Entergy

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NL-18-019

April 04, 2018

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Relief Request Number IP2-ISI-RR-06 - Proposed Alternative to Use Reactor Vessel Head Penetration Embedded Flaw Weld Repair Method
Indian Point Unit 2
Docket No. 50-247
License No. DPR-26

Dear Sir or Madam:

On March 31, 2018, during the Indian Point Unit 2 refueling outage, with the reactor defueled and the head removed and located on the head stand, and all fuel from the reactor vessel removed and located in the spent fuel pool, while performing planned examinations on the 97 reactor vessel head penetrations, it was determined that one penetration could not be dispositioned as acceptable per the requirements of 10CFR50.55a for the reactor coolant system pressure boundary. The planned examinations for the remaining 96 penetrations did not identify any unacceptable indications. Repairs are planned, and will be completed prior to entering Mode 5 from the current refueling outage.

Pursuant to 10 CFR 50.55a(z)(1), Entergy Nuclear Operations, Inc. requests NRC approval of a relief request to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," on the basis that the current code requirements provide an acceptable level of quality and safety. The proposed relief request is provided in Attachment 1 to this letter.

In accordance with 10 CFR 50.55a(z)(1), the proposed alternatives may be approved by the NRC, provided an acceptable level of quality and safety are maintained. Entergy Nuclear Operations, Inc. requests approval of the proposed alternative in order to support Indian Point Unit 2 return to service from the current refueling outage.

This relief request is required to address an emergent condition at the Indian Point Energy Center. Entergy requests NRC approval as soon as possible but no later than April 12, 2018 at 0100 hours. This schedule is subject to fluctuation. Relief is requested for the duration of the upcoming Unit 2 operating cycle which is currently expected to conclude in the spring of 2020.

Entergy is formally committing to submit Westinghouse Letter LTR-SDA-18-035, Fracture Mechanics Assessment of Embedded Flaw Repair Acceptability for Indian Point Unit 2, prior to entering Mode 5 at the conclusion of the present refueling outage. Refer to Attachment 2. Should you have any questions regarding this matter, please contact Mr. Robert Walpole, Manager, Regulatory Assurance, Indian Point Energy Center at (914) 254-6710.

Sincerely,

Mandy K Halter

MKH/trj

Attachment 1: Relief Request IP2-ISI-RR-06

Attachment 2: Entergy Commitment

cc: Mr. David Lew, Acting Regional Administrator, NRC Region I
Mr. Richard Guzman, NRR Senior Project Manager
NRC Resident Inspector's Office

Attachment 1

to

Letter NL-18-019

Relief Request IP2-ISI-RR-06

RELIEF REQUEST IP2-ISI-RR-06

1. **ASME Code Component(s) Affected:**

   Component: Reactor Pressure Vessel (RPV) Head Penetration #3

   Code Class: 1

   Exam. Cat.: ASME Code Case N-729-4

   Item No. B4.10 and B4.20

   Unit: Indian Point Energy Center, Unit 2 (IP2)

   Interval: Fifth (5^{th})

2. **Applicable Code Edition and Addenda:**

   ASME Section XI, 2007 Edition through 2008 Addenda

   ASME Section XI Code Case N-729-4

   ASME Section III, 1965 Edition through Summer 1965 Addenda including Code Cases 1332, 1335, 1339, and 1359 (Original Construction Code)

   ASME Section III, Subsection NB, 2001 Edition/2003 Addenda

3. **Applicable Code Requirement:**

   IWA-4000 of ASME Section XI contains requirements for removing defects such as weld defects from ASME components. The specific ASME Section XI Code requirements for which use of the proposed alternative is being requested are as follows:

   - IWA-4421 states:

     Defects shall be removed or mitigated in accordance with the following requirements:

     (a) Defect removal by mechanical processing shall be in accordance with IWA-4462.

     (b) Defect removal by thermal methods shall be in accordance with IWA-4461.

     (c) Defect removal or mitigation by welding or brazing shall be in accordance with IWA-4411.

