May 1, 2003

Mr. Michael R. Kansler, President
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

SUBJECT: RELIEF REQUEST NOS. 61 AND 3-31 FROM AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE SECTION XI, INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3 (TAC NOS. MB5712 AND MB5713)

Dear Mr. Kansler:

In a letter dated July 29, 2002, as supplemented on September 26, 2002, Entergy Nuclear Operations, Inc. (Entergy), submitted Relief Request (RR) Nos. 61 and 3-31 for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and 3), respectively. Relief was requested from the repair requirements of Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) in order to use an alternative method to the temper bead welding requirements of ASME Section XI, IWA-4300 and IWA-4500 for reactor pressure vessel head penetration nozzle welds. Specifically, Entergy proposes to perform ambient temperature temper bead welding using a machine gas tungsten arc welding temper bead technique.

The NRC staff reviewed the proposed alternative in RR 61 and RR 3-31. The results are provided in the enclosed safety evaluation.

The NRC staff has concluded that the proposed alternative to the ASME Code requirements in RRs 61 and 3-31 are acceptable. Pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative is authorized for the remainder of the third inservice inspection interval which is until April 3, 2006, for IP2 and until July 20, 2009, for IP3.

If you should have any questions, please contact Patrick Milano at 301-415-1457. This completes the NRC staff's action on TAC Nos. MB5712 and MB5713.

Sincerely,

/RA/

Richard J. Laufer, Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosure: Safety Evaluation

cc w/encl: See next page

If you should have any questions, please contact Patrick Milano at 301-415-1457. This completes the NRC staff's action on TAC Nos. MB5712 and MB5713.

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Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF NOS. 61 AND 3-31

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3

DOCKET NOS. 50-247 AND 50-286

1.0 INTRODUCTION

The Inservice Inspection (ISI) of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Class 1, Class 2, and Class 3 components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by Section 50.55a(g) of Title 10 of the *Code of Federal Regulations* (10 CFR), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) of 10 CFR states, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that: (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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) will 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. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and that 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) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The inservice inspection code of record for the third 10-year ISI interval at Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) is the 1989 Edition of the ASME Code.

By letter dated July 29, 2002, as supplemented September 26, 2002, Entergy Nuclear Operations, Inc. (ENO, the licensee), requested approval to utilize an alternative method to the temper bead welding requirements of ASME Section XI, IWA-4300 and IWA-4500 for reactor pressure vessel (RPV) head penetration nozzle welds.

2.0 ISI RELIEF REQUEST (RR) NOS. 61 AND 3-31

2.1 Code Requirement for which Relief is Requested

Section IWA-4120(a) of ASME Section XI, 1989 Edition, states: "Repairs shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later editions and Addenda of the Construction Code or of Section III, either in their entirety or portions thereof, and Code Cases may be used. If repair welding cannot be performed in accordance with these requirements, the applicable alternative requirements of IWA-4500 and the following may be used:

(1) IWB-4000 for Class 1 components
(2) IWC-4000 for Class 2 components
(3) IWD-4000 for Class 3 components
(4) IWE-4000 for Class MC components
(5) IWF-4000 for component supports."

IWA-4500 of ASME Section XI establishes alternative repair welding methods for performing temper bead welding.

IWA-4530 applies to dissimilar materials such as welds that join P-No. 8 or P-No. 43 nickel alloys to P-No. 3 low alloy steels. According to IWA-4530, "Repairs to welds that join P-No. 8 or P-No. 43 material to P-Nos. 1, 3, 12A, 12B, or 12C material where the ferritic base material is within 1/8-inch of being exposed shall be made by welding in accordance with the provisions of Section III, without the specified post weld heat treatment, provided the requirements of IWA-4531 through IWA-4534 are met."

Half bead welding technique repairs of RPV head penetration nozzle J-welds are performed in accordance with IWA-4500, in particular IWA-4530 whenever the repair cavity is within 1/8-inch of the ferritic base materials of the RPV head. The requirements of IWA-4530 include:

> The weld metal shall be deposited by the shielded metal-arc welding process (SMAW).
>
> A minimum preheat temperature of 300 °F shall be maintained for at least 30 minutes before welding is started. Interpass temperature cannot exceed 400 °F.
>
> The preheat temperature of 300 °F shall be maintained until the exposed base metal is covered with at least 3/16" of weld metal.
>
> After at least 3/16" of weld metal has been deposited, the 3T band to be heat-treated shall be maintained in the range of 450 °F to 550 °F for 2 hours as a minimum.
>
> Preheat, interpass, and heat treatment temperatures shall be monitored using thermocouples and recording instruments.
>
> A liquid penetrant test (PT) shall be performed in the area being repaired after the heat treatment is complete.

