October 29, 2007

Mr. Michael A. Balduzzi
Sr. Vice President & COO
Regional Operations, NE
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

SUBJECT: INDIAN POINT NUCLEAR GENERATING UNIT NO. 2 - RELIEF REQUEST (RR) NO. RR-06 (TAC NO. MD4701)

Dear Mr. Balduzzi:

By letter dated February 28, 2007, Entergy Nuclear Operations, Inc. (Entergy or the licensee), submitted a relief request for the fourth 10-year inservice inspection interval. The request proposed to postpone the third 10-year inservice inspection interval reactor vessel weld examinations by one additional operating cycle until the refueling outage (2R19) in the spring of 2010. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(i), Entergy requested approval to use an alternative to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Paragraph IWB-2412, "Inspection Program B," for Indian Point Nuclear Generating Unit No. 2 (IP2).

Inservice inspection of ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i). Also, 10 CFR 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if: (i) the proposed alternatives would 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.

Based on the enclosed safety evaluation, the NRC staff concludes that, in accordance with 10 CFR 50.55a(a)(3)(i), the proposed alternative program will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the proposed alternative under RR-04, until the end of refueling outage 2R19.

If you have any questions regarding this approval, please contact the Indian Point Project Manager, John Boska, at (301) 415-2901.

Sincerely,

/RA/

Mark G. Kowal, 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: See next page

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ADAMS ACCESSION NUMBER: ML072480249 *See memo dated August 24, 2007

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Indian Point Nuclear Generating Unit No. 2

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Indian Point Nuclear Generating Unit No. 2

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF NO. RR-06

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NO. 2

DOCKET NO. 50-247

1.0 INTRODUCTION

By letter dated February 28, 2007, Agencywide Documents Access and Management System (ADAMS) Accession No. ML070640101, Entergy Nuclear Operations, Inc. (Entergy or the licensee) submitted the Indian Point Nuclear Generating Unit No. 2 (IP2) Fourth 10-year Interval Inservice Inspection (ISI) and Containment Inservice Inspection Program (CISI) plan to the Nuclear Regulatory Commission (NRC). The submittal proposed Relief Request (RR)-06, an alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI requirements that relate to the inspection interval for reactor vessel (RV) weld examinations for IP2. The submittal requested authorization to postpone the applicable B-A and B-D weld examinations by an additional operating cycle, until refueling outage 2R19, scheduled for the spring of 2010. The inspection interval for performing RV weld examinations is specified in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components." The RV weld ISI consists of ultrasonic examinations intended to discover flaws or other discontinuities. Periodic examination is performed to determine whether flaws have initiated, whether pre-existing flaws have extended, or whether pre-existing flaws that have been missed using older non-destructive examination technology are discernable using more advanced technology. The examinations must be performed at least once during every program interval, as defined in Section XI of the ASME Code.

These B-A and B-D weld examinations which are related to the third 10-year ISI interval are being tracked in the fourth ISI interval. The third 10-year ISI interval for IP2 began on July 1, 1994; the fourth 10-year ISI interval began on March 1, 2007. The ASME Code of record for the third 10-year ISI interval for IP2 is the 1989 Edition.

2.0 REGULATORY REQUIREMENTS

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50.55a, "Codes and standards," requires licensees to perform periodic inspections of components. 10 CFR 50.55a(g), "Inservice inspection requirements," requires licensees to perform surveillance testing in accordance with the ASME Code, Section XI requirements. IP2 is using Inspection Program B from the 1989 Edition of Section XI of the ASME Code. Subsection IWB-2412, "Inspection Program B," of this edition of the ASME Code states, ". . . the required examinations in each

examination category shall be completed during each successive inspection interval in accordance with Table IWB-2412-1." Entergy requested relief from this requirement and proposed an alternative.

IWA-2430 (d) states, "[f]or components inspected under Program B, each of the inspection intervals may be extended or decreased by as much as 1 year. Adjustments shall not cause successive intervals to be altered by more than 1 year from the original pattern of the intervals." Entergy has taken advantage of this paragraph for an extension of up to 1 year. IWA-2430 (e) states, ". . . for power units that are out of service continuously for 6 months or more, the inspection interval during which the outage occurred may be extended for a period equivalent to the outage and the original pattern of intervals extended accordingly for successive intervals." Entergy has twice taken advantage of this paragraph for a total of 647 days extension due to extended maintenance outages reported in 1997-1998 and 2000-2001. Further, an NRC safety evaluation (SE) dated February 22, 2006, approved an RR that extended the third ISI interval to the end of the IP2 spring 2008 refueling outage, so that the subject examinations can be conducted during the spring 2008 outage. This approval was based on deterministic and risk-informed considerations.