     (d) Defect removal or mitigation by modification shall be in accordance with IWA-4340.

     - Note that use of IWA-4340 for "Mitigation of Defects by Modification" is prohibited by the NRC in 10 CFR 50.55a(b)(2)(xxv).

- IWA-4411 states in part:

  Welding, brazing, fabrication, and installation shall be performed in accordance with the Owner's Requirements and, except as modified below, in accordance with the Construction Code of the item.

  (a) Later editions and addenda of the Construction Code, or a later different Construction Code, either in its entirety or portions thereof, and Code Cases may be used provided the substitution is as listed in IWA-4221(c).

The Construction Code that will be used for performing defect removal and repair of welds on the RPV head at IP2 is the 2001 Edition/2003 Addenda of ASME Section III. Requirements applicable to repair of weld defects are specified in NB-4450 as follows:

- NB-4451, which provides general requirements for removal of weld metal defects, states:

  Defects in weld metal detected by the examinations required by NB-5000, or by the tests of NB-6000, shall be eliminated and repaired when necessary.

- NB-4452, which provides requirements for eliminating weld surface defects without welding, states:

  Weld metal surface defects may be removed by grinding or machining, and need not be repaired by welding, provided that the requirements of (a) through (c) below are met.

  (a) The remaining thickness of the section is not reduced below that required by NB-3000.

  (b) The depression, after defect elimination, is blended uniformly into the surrounding surface.

  (c) The area is examined by a magnetic particle or liquid penetrant method in accordance with NB-5110 after blending and meets the acceptance standards of NB-5300 to ensure that the defect has been removed or reduced to an imperfection of acceptable limit. Defects detected by visual or volumetric method and located on an interior surface need only be reexamined by the method which initially detected the defect when the interior surface is inaccessible for surface examination.

- NB-4453.1, which provides requirements for repairing weld defects with welding, states:

  Defects may be removed by mechanical means or by thermal gouging processes. The area prepared for repair shall be examined by a liquid penetrant or magnetic particle method in accordance with NB-5110, and meet the acceptance standards of NB-5340 or NB-5350. This examination is not required where defect elimination removes the full thickness of the weld and where the backside of the weld joint is not accessible for removal of examination materials.

4. **Reason for Request:**

IP2 is presently in Refueling Outage 2R23. While performing the VT-2 visual examination of the Reactor Pressure Vessel Head (RPVH) required by Code Case N-729-4 (Item No. B4.10)[1], a white substance was observed on the annulus region of RPVH Penetration #3. Ultrasonic (UT) and eddy current (ET) examinations - performed in accordance with Code Case N-729-4 - of the Control Rod Drive Mechanism (CRDM) nozzle of RPVH Penetration #3 did not reveal any indications. However, the UT leak path assessment did provide evidence of change from previous outages. It should also be noted that the VT-2 visual examination of the RPVH did not identify any other relevant indications or base material wastage.

Follow-up surface examinations were also performed on the partial penetration J-groove weld of RPVH Penetration #3 using the liquid penetrant (PT) and ET techniques. The PT and ET examinations confirmed the presence of relevant indications on the face of the J-groove weld. One of the indications was determined to be axial with a measureable through-weld component and is believed to be the initiation source of leakage. Although the depth of this indication could not be conclusively established, its location and characteristics (i.e. dark appearance rather than red indicating that water prevented the red die from penetrating the indication) indicate that this indication was likely the through-weld leakage source. See Figure 1 for additional details.

Due to the through-weld indication described above, a weld repair of the subject J-groove weld is necessary. As an alternative to the defect removal and weld repair provisions of ASME Section XI, IWA-4000 and ASME Section III, NB-4450, Entergy proposes to repair the subject J-groove weld using the embedded flaw repair process as described in WCAP-15987-P-A (Reference 1).