The repair weld and preheated band shall be nondestructively examined after the completed weld has been at ambient temperature for 48 hours as a minimum.

The nondestructive examination (NDE) of the repaired region shall include radiography (RT), if practical, ultrasonic examination (UT), and liquid penetrant examination.

Areas from which welded thermocouples have been removed shall be ground and examined by magnetic particle testing (MT) or PT methods.

2.2 Licensee's Proposed Alternative to Code

In lieu of the SMAW-temper bead welding requirements of IWA-4500, and IWA-4530 of ASME Section XI, 1989 Edition, [ENO] proposes the alternatives as described below. These alternatives conform to ASME Code Case N-638. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), ENO proposes alternatives to the SMAW temper bead welding requirements of IWA-4500 and IWA-4530 of ASME Section XI. Specifically, ENO proposes to perform ambient temperature temper bead welding in accordance with Enclosure 1 [to its July 29, 2002, letter] of this relief request, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW [Gas Tungsten Arc Welding] Temper Bead Welding Technique."

ENO has reviewed the proposed ambient temperature temper bead welding techniques of Enclosure 1 against the SMAW-temper bead welding requirements of IWA-4500 and IWA-4530. This review was performed to identify and to reconcile the differences between the proposed alternatives in Enclosure 1 and IWA-4500 and IWA-4530 requirements. Specifically, ENO proposes these alternatives to the requirements of the following ASME Section XI subsections:

1. IWA-4530 specifies that repairs made to dissimilar materials identified in IWA-4530 may be performed without the specified post weld heat treatment of ASME Section III provided the requirements of IWA-4531 through IWA-4534 are met. As an alternative, ENO proposes to perform temper bead weld repairs using the ambient temperature temper bead welding technique described in Enclosure 1.

2. IWA-4531 (a) and (b) specify that the weld metal shall be deposited by the SMAW using F-No. 43 weld metal for P-No. 43 to P-No. 3 weld joints. The maximum bead width shall be three times the electrode core diameter. Also, the precautions of IWA-4521(b) shall be met. As an alternative, ENO proposes to use the Machine or Automatic GTAW welding process with F-No. 43 weld metal when performing ambient temperature temper bead welding in accordance with Enclosure 1.

3. IWA-4533(a) and (d) specify that the cavity and area to be repaired shall be preheated to 300 °F. This minimum temperature shall be maintained for at least 30 minutes before welding is started, during welding, and until starting the post weld heat treatment of 450 °F to 550 °F. The width of the band to be heat-treated shall be three times the thickness (3T) of the component to be welded, but need not exceed 10". The maximum interpass temperature

shall be 400 °F. The minimum preheat temperature for ferritic base material shall be 300 °F, and shall be maintained until the exposed base metal is covered with at least 3/16" of weld metal. The preheat shall be maintained until the heat treatment specified in IWA-4533(b) is performed. For the balance of welding, the maximum interpass temperature shall be 350 °F, and the minimum preheat shall be 60 °F. After at least 3/16" of weld metal has been deposited, the 3T band shall be maintained in the range of 450 °F to 550 °F for 2 hours as a minimum. ENO proposes that the weld area plus a band around the repair area of at least 1.5 times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 50 °F for the GTAW welding process during welding, maximum interpass temperature shall be 150 °F for the 1/8-inch butter thickness (first three weld layers as a minimum) and 350 °F for the balance of welding.

4. IWA-4533(b) specifies that thermocouples and recording instruments shall be used to monitor process temperatures. As an alternative, ENO proposes to monitor preheat and interpass temperatures using an infrared thermometer.

5. IWA-4533(b) specifies that thermocouples shall be attached by either welding or mechanical methods. Because ENO will use an infrared thermometer to monitor preheat and interpass temperatures, thermocouples will not be used. Therefore, the thermocouple attachment requirements of IWA-4533(b) do not apply.