In the current application, Entergy proposed not to perform the examinations during IP2's spring 2008 refueling outage. Instead, Entergy requested authorization for postponement of the examinations by an additional operating cycle until refueling outage 2R19.

10 CFR 50.55a(a)(3)(i) states, in part, that the Director of the Office of Nuclear Reactor Regulation (NRR) may authorize alternatives to the requirements of 10 CFR 50.55a(g). In order for the Director of NRR to authorize an alternative in accordance with 10 CFR 50.55(a)(3)(i), Entergy must demonstrate that the proposed alternative provides an acceptable level of quality and safety.

3.0 EVALUATION

3.1 Systems/Components for Which Relief Is Requested

The affected component is the IP2 RV. The ASME Code, Section XI examination categories and item numbers for the RV were provided by Entergy in the submittal as shown in the table:

Examination Category	Item Number	Description	Component IDs
B-A	B1.11	Circumferential Shell Welds	RPVC2, RPVC3, RPVC4
B-A	B1.12	Longitudinal Shell Welds	RPVL1 through RPVL8
B-A	B1.21	Circumferential Shell Welds	RPVC5
B-A	B1.22	Lower Meridional Shell Welds	RPVM1 through RPVM6

B-A	B1.30	Shell-to-Flange welds	RPVC1
B-D	B3.90	Nozzle-to-Vessel Welds	RPVN1 through RPVN8
B-D	B3.100	Nozzle Inner Radius Areas	RPVN1 (IR) through RPVN8(IR)

These examination categories and item numbers are from IWB-2500 and Table IWB-2500-1 of the ASME Code, Section XI.

3.2 Licensee's Basis

Entergy provided a qualitative assessment of the risk of RV failure. The assessment included the following:

- Plant-specific RV ISI history,
- Fleet-wide RV ISI history,
- Degradation mechanisms in the RV,
- Material condition of the RV relative to neutron embrittlement,
- Operational experience relative to RV structural integrity challenging events, and
- A description of the procedures used by the operators to identify, monitor, and mitigate potential pressurized thermal shock (PTS) events.

Entergy said that it examined the Category B-A and B-D welds and nozzle inner radius areas three times previously: once pre-service and twice inservice. Those examinations achieved acceptable coverage. Entergy concluded that the examinations were of sufficient quality to detect any significant flaws that would challenge RV integrity. During the first 10-year RV ISI examination in 1984, an indication was reported in the RV lower shell course located in circumferential weld RPVC3, approximately 240 inches below the vessel flange at azimuth 345 degrees. This indication was inspected again during an augmented inspection in 1987 and during the second 10-year ISI examination in 1995. The indication's characteristics remained similar in all three examinations. The indication is embedded and its dimensions were compared to the acceptance criteria of ASME Code, Section XI IWB-3500 and found to be acceptable. It was concluded that the indication was most likely a subsurface welding inclusion that has existed unchanged since the vessel was fabricated.

Entergy described the results of ISI examinations at 14 plants representing 301 total years of service, including plants fabricated by various vendors. No reportable indications were discovered at that group of plants. Entergy noted in its June 8, 2005, submittal that studies by Pacific Northwest National Laboratory (PNNL) documented in NUREG/CR-6471, "Characterization of Flaws in U.S. Reactor Pressure Vessels," indicate that surface-breaking flaws are unlikely to extend through multiple layers of cladding. The IP2 RV cladding is constructed with multi-pass welding and, therefore, has a low probability of containing through-cladding, surface-breaking flaws. Finally, Entergy noted that all pressurized-water reactor (PWR) plants have performed at least one ISI, and that no surface-breaking, or near-surface flaws, of any significance have been found.

Entergy identified fatigue as the only operable degradation mechanism for these welds, indicated that the fatigue usage factor is very low, and identified the cooldown transient as the most challenging loading sequence. Since approximately one additional cooldown transient is anticipated during the requested one cycle extension, Entergy concluded that any hypothetical fatigue crack growth would be inherently small.