5. **Proposed Alternative and Basis for Use:**

Pursuant to 10 CFR 50.55a(z)(1), Entergy proposes to repair the J-groove weld of RPVH Penetration #3 using an embedded flaw repair process as an alternative to the defect removal and weld repair provisions of ASME Section XI, IWA-4000 and ASME Section III, NB-4450. The proposed embedded flaw repair process is described in WCAP-15987-P-A (Reference 1) and was approved by the NRC in Reference 2. This proposed alternative is requested for one-cycle of operation as Entergy intends to cease power operations of IP2 upon completion of Cycle 24 (Spring 2020).

Basis for Use:

Entergy's review concludes that the proposed embedded flaw repair process based on WCAP-15987-P-A provides an acceptable level of quality and safety. In the Safety Evaluation Report for WCAP-15987-P-A, the NRC documented the same conclusion subject to their specified conditions and limitations (Reference 2). Consistent with WCAP-15987-P-A methodology, the following repair requirements will be met.

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[1] Code Case N-729-4 as amended in 10CFR50.55a(g)(6)(ii)(D)

5.1 J-Groove Weld Repair Methodology

A. The interface boundary between the J-groove weld and stainless steel cladding will be located with a hand-held ferrite meter instrument that identifies this interface boundary. This technique has been used successfully for positive identification of the weld cladding interface to ensure that all of the Alloy 82/182 material of the J-groove weld is overlaid during the repair. Markings are made to locate the interface as well as a boundary of at least one half inch outboard of the stainless steel cladding and Alloy 82/182 interface.

B. The J-groove weld will be sealed/isolated from the primary water environment by deposition of a 360 degree overlay consisting of at least three (3) layers of Alloy 52 or 52M weld metal. The seal weld will extend onto and encompass the outside diameter of the Alloy 600 penetration nozzle by at least ½". (The seal weld on the Alloy 600 tube will consist of at least 2 layers of Alloy 52 or 52M weld metal.) It will also extend at least ½" beyond the stainless steel cladding interface after deposition of the ER309L buffer layer discussed in paragraph 3 below. Excavation or partial excavation of J-groove weld flaws is not required. See Figure 2 for additional details.

C. Prior to application of the Alloy 52/52M repair weld layers on the RPVH cladding surface, at least three (3) passes (one layer) of ER309L stainless steel buffer will be installed on the clad surface approximately 0.5 inch beyond the interface of the clad and J-groove weld metal 360 degrees around. These weld passes serve to isolate subsequent ERNiCrFe-7A weld passes from contaminants in the cladding.

D. Nondestructive examinations, including preservice, of the completed seal weld repair will be performed as specified in the NRC's Safety Evaluation (Reference 3) for WCAP-15987-P, Revision 2-P-A with modifications summarized below. As previously stated, Entergy intends to cease power operations of IP2 upon completion of Cycle 24 (Spring-Summer 2020); therefore, this proposed alternative does not include any requirements for inservice inspections.

Flaw Orientation	Repair NDE (Note 1)
Axial	UT and Surface (Notes 2 and 3)
Circumferential	UT and Surface (Notes 2 and 3)

Note:

1) Preservice inspection will be consistent with 10 CFR 50.55a(g)(6)(ii)(D), which requires the implementation of Code Case N-729-4 with conditions; or NRC approved alternatives to these specified conditions.

2) UT personnel and procedures qualified in accordance with 10 CFR 50.55a(g)(6)(ii)(D), which requires the implementation of Code Case N-729-4 with conditions. Accessible portion of the J-groove repaired region will be examined. The UT plus surface examination coverage must equal 100 percent.

3) Surface examination shall comply with the acceptance standards of ASME Section III, NB-5350 as stipulated in 10 CFR 50.55a(g)(6)(ii)(D). The surface examination of the completed seal weld will include ½" of adjacent material but need not include the threads or thread relief at the end of the CRDM nozzle.

5.2 Technical Basis for Proposed Alternative

A. The purpose of the proposed alternative is to embed and isolate the Alloy 600 (Inconel 82/182) J-groove weld and any identified flaws. The repair overlay welds are not credited for providing structural strength to the original pressure boundary materials.