6. IWA-4533(c) specifies that all areas of the ferritic base metal, exposed or not, shall be covered with one layer of weld deposit using 3/32" diameter electrodes. Approximately one-half the thickness of this layer shall be removed by grinding before depositing the second layer, and subsequent layers with 1/8" diameter electrodes. As an alternative, ENO proposes to butter the weld area with a minimum of three layers of weld metal to obtain a minimum butter thickness of 1/8-inch. The heat input of each weld layer in the 1/8-inch thick buttered section shall be controlled to within +/-10% of that used in the procedure qualification test. The heat input for subsequent weld layers shall not exceed the heat input used for layers beyond the 1/8-inch thick buttered section (first three weld layers) in the procedure qualification.

7. IWA-4534(b) specifies the repair area and the 3T band as defined in IWA-4534(a) shall be nondestructively examined after the completed weld has been at ambient temperature for a period of 48 hours minimum. The nondestructive examination of the repair-welded region shall include radiography, if practical, ultrasonic examination, and liquid penetrant examination. As an alternative to the volumetric examination of IWA-4534(b), ENO proposes the repair welds will be progressively examined by the liquid penetrant method in accordance with NB-5245 of ASME Section III, 1989 Edition. Acceptance criteria shall be in accordance with NB-5350.

8. IWA-4534(c) specifies that areas from which weld attached thermocouples have been removed shall be ground and examined by the magnetic particle method or by the liquid penetrant method. Because ENO will use an infrared thermometer to monitor preheat and interpass temperatures, thermocouples will not be used. Therefore, the examination requirements of IWA-4534(c), for the areas from which weld attached thermocouples have been removed, do not apply.

These proposed alternatives are specific to localized weld repair of RPV head penetration nozzle J-welds where 1/8-inch or less of Inconel weld metal exists between the J-weld repair cavity and the ferritic base material of the RPV head. All flaws in the J-weld will be removed prior to performing any temper bead weld repairs in accordance with this relief request.

2.3 Licensee's Basis for Relief

The licensee stated IWA-4500 and IWA-4530 of ASME Section XI establish the requirements for performing temper bead welding of "base materials" and "dissimilar materials." According to IWA-4531, the SMAW process shall be used. The IWA-4500, and IWA-4530 temper bead welding process is a time and dose intensive process. Resistant heating blankets are attached to the RPV head and typically a capacitor discharge stud welding process is used. Thermocouples must also be attached to the RPV head using a capacitor discharge welding process to monitor preheat, interpass and post weld bake temperatures. Prior to heat-up, thermal insulation is also installed. Upon completion of repair welding (including the post weld bake), the insulation, heating blankets, studs, and thermocouples must be removed from the RPV head. Thermocouples and stud welds are removed by grinding. The ground areas are subsequently examined by the LPT or MT method. A significant reduction in dose could be realized by utilizing an ambient temperature temper bead welding process. Because the ASME Code does not presently include rules for ambient temperature temper bead welding, ENO proposes the alternatives as described in Enclosure 1 to its July 29, 2002, letter.

The licensee indicated that research by the Electric Power Research Institute (EPRI) and other organizations on the use of an ambient temperature temper bead welding operation using the machine GTAW welding process is documented in EPRI Report GC-111050. According to the EPRI report, repair welds performed with an ambient temperature temper bead welding procedure utilizing the machine GTAW welding process exhibit mechanical properties equivalent or better than those of the surrounding base material. Laboratory testing, analysis, successful procedure qualifications, and successful repairs have all demonstrated the effectiveness of this process.

The principal reason to preheat a component prior to repair welding is to minimize the potential for cold cracking according to the licensee. The licensee stated the two cold cracking mechanisms are hydrogen cracking and restraint cracking. Both of these mechanisms occur at ambient temperature. Preheating slows down the cooling rate resulting in a ductile, less brittle microstructure, thereby lowering susceptibility to cold cracking. Preheat also increases the diffusion rate of monatomic hydrogen that may have been trapped in the weld during solidification. As an alternative to preheat, the ambient temperature temper bead welding process utilizes the tempering action of the welding procedure to produce tough and ductile microstructures. Because precision bead placement and heat input control is characteristic of the machine GTAW welding process, effective tempering of weld heat-affected zones (HAZs) is possible without the application of preheat. According to EPRI Report GC-111050, "The temper bead welding process is carefully designed and controlled such that successive weld beads supply the appropriate quantity of heat to the untempered [HAZ] such that the desired degree of carbide precipitation (tempering) is achieved. The resulting microstructure is very tough and ductile."