Entergy noted that the IP2 RV weld material is below, and will remain below, the PTS screening criteria (according to 10 CFR 50.61) during the requested one cycle extension. Entergy indicated that its operating procedures and its low leakage cores provide margin with respect to PTS.

Entergy indicated that the most severe operational challenge to RV integrity is due to PTS events. Entergy has implemented emergency operating procedures (EOPs) and operator training to lower the likelihood of a PTS event occurring. The IP2 emergency procedure, FR-P.1, "Response to Imminent Pressurized Thermal Shock Condition," provides actions to avoid, or limit, thermal shock to the RV, or over-pressure conditions at low temperature. The IP2 control room operators receive training via the training simulator on the EOP at least every 2 years. Combining the low probability of a PTS event with the low probability of a flaw existing in the RV, Entergy concluded that the probability of RV failure due to PTS is very small.

With regard to the indication located in circumferential weld RPVC3, Entergy noted that the indication is embedded near the outside diameter (OD) of the RV. Given that cooldown transients do not create tensile stresses on the OD of the vessel, growth due to a cooldown transient is not probable. Similarly, PTS events do not cause crack growth of indications located near the OD of the RV, so the indication would not be subjected to tensile loading due to the thermal transient during a PTS event. While heatup transients do produce tensile loading on the OD, the heatup rate is controlled by technical specifications to be less than 100 °F per hour so the potential for growth during heatup is small.

Entergy noted that no Alloy 600, 82, or 182 materials are present in any of these welds, or adjacent base materials, addressed by the subject alternative.

3.3 NRC Staff Evaluation

ISI of RV welds helps to ensure structural integrity by identifying flaws which are large enough to represent challenges to pressure boundary integrity. Entergy summarized prior examinations performed on the RV welds. All of the subject welds have been examined and only one indication, located in circumferential weld RPVC3, has been found. This indication was found in 1984, and was initially determined to be unacceptable per ASME Code requirements. The NRC, in an SE dated October 16, 1984, required inspections at shorter intervals. This indication was reinspected in 1987 using advanced techniques, was found to be acceptable per ASME Code requirements, and had not increased in size. The NRC staff's SE dated July 12, 1988, agreed with this finding and concluded that the short interval inspections could be discontinued. The licensee examined this indication again in 1995 and noted that the indication characteristics remained the same. Although ultrasonic examination technology has improved over the past decade, the geometry and materials involved in RV weld examinations are such that the NRC staff is confident that the exams done previously were accurate and comprehensive. Therefore, the NRC staff agrees with Entergy's qualitative assessment that the prior examinations were of sufficient quality to identify any significant flaws that would

challenge RV integrity. The staff also agrees with the licensee's assessment that the indication discussed here would be unlikely to grow to exceed the Table IWB-3510-1 acceptance standards during the requested one cycle extension. Since the indication is located near the OD of the vessel, the staff concurs with the licensee's assessment that it would not be subject to tensile loading due to the thermal transient during PTS events.

Entergy discussed the population of all PWRs and indicated that no surface-breaking flaws have been discovered and, for a population of 14 plants that were reviewed in detail, no reportable indications were identified in any of the RV welds. Entergy also noted that NUREG/CR-6471 provides an estimate of the most likely flaw distribution for RV welds, which indicates that large flaws are not generally expected. The NRC staff concludes that the plant-specific and fleet ISI experiences are consistent with the PNNL evaluations: no significant flaws are expected. Furthermore, the NRC staff agrees that the IP2 RV's multi-pass cladding results in a low probability that a surface-breaking flaw could extend through the cladding to either the low alloy steel RV forging or weld material.

Entergy indicated that fatigue is the only operative mechanism that could cause flaws to either initiate or grow in the welds during the requested one cycle extension. The NRC staff concludes that corrosion, stress-corrosion cracking, and other forms of degradation due to the materials interaction with its chemical environment are not active degradation mechanisms for the RV welds. This is because the RV forgings and welds are separated from the reactor coolant by a layer of corrosion-resistant cladding. Furthermore, the welds have not been subjected to a history of abnormal operational loading events, so mechanical overload has not been the cause of active flaw initiation or propagation. Therefore, the NRC staff agrees with the conclusion that fatigue is the only likely operative mechanism that could create or propagate flaws during the requested one cycle extension.