B. As discussed in WCAP-15987-P, the embedded flaw repair technique is considered a permanent repair. As long as a PWSCC flaw remains isolated from the primary water environment, it cannot propagate. Since an Alloy 52/52M weldment is considered highly resistant to PWSCC, a new PWSCC flaw should not initiate and grow through the Alloy 52/52M seal weld to reconnect the primary water environment with the embedded flaw. Structural integrity of the affected J-groove weld will be maintained by the remaining unflawed portion of the weld. Alloy 52/52M weld metal is highly resistant to PWSCC, as demonstrated by multiple laboratory tests, as well as over twenty years of service experience in replacement steam generators.

C. WCAP-15987-P notes that the residual stresses produced by the embedded flaw technique have been measured and found to be relatively low because of the small thickness of the seal weld. This implies that no new flaws will initiate and grow in the area adjacent to the repair weld. There are no other known mechanisms for significant flaw propagation in the reactor vessel closure head and penetration tube region since cyclic loading is negligible. In Section 3.2 of the Safety Evaluation for WCAP-15987-P, the NRC recognized this conclusion and its basis which is provided in WCAP-13998, Revision 1 (Reference 4).

D. The thermal expansion properties of Alloy 52 or 52M weld metal are not specified in the ASME Code. In this case, the properties of the equivalent base metal (Alloy 690) should be used. For Alloy 690, the thermal expansion coefficient at 600 degrees Fahrenheit (F) is 8.2E-6 in/in/degree F as found in Section II part D. The Alloy 600 base metal has a coefficient of thermal expansion of 7.8 E-6 in/in/degree F, a difference of about 5 percent. The effect of this small difference in thermal expansion is that the weld metal will contract more than the base metal when it cools, thus producing a compressive stress on the Alloy 82/182 J-groove weld. This beneficial effect has already been accounted for in the residual stress measurements reported in the technical basis for the embedded flaw repair, as noted in the WCAP-15987-P.

E. Westinghouse letter LTR-SDA-18-035, *Fracture Mechanics Assessment of Embedded Flaw Repair Acceptability for Indian Point Unit 2*, will provide a technical basis for returning the Reactor Pressure Vessel to service with the embedded flaw repair of Penetration #3 J-groove weld. This technical basis will include a discussion of the significant experience with embedded flaw repairs

within the PWR fleet using WCAP-15987-P and ASME Section XI flaw analysis. The letter will also discuss the applicability and conservatism of the historical analyses relative to the Indian Point 2 repair. The conclusion of the Westinghouse evaluation will provide additional technical basis for one additional cycle of operation.

5.3 NRC Submittals

Entergy will submit Westinghouse Letter LTR-SDA-18-035, Fracture Mechanics Assessment of Embedded Flaw Repair Acceptability for Indian Point Unit 2, prior to entering Mode 5 during the present refueling outage, 2R23. Mode 5 is currently expected to occur on April 12, 2018 at 0100 hours.

Entergy's review concludes that the proposed embedded flaw repair of the RPVH Penetration #3 J-groove weld is a technically sound alternative to performing an ASME Section XI Code repair in accordance with IWA-4000 and ASME Section III, NB-4450. The embedded flaw weld repair isolates the PWSCC susceptible Alloy 81/182 J-groove weld from the primary water environment by deposition of a 360 degree overlay consisting of Alloy 52 or 52M weld metal. This seal weld will extend at least ½" beyond the stainless steel cladding interface and encompass the outside diameter of the Alloy 600 penetration nozzle by at least ½". The seal weld will be examined by both surface and UT examination methods as described in Section 5.1. Because Alloy 52/52M welds are considered highly resistant to PWSCC, a new PWSCC flaw should not initiate and grow through the Alloy 52/52M seal weld to reconnect the primary water environment with the embedded flaw. Furthermore, the existing flaw in the J-groove weld can no longer grow by the PWSCC since the weld is isolated from the reactor coolant environment. Additional technical justification is provided in Section 5.2. In conclusion, Entergy believes that this proposed alternative provides an acceptable level of quality and safety as required by 10 CFR 50.55a(z)(1).