Hydrogen cracking is a form of cold cracking. It is produced by the action of internal tensile stresses acting on low toughness HAZs. The internal stresses are produced from localized build-up of monatomic hydrogen. Monatomic hydrogen forms when moisture or hydrocarbons interact with the welding arc and molten weld pool. The monatomic hydrogen can be entrapped during weld solidification and tends to migrate to transformation boundaries or other microstructure defect locations. As concentrations build, the monatomic hydrogen will recombine to form molecular hydrogen, thus, generating localized internal stresses at these internal defect locations. If these stresses exceed the fracture toughness of the material, hydrogen induced cracking will occur. This form of cracking requires the presence of hydrogen and susceptible materials. It is manifested by intergranular cracking of susceptible materials and can occur within 48 hours of welding.

IWA-4500 establishes elevated preheat and post weld bake requirements. The elevated preheat temperature of 300 °F increases the diffusion rate of hydrogen from the weld. The post weld bake at 450 °F was also established to bake-out or facilitate diffusion of any remaining hydrogen from the weldment. However, while hydrogen cracking is a concern for SMAW which uses flux covered low hydrogen electrodes, the potential for hydrogen cracking is significantly reduced when using the machine GTAW welding. The machine GTAW welding process is inherently free of hydrogen. Unlike the SMAW process, GTAW welding filler metals do not rely on flux coverings that are susceptible to moisture absorption from the environment. Conversely, the GTAW welding process utilizes dry, inert shielding gases that protect the molten weld pool from oxidizing atmospheres. Any moisture on the surface of the component being welded will be vaporized ahead of the welding torch. The vapor is prevented from being mixed with the molten weld pool by the inert shielding gas that blows the vapor away before it can be mixed. This is important because filler metals and base materials are the most realistic sources of hydrogen for automatic or machine GTAW temper bead welding.

As explained above by the licensee, the potential for hydrogen induced cracking is greatly reduced by using the machine GTAW welding process. However, should it occur, cracks would be detected by the final NDE performed after the completed repair weld has been at ambient temperature for at least 48 hours as required in Enclosure 1 to the licensee’s letter of July 29, 2002. Regarding this issue, EPRI Report GC-11105C, Section 6.0 concluded the following:

> No preheat temperature or post weld bake above ambient temperature is required to achieve sound machine GTAW temper bead weld repairs that have high toughness and ductility. This conclusion is based on the fact that the GTAW welding process is an inherently low hydrogen process regardless of the welding environment. Insufficient hydrogen is available to be entrapped in solidifying weld material to support hydrogen delayed cracking. Therefore, no preheat nor post weld bake steps are necessary to remove hydrogen because the hydrogen is not present with the Machine GTAW welding process.

As stated above, the licensee indicated that the temper bead welding process requirements under IWA-4530 includes a post weld bake requirement. Performed at 450 °F to 550 °F for four hours (P-No. 3 base materials), this post weld bake assists diffusion of any remaining hydrogen from the repair weld. This post weld bake is a hydrogen bake-out and not a post weld heat treatment as defined by the ASME Code. At 450 °F to 550 °F, the post weld bake does not stress relieve, temper, or alter the mechanical properties of the weldment in any manner.

Cold cracking generally occurs during cooling at temperatures approaching ambient temperature. As stresses build under a high degree of restraint, cracking may occur at defect locations. Brittle microstructures with low ductility are subject to cold restraint cracking. However, the ambient temperature temper bead weld technique is designed to provide sufficient heat inventory so as to produce the desired tempering for high toughness. Because the machine GTAW temper bead weld process provides precision bead placement and control of heat, the toughness and ductility of the HAZ will typically be superior to the base material. Therefore, the resulting structure will be appropriately tempered to exhibit toughness sufficient to resist cold cracking. Additionally, even if cold cracking were to occur, it would be detected by the final NDE performed after the completed repair weld has been at ambient temperature for at least 48 hours.