Entergy said that the fatigue usage factor for these welds will be much lower than 1.0 after 40 projected years of operation and that the most severe fatigue transient would be the cooldown. The NRC staff agrees that any flaw growth due to normal operational transients during the requested one cycle extension is likely to be very small.

Entergy provided the PTS reference temperature (RT_{PTS}) values for each of the RV beltline materials at the end of 40-year operation. Entergy noted that the RT_{PTS} value for each RV material will remain below the screening criteria of 10 CFR 50.61. The NRC staff had previously reviewed and approved these calculations as part of its review of the IP2 response to Generic Letter 92-01, "Reactor Vessel Structural Integrity." Since the materials will remain below the screening criteria, the probability of brittle fracture during a PTS event is acceptably low. The analyses that supported the development of 10 CFR 50.61 included assumptions about the size, number, and distribution of hypothetical flaws that bound the sizes, number, and distribution identified by IP2 during their previous ISI examinations of the RV welds. Therefore, the staff concludes that complying with 10 CFR 50.61 is sufficient to demonstrate that the probability of RV failure due to PTS is adequately low.

The PTS risk associated with operation during any time interval depends on the likelihood that a significant flaw exists and the likelihood that a PTS event occurs during the interval which would challenge the flaw. An increased risk associated with the requested extension arises from the potential existence of a significant flaw that would have been detected and repaired during the inspection prior to the requested extension. Hence, with the postponement of inspection for an

additional cycle, this flaw would continue to be vulnerable to a severe PTS event during the period of the requested extension. Instead of estimating this increased risk, Entergy provided a qualitative assessment of the likelihood of a severe PTS event during the next operating cycle that could challenge the integrity of the RV if a significant flaw exists.

Entergy characterized IP2's response to three accident sequences that are believed to be most likely to cause a PTS event that would challenge significant flaws in the RV welds. The three sequences are:

- One stuck-open pressurizer safety relief valve that re-closes after 1 hour,
- Excessive loss of secondary steam caused by steam line break or stuck-open atmospheric dump valves, and
- Four-inch to nine-inch loss-of-coolant accidents.

Entergy discussed the procedures at IP2 that the operators would use to identify and mitigate the severity of a PTS event following either of the first two sequences. The third sequence normally provides little time for operator intervention following the initiating event but, as discussed above, the RT_{PTS} value for each RV material will remain below the screening criteria, thereby reducing the sensitivity of the materials to relatively cooler water injection into the vessel. The NRC staff concurs that the likelihood of any of these accident sequences occurring during the extension period is low. Furthermore, existing plant procedures and material properties can mitigate the severity of, or the effects of, the PTS event that would be caused by these sequences.

In summary, the NRC staff has reviewed Entergy's evaluation and makes the following conclusions:

- Previous RV ISI examinations in 1984 and 1995 were of sufficient quality to provide useful results, which show no indications that are currently considered to be reportable or that currently require monitoring.
- The RV welds are similar metal welds of low-alloy steel and are not susceptible to flaw initiation from mechanisms which can lead to rapid flaw growth, such as primary water stress corrosion cracking.
- Industry ISI examinations of similar welds have uncovered no significant flaws, indicating that the manufacturing of RVs had good quality control and that flaw initiation has not been occurring.
- The most severe degradation mode that is expected to affect these vessel welds is fatigue, and the most severe operational event with respect to fatigue is cooldown, which is an infrequent evolution. There is a cooldown performed for each refueling outage every 2 years, and typically only one cooldown between refueling outages as needed for emergent repairs, based on past performance. Therefore, growth of flaws due to fatigue would be minimal during the requested one cycle extension.
- The RV material has sufficient toughness to be acceptable with respect to PTS, as determined by Entergy's compliance with the requirements of 10 CFR 50.61.
- The likelihood of a severe PTS event occurring during the proposed extension period is low.

Accordingly, the NRC staff concurs with Entergy’s qualitative assessment that the IP2 RV welds have a low likelihood of having significant flaws and that there is a low likelihood of experiencing

a severe PTS event during the proposed extension period. Operation of the RV for an additional cycle, without performing the ISI examination of the subject welds, would not significantly increase the risk of RV failure.

4.0 CONCLUSION

Based on the above evaluation, the NRC staff concludes that Entergy's proposed alternative provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the postponement of the third 10-year ISI interval RV examinations until the end of Refueling Outage 2R19.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested and approved, remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Simon Sheng

Date: October 29, 2007