6. Duration of Proposed Alternative:

This proposed alternative is for one-cycle of operation as Entergy intends to cease power operations of IP2 upon completion of Cycle 24 (Spring 2020).

7. Precedent:

1. Indian Point, Unit 2 (Entergy) – Relief Request RR-07: Reactor Vessel Head Alternative Weld Repair Methods (Docket No. 50-247), dated August 15, 2007

2. Beaver Valley, Unit No. 2 (First Energy Nuclear Operating Company) – Relief Request 2-TYP-3-RV-04, Revision 1: Alternative Examination of Reactor Vessel Head Penetration J-Groove Weld Repairs (Docket No. 50-412), dated November 16, 2016

3. Byron Station, Units 1 and 2 (Exelon) - Relief Request 14R-10, Revision 1: Alternative Requirements for the Repair of Reactor Vessel Head Penetrations in Accordance with 10 CFR 50.55a(z)(1) (Docket Nos. STN 50-454 and STN 50-455) dated December 29, 2016

4. Virgil C. Summer Nuclear Station (SCE&G) Relief Request RR-4-05: Alternative Weld Repair for Reactor Vessel Upper Head Penetrations (Docket 50-395), dated February 24, 2014

8. References:

1. Westinghouse Topical Report, WCAP-15987-P, Revision 2-P-A, "Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations," dated December 2003.

2. Letter H. N. Berkow (U.S. NRC) to H. A. Sepp (Westinghouse Electric Company), "Acceptance for Referencing - Topical Report WCAP-15987-P, Revision 2, 'Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetration,' (TAC NO. MB8997)," dated July 3,2003 [ML031840237]

3. Letter from H. N. Berkow (U.S. NRC) to H. A. Sepp (Westinghouse Electric Company), "Acceptance for Referencing -Topical Report WCAP-15987-P, Revision 2, 'Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations,' (TAC No. MB8997)," dated July 3, 2003, Accession Number ML031840237