Enclosure 1 to the licensee's July 29, 2002, letter establishes detailed welding procedure qualification requirements. Simulating base materials, filler metals, restraint, impact properties, and procedure variables, the qualification requirements provide assurance that the mechanical properties of repair welds will be equivalent or superior to those of the surrounding base material. It should also be noted that these qualification requirements are identical to those in IWA-4512. Based upon ambient temperature temper bead procedure qualification test results, the impact properties of the base material HAZ were greater than those of the unaffected base material.

The licensee concluded that no elevated preheat or post weld bake above ambient temperature is required to achieve sound and tough repair welds when performing ambient temperature temper bead welding technique using the machine GTAW welding process. This conclusion is based upon strong evidence that hydrogen cracking will not occur with the GTAW welding process. In addition, automatic or machine temper bead welding procedures without preheat will produce satisfactory toughness and ductility properties both in the weld and weld HAZs. The results of previous industry qualifications and repairs further support this conclusion. The use of an ambient temperature temper bead welding procedure will improve the feasibility of performing localized weld repairs with a significant reduction in radiological exposure. EPRI Report GC-111050, concluded the following:

> Repair of RPV components utilizing machine GTAW temper bead welding at ambient temperature produces mechanical properties that are commonly superior to those of the service-exposed substrate. The risk of hydrogen delayed cracking is minimal using the GTAW process. Cold stress cracking is resisted by the excellent toughness and ductility developed in the weld HAZ (heat-affected zone). Process design and geometry largely control restraint considerations, and these factors are demonstrated during weld procedure qualification.

2.4 Staff Evaluation

According to IWA-4530, repairs may be performed to dissimilar base materials and welds without the specified post weld heat treatment of ASME Section III provided the requirements of IWA-4531 through IWA-4534 are met. The temper bead welding rules of IWA-4531 through IWA-4534 apply to dissimilar materials such as P-No. 43 to P-No. 3 base materials welded with F-No. 43 filler metals. When using the machine GTAW welding process, the IWA-4500 and IWA-4530 temper bead welding technique is based fundamentally on an elevated temperature of 300 °F, a maximum interpass temperature of 450 °F and a post weld bake of 450 °F to 550 °F. The licensee's proposed alternative described also establishes requirements to perform temper bead welding on dissimilar material welds that join P-No. 43 to P-No. 3 base materials using F-No. 43 filler materials. However, the proposed temper bead welding technique is an ambient temperature technique, which utilizes the machine GTAW process.

According to IWA-4531(a) and (b), the weld metal shall be deposited by SMAW using F-No. 43 weld metal for P-No. 3 to P-No. 43 weld joints. The maximum bead width shall be three times the electrode core diameter. Also, the precautions of IWA-4521 (b) shall be met. Only the machine or automatic GTAW welding process with F-No. 43 weld metal can be used when performing ambient temperature temper bead welding. This is suitable because the heat penetration of subsequent weld layers is carefully applied to produce overlapping thermal profiles that develop an acceptable degree of tempering in the underlying HAZ.

According to IWA-4533(a) and (d), the cavity and area to be repaired shall be preheated to 300 °F. This minimum temperature shall be maintained for at least 30 minutes before welding is started, during welding, and until starting the post weld bake of 450 °F to 550 °F. The width of the band to be heat-treated shall be three times the thickness (3T) of the component to be welded, but need not exceed 10 inches. The maximum interpass temperature shall be 400 °F. The minimum preheat temperature for ferritic base material shall be 300 °F and shall be maintained until the exposed base metal is covered with at least 3/16" of weld metal. The preheat shall be maintained until the heat treatment specified in IWA-4533(b) is performed. For the balance of welding, the maximum interpass temperature shall be 350 °F and the minimum preheat shall be 60 °F. ENO proposes that the weld area plus a band around the repair area of at least 1-1/2 times the component thickness (T), or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 50 °F for the GTAW welding process during welding; maximum interpass temperature shall be 150 °F for the 1/8-inch butter thickness (first three weld layers as a minimum) and 350 °F for the balance of welding. This is suitable because the heat penetration of subsequent weld layers is carefully applied to an acceptable degree of tempering in the underlying HAZ.

