20% to 30% through-wall extent was missed. The Paragon system was demonstrated to be successful in determining the orientation of all flaws longer than 0.47 inch. The WesDyne Paragon system is the system that the licensee contracted for use at IP3.

Section 3 of MRP-166 contains graphs that depict measured flaw depth and length versus actual flaw depth and length. These graphs indicate that the techniques demonstrate a higher capability to measure flaw length than depth. The NRC staff considers that the most important attribute for inspection of components susceptible to PWSCC is flaw detection. Due to the high growth rate of PWSCC, any BMI determined to have PWSCC would most likely have to be repaired since it would be difficult to justify continued operation and the burden of successive inspections.

Given the short time frame of this IP3 request of authorization, and the actions that would be taken if a service-induced planar flaw is detected, the NRC staff has concluded that the results of the WesDyne Paragon system demonstration are acceptable, notwithstanding the limitations discussed above.

3.6.4 Reporting and Recording Criteria for Flaws

The UT procedures used during the demonstration included instructions for differentiating service-induced flaws from fabrication defects. Fabrication flaws are not considered reportable but are characterized and recorded to allow comparison in future examinations. Recordable indications that are fabrication flaws, including lack of fusion (LOF), are flaws that can be seen by both circumferential and axial TOFD UT and with the 0° UT transducer. They are classified as fabrication flaws by the procedure. LOF flaws were not intentionally placed at the weld/tube interface. However, some unintentional LOF was detected during the demonstration.

Recordable indications that are reportable are service-induced flaws that are typically planar in nature (i.e., detected by either axial or circumferential TOFD UT transducers) and cannot be seen by 0° UT transducers. Since the only viable degradation mechanism that would produce planar service-induced flaws in BMI tubes is PWSCC, any planar flaw detected would be attributed to PWSCC.

The NRC staff considers these criteria for distinguishing between service-induced and fabrication-induced flaws to be logical and appropriate. The NRC staff also agrees with the provisions of the procedures that specify that service-induced flaws are reportable and fabrication flaws are recordable, since service-induced flaws would require licensee action and recording fabrication flaws allows comparison with future examination results. These criteria are consistent with criteria that the NRC staff has previously determined to be acceptable.

3.6.5 Personnel Training

In light of the fact that a high degree of operator skill is required to correctly interpret TOFD UT inspection results, the licensee provided information to the NRC staff on the training and qualification requirements for personnel to carry out the TOFD UT data acquisition and analysis at IP3. The WesDyne written practice meets the requirements of ASME Code, Section XI, IWA-2300 and Appendix VII for UT Examiner Certification. Additional training for the BMI-specific application is as follows:

- For BMI Acquisition – The requirement is for 80 hours of "Paragon Operator Training for Reactor Vessel Examinations." Included in this course is training on the basic TOFD theory, BMI acquisition procedure review, Paragon TOFD display setup, and acquisition responses from BMI tubes.

- For BMI Analysis – The Basic Paragon Operator Training is a pre-requisite for BMI analysis. The requirement for a BMI analyst is for a 40-hour BMI specific course. The course covers additional BMI theory, TOFD calibration, data quality, acquisition and analysis procedure reviews and hands on with recent field inspection data.

Although the NRC staff do not have specific requirements in the area of personnel certification and training for BMI nozzle examination, the certification and training provided to the WesDyne examiners performing the BMI nozzle examinations at IP3 are comparable to the certification and training requirements for examinations of other safety-related components addressed by the ASME Code, Section XI.

3.6.6 Procedures

The open mockup phase of the demonstration was used to develop the inspection procedures used during the blind phase of the demonstration. The equipment and procedures that were demonstrated by WesDyne have remained largely unchanged since the time of the demonstration. The changes that were made since the original demonstration were as follows:

- Following the demonstration, the 0 degree transducer was modified to obtain a better signal-to-noise ratio. The size and frequency of the 0 degree transducer was optimized, and the transducer material was changed to a composite.

- WesDyne was initially successful in collecting good quality UT/ET data from the ID of the Westinghouse 3 and 4 loop design. However, several false calls were made where manufacturing defects, in the weld region, were incorrectly identified as PWSCC. WesDyne decided to optimize its Paragon analysis procedure to further reduce these false calls. The Westinghouse 3 and 4 loop data were reanalyzed after enhancement of the procedure. The procedure enhancements improved the ability to characterize the fabrication defects which reduced the number of false calls. All but one of the false calls was eliminated.

The BMI examination at IP3 utilizes the equipment and procedure changes noted above. Since these changes would not be expected to affect detection and sizing but would enhance data analysis and characterization, the NRC staff considers the implementation of these changes without an additional demonstration to be acceptable.

3.6.7 WesDyne Technical Justification

The WesDyne technical justification was developed to show the equivalency of the probe diameter change from the demonstrated Westinghouse 2 loop and 3 and 4 loop plant BMI tube configurations to the IP3 specific configuration. Though IP3 is a Westinghouse 4 loop plant, the dimensions of the IP3 configuration is between the dimensions of the Westinghouse 2 loop and

3 and 4 loop plant BMI tube configurations. Demonstrating at the limits of an examination technique is a reasonable and standard approach for procedure qualification. This rationale is used by ASME Code, Section XI, Appendix VIII.

The BMI tube walls at IP3 are thicker than the tube walls used in the Westinghouse 3 and 4 loop demonstration and are thinner than the tube walls used in the Westinghouse 2 loop demonstration. Though the change in wall thickness is small, the increase in ID over the Westinghouse 2 loop design allows improved probe contact and footprint. The inspection procedures are the same for both the minimum and maximum bore sizes.

The IP3 BMI probe configuration would be expected to perform better than probes previously demonstrated on the Westinghouse 2 loop mockup and may perform similarly to the performance of the Westinghouse 3 and 4 loop probe. The larger transducer footprint for the IP3 probe will require using less gain for an equivalent examination. Using less gain will result in less noise and, therefore, better signal resolution.

WesDyne has demonstrated techniques for nozzle thicknesses larger and smaller than the nozzle thickness at IP3. The blind demonstration for the Westinghouse 2 loop configuration detected flaws from 5% to 100% through wall extent; however, a 20% to 30% through wall OD connected flaw was missed. The blind demonstration for the Westinghouse 3 and 4 loop configuration detected all flaws with the smallest flaw having a 10% through wall extent. Given that the UT alternative is for one inspection period and the alternative is in lieu of performing a bare metal visual examination looking for leakage, the NRC staff does not consider this difference in capability to be of consequence. Therefore, the NRC staff concludes that the technical justification prepared by WesDyne is acceptable for this application.

4.0 CONCLUSION

Based on the discussion above, the NRC staff concludes that the alternatives proposed in RR 3-48 to perform volumetric and surface inspections of the inside of the 58 BMI nozzles in lieu of bare metal visual examination of the nozzles from outside the reactor vessel as required by 10 CFR 50.55a(g)(6)(ii)(E) will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes RR 3-48 for performing volumetric and surface inspections of the inside of the 58 BMI nozzles at IP3. This relief request is authorized for use during the spring 2009 refueling outage at IP3. The inspection performed using this relief request is applicable to the third 10-year ISI interval for IP3 which began July 21, 2000, and ended July 21, 2009.

All other ASME Code, Section XI 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 Contributors: Edmund J. Sullivan
Carol Nove

Date: July 30, 2009

July 30, 2009

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/RA/

Nancy L. Salgado, Chief
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ADAMS ACCESSION NO.: ML091740558 *See memo dated June 11, 2009

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