4. WCAP-13998, Revision 1, "RV Closure Head Penetration Tube ID Weld Overlay Repair," November 1995

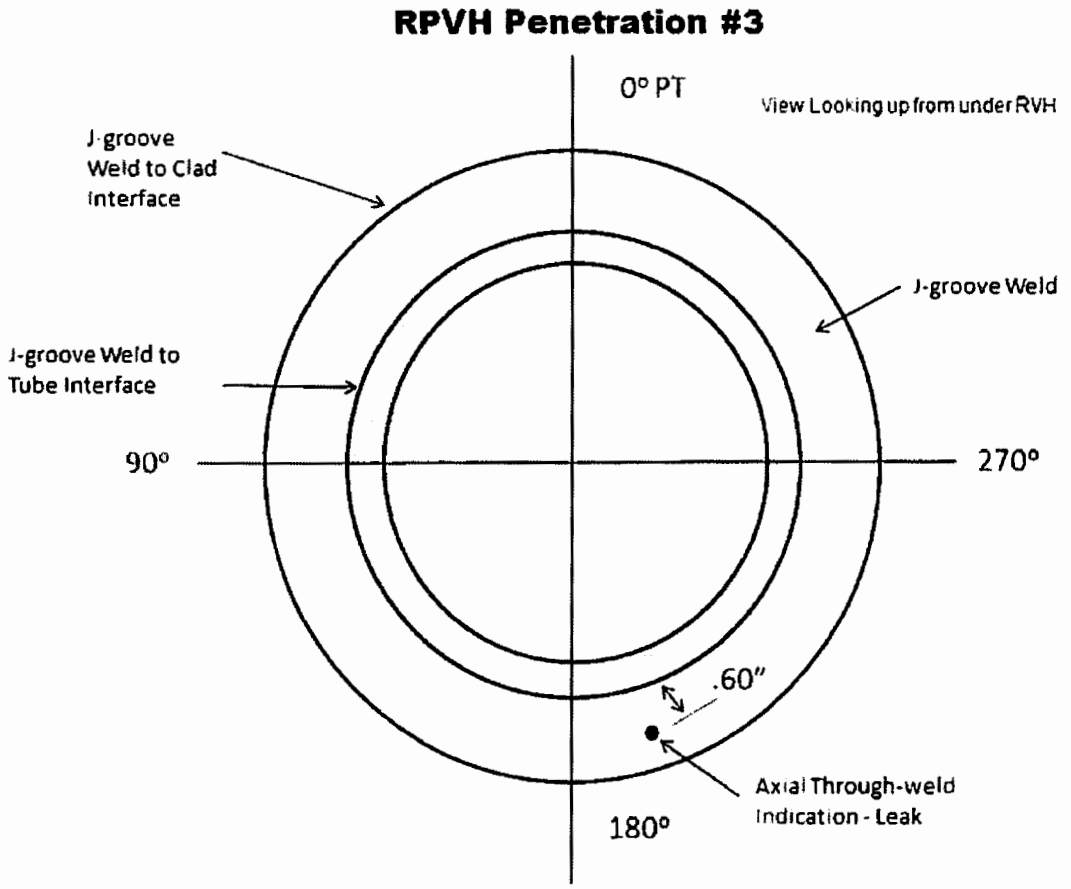

Figure 1: Location of Through-weld Indication

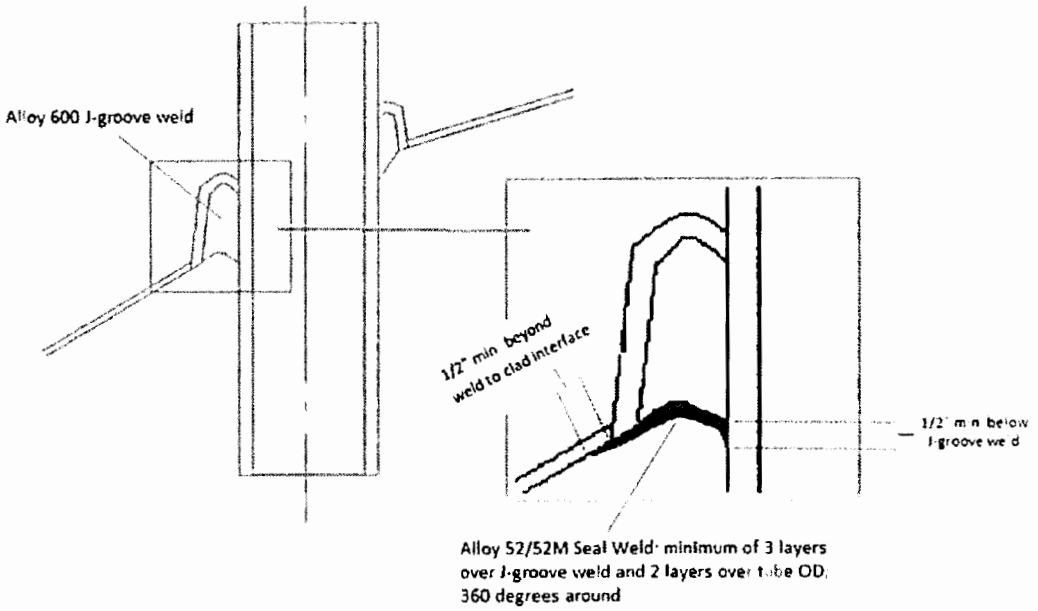

Figure 2: Repair of J-groove Weld

Attachment 2

to

Letter NL-18-019

Commitment

This table identifies actions discussed in this letter for which Entergy commits to perform. Any other actions discussed in this submittal are described for the NRC's information and are **not** commitments.

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
Entergy will submit Westinghouse Letter LTR-SDA-18-035, Fracture Mechanics Assessment of Embedded Flaw Repair Acceptability for Indian Point Unit 2, prior to entering Mode 5 during the present refueling outage, 2R23. Mode 5 is currently expected to occur on April 12, 2018 at 0100 hours.	X		Prior to entering Mode 5 during the present refueling outage, 2R23.