According to IWA-4533(b), thermocouples and recording instruments shall be used to monitor the preheat and interpass requirements and the 450 °F to 550 °F post weld bake. Thermocouples may be attached by welding or by mechanical methods. As an alternative to IWA-4533(b), ENO proposes to monitor preheat and interpass temperatures using an infrared thermometer. Infrared thermometers are hand-held devices that can be used to monitor process temperature from a remote location. The preheat temperature will be verified to be 55 °F (minimum) prior to depositing the first weld layer. Prior to depositing the second and third weld layers, the interpass temperatures will be verified to be at least 55 °F, but less than 150 °F. The interpass temperature of each remaining layer will be verified to be at least 55 °F, but less than 350 °F prior to depositing the subsequent weld layers. The initial preheat temperature and the interpass temperatures for each weld layer will be recorded in the weld documentation of the repair traveler for each repair weld. The weld documentation of the repair traveler will be maintained as a permanent plant record. The preheat temperature required for this welding is 55°F. This temperature is to be maintained on a weldment inside a building which normally is above this temperature. Thus, preheat measurement by this alternate method is acceptable. The maximum interpass temperatures required for this welding (150°F for the first three layers, and a maximum interpass temperature of 350°F for the balance of welding), can easily be measured with this type of device; however, procedure qualifications performed for this welding showed that these temperatures were not exceeded or even approached when these tests where performed on similar materials, thicknesses and welding processes. Therefore, it is unlikely that these welds will ever exceed these temperatures and with the alternate temperature measurement methods, a close control will be maintained on these temperatures. Therefore, this type of temperature measurement is acceptable.

According to IWA-4533(c), all areas of the ferritic base metal, exposed or not, on which weld metal is to be deposited, shall be covered with a single layer of weld deposit using 3/32-inch diameter electrodes. Approximately one-half the thickness of this layer shall be removed by grinding before depositing the second layer. The second and subsequent layers shall be deposited with 1/8-inch diameter electrodes. The techniques described in this paragraph shall be duplicated in the procedure qualification. In the proposed alternative, the deposition and removal of a final reinforcement layer is not required. A final reinforcement layer is required when a weld repair is performed on a ferritic base material or ferritic weld using a ferritic weld metal. On ferritic materials, the weld reinforcement layer is deposited to temper the last layer of untempered weld metal of the completed repair weld. Because the weld reinforcement layer is untempered (and unnecessary), it is removed. However, when repairs are performed using non-ferritic weld metal, a weld reinforcement layer is not required because non-ferritic weld metal does not require tempering. When performing a dissimilar material weld with a non-ferritic filler metal, the only location requiring tempering is the weld HAZ in the ferritic base material along the weld fusion line. However, the three weld layers of the 1/8-inch thick butter section are designed to provide the required tempering to the weld HAZ in the ferritic base material. Therefore, a weld reinforcement layer is not required. This position is supported by the fact that ASME Code Case N-638 only requires the deposition and removal of a reinforcement layer when performing repair welds on similar (ferritic) materials. Repair welds on ferritic base materials using a non-ferritic weld filler material are exempt from this requirement. The very precise control over these factors afforded by the alternative provides more effective tempering and eliminates the need to grind or machine the first layer of the repair. Non-ferritic filler metals, such as the F-No. 43 filler metal, do not undergo a phase change at elevated temperature and, therefore, do not require a post-weld heat treatment. Since the last layer of weld metal is a non-ferritic metal being deposited over two previous non-ferritic weld filler metal layers, the need for a tempering layer is unnecessary and, therefore, its removal is unnecessary. Therefore, deletion of this requirement is acceptable.

According to IWA-4533(d), after at least 3/16-inch of weld metal has been deposited, the 3T band shall be maintained in the range of 400 °F to 550 °F for two hours as a minimum. As an alternative, ENO proposes that an interpass temperature of 350 °F be used after depositing at least 1/8-inch of weld metal without a post weld bake. The proposed ambient temperature temper bead welding technique is carefully designed and controlled such that successive weld beads supply the appropriate quantity of heat to the untempered HAZ and the desired degree of tempering is achieved. The use of the automatic or machine GTAW process utilized for temper bead welding allows more precise control of heat input, bead placement, bead size, and bead contour than the manual SMAW process. The resulting microstructure is tough and ductile. Based on Charpy V-notch testing of the procedure qualification test coupon, impact properties in the weld HAZ were greater than those of the unaffected base material. Therefore, the proposed heat input controls provide an appropriate level of tempering. The use of a GTAW temper bead welding technique to avoid the need for postweld heat treatment is based on research that has been performed by EPRI and other organizations. The research demonstrates that carefully controlled heat input and bead placement allows subsequent welding passes to relieve stress, and temper the HAZ of the base material and preceding weld passes. Data presented in the EPRI report show the results of acceptable procedure qualifications performed with 300 °F preheats and 500 °F preheats, as well as with no preheat and postheat. Many acceptable procedure qualification records and weld procedure specifications presently exist which have been utilized to perform numerous successful repairs which indicate that the use of a GTAW temper bead welding technique is an acceptable approach. From this data, it can be shown that adequate toughness can be achieved in base metal and HAZs with the use of a GTAW temper bead welding technique. The temper bead process has been shown effective by research, successful procedure qualifications, and many successful repairs performed since the technique was developed. Therefore, the alternative temperature proposal is acceptable.

IWA-4534(b) specifies the repair area and the 3T band as defined in IWA-4534(a) shall be nondestructively examined after the completed weld has been at ambient temperature for a period of 48 hours minimum. The NDE of the repair-welded region shall include RT, if practical, UT, and MT. As an alternative to the volumetric examination of IWA-4534(b), ENO proposes progressive PT and a final PT after the weld has been at ambient temperature for 48 hours for repair welds in RPV penetration nozzle J-welds.

In its supplemental letter dated September 26, 2002, the licensee stated that RT is not appropriate for base material weld repairs of RPV head penetration nozzles. RT techniques require that the source of radiation be placed as near normal as possible to the item being examined with the film in intimate contact with the item on the opposite surface. Attempting to RT the repair welds would have the radiation source being placed at various angles other than normal. The required radiographic sensitivity and geometric unsharpness would be unacceptable. Clearances between the RPV nozzles and the RPV head would make radiography of a repair weld impractical.

The licensee went on to state that UT is not appropriate for base material weld repairs of RPV head penetration welds. The J-groove weld configuration and geometry of the penetration in the head limits access making it impractical to perform UT. Multiple readings utilizing various angle beams would be required to get meaningful data on the soundness of the repairs due to the changing thickness and geometry that would be increasing as the repair weld moved up the nozzle bore.

The licensee stated that the J-groove welds of the RPV penetration nozzles were designed and fabricated in accordance with ASME Section III, 1965 Edition, 1966 Addenda, Section N-457(c) and Figure N-462.4(d). These subsubparagraphs required that the welds be examined with progressive PT, and that later Editions of the Code do not require volumetric examination. The licensee stated that cold cracking, should it occur, would be detected by the progressive PT and delayed hydrogen cracking would be detected by the final NDE of the weld.

The staff concludes that sufficient information is presented in EPRI Report GC-11105C to indicate that both cold and delayed hydrogen cracking is unlikely. The progressive PT will provide assurance that each weld pass will meet the Code acceptance criteria and the final PT will assure any delayed cracking will be detected should it occur. Based on the above discussion, the staff concludes that the alternative NDE provides an acceptable level of quality and safety.

With respect to monitoring the performance of repairs to J-groove welds and nozzle material, the staff has determined that successive inspections are necessary to assure cracking under the repairs remains dormant. This concern is due to the safety significance of the component and the fact that there is little field experience with these repairs in service. As a result of the February 11, 2003 Order, EA-03-009, any repairs to RPV head penetration nozzles and J-groove welds will automatically require the subject plant to be placed into the high susceptibility category. Each high susceptibility plant must perform a Bare Metal Visual Examination of the RPV head and a UT or eddy-current testing of the wetted surfaces after each cycle of operation. This action is to continue after each cycle of operation until such time the requirements of the Order are modified for the specific unit, or the head is replaced.

3.0 CONCLUSION

On the basis of the above evaluation, the NRC staff concludes that the licensee's proposed alternative to use GTAW ambient temperature temper bead welding and progressive PT for RPV head penetration nozzle J- groove weld repairs under RR-61 and RR-3-31 provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed alternative to the SMAW temper bead welding requirements of IWA-4500 and IWA-4530 of ASME Section XI at IP2 and IP3 for the third 10-year ISI interval which is until April 3, 2006, for IP2 and until July 20, 2009 for IP3. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

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Date: May 1, 2003