August 26, 2008

Mr. Dennis R. Madison
Vice President - Hatch
Edwin I. Hatch Nuclear Plant
11028 Hatch Parkway North
Baxley, GA 31513

SUBJECT: EDWIN I. HATCH NUCLEAR PLANT, UNIT NO. 1, SAFETY EVALUATION FOR REQUEST TO USE ASME CODE CASES N-504-2 AND N-638-1 FOR WELD OVERLAY REPAIRS FOR ALTERNATIVE TO ASME CODE, SECTION XI REPAIR REQUIREMENTS (TAC NO. MD8152)

Dear Mr. Madison:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated February 26, 2008, as supplemented by letters dated February 28, 2008, and March 17, 2008, Southern Nuclear Operating Company, Inc., (SNC, the licensee) submitted a request for relief from certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code requirements at Edwin I. Hatch Nuclear Plant, Unit 1 (HNP-1). As an alternative to the ASME Code requirements, the licensee proposed to implement a full structural weld overlay (FSWOL) repair in accordance with ASME Code Cases N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique, Section XI, Division 1," and N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1," as modified by the licensee in the application and supplemental letters.

Based on the NRC staff review of the information provided in the application and supplemental letters listed above, the NRC staff finds that the modifications proposed in the Relief Request ISI-GEN-ALT-08-01, Version 1.0 to perform a FSWOL for the control rod drive (CRD) return line N9 nozzle, nozzle-to-cap weld joint dissimilar metal weld at HNP-1 will provide an acceptable level of quality and safety. Therefore, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 Section 55a(a)(3)(i), the proposed Relief Request ISI-GEN-ALT-08-01, Version 1.0 for the installation of a FSWOL over the weld identified in the subject relief request is authorized for the HNP-1 fourth 10-year inservice inspection (ISI) interval which began January 1, 2006, and will end on December 31, 2015. All other requirements of 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.

Please contact Robert Martin at 301-415-1493 with any questions.

Sincerely,

/RA/

Melanie C. Wong, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-321

Enclosure:
Safety Evaluation

cc w/encl: See next page

Please contact Robert Martin at 301-415-1493 with any questions.

Sincerely,

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM REQUEST FOR ALTERNATIVE FOR

EDWIN I. HATCH NUCLEAR PLANT, UNIT NO. 1

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

DOCKET NO. 50-321

1.0 INTRODUCTION

By letter dated February 26, 2008 (Agencywide Document Access and Management System (ADAMS) Accession No. ML080570570), to the U.S. Nuclear Regulatory Commission (NRC), as supplemented by letters dated February 28, 2008, and March 17, 2008 (ADAMS Accession Nos. ML080590566 and ML080770193, respectively), Southern Nuclear Operating Company Inc. (SNC, the licensee), requested relief under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.55a(a)(3)(i), from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) requirements at Edwin I. Hatch Nuclear Plant Unit 1 (HNP-1). As an alternative to the ASME Code requirements, the licensee proposed to implement a full structural weld overlay (FSWOL) repair in accordance with ASME Code Cases N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique, Section XI, Division 1," and N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1," as modified by the licensee in its submittal letters. The alternatives shown in Relief Request ISI-GEN-ALT-08-01, Version 1.0, would be used to perform a FSWOL on the reactor vessel (RV) Control Rod Drive (CRD) Return line N9 nozzle, cap-nozzle weld joint dissimilar metal weld. The subject weld was fabricated using Alloy 82, with Alloy 182 buttering. This safety evaluation (SE) is for the configuration of a FSWOL.

This SE is being issued to document the decision made by the NRC staff to grant the licensee's request by verbal authorization on February 29, 2008. Hence, the tense of this SE will reflect the NRC staff decision prior to installation of the HNP-1 FSWOL. The licensee implemented the installation of the FSWOL in its HNP-1 spring 2008 refueling outage.

2.0 REGULATORY EVALUATION

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 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 inservice inspection (ISI) 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. The fourth 10-year ISI interval for HNP-1 began January 1, 2006, and will end on December 31, 2015. The ISI code of record for HNP-1 for the fourth ten-year ISI interval is the ASME Code, Section XI 2001 Edition, including Addenda through 2003, with an exception. The exception is that for ASME Code, Section XI, Appendix VIII, the 2001 Edition of ASME Code will be used.

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 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. The licensee submitted the subject relief request, pursuant to 10 CFR 50.55a(a)(3)(i), which proposed an alternative to the implementation of the ASME Code, Section XI requirements based on ASME Code Cases N-638-1 and N-504-2 as modified by the licensee for the deposition of a FSWOL for the remaining service life of the identified components.

TECHNICAL EVALUATION

3.1 Component Affected

RV N9 CRD return line nozzle (P No. 3) to a nickel-based alloy cap (P No. 43) weld.

3.2 Code Requirements for which Relief is Requested

The ISI code of record for HNP-1 for the fourth ten-year ISI interval is the ASME Code, Section XI 2001 Edition, including Addenda through 2003, with an exception. The exception is that for ASME Code, Section XI, Appendix VIII, the 2001 Edition of ASME Code will be used.

Under the rules of IWA-4220, repairs shall be performed in accordance with the licensee's design specification and the original Construction Code. Later editions and addenda of the Construction Code or of ASME Section III, either in their entirety or portions thereof, and ASME Code Cases may be used.

3.3 Duration of Relief Request

This Relief Request for HNP-1 is applicable to its fourth 10-year ISI interval which began January 1, 2006, and will end on December 31, 2015.

3.4 Licensee's Proposed Alternatives to ASME Code Case N-504-2

3.4.1 ASME Code Case N-504-2, Requirement (b) requires that the FSWOL be low carbon (0.035% maximum) austenitic stainless steel. An alternative was required since a nickel-based filler (Alloy 52/52M/152) has been selected to be used.

3.4.2 ASME Code Case N-504-2, Requirement (e) requires the first two layers of the FSWOL to have a ferrite content of at least 7.5 FN (Ferrite Number). These measurements will not be performed for this overlay since the nickel alloy filler is a fully austenitic material and does not contain ferrite.

3.4.3 ASME Code Case N-504-2, Requirement (f)(2) allows four axial flaws each less than 1.5 inches in length in a FSWOL. The proposed alternative design of the subject FSWOL does not allow any reportable axial flaws.

3.4.4 ASME Code Case N-504-2, Requirement (a) requires ASME Code, Section III acceptance criteria for the non-destructive examination (NDE) of the FSWOL. Since the NDE acceptance criteria under the ASME construction code are based on radiography testing (RT) rather than ultrasonic testing (UT), as an alternative, UT examination acceptance criteria per ASME Code, Section XI will be used.

3.4.5 ASME Code Case N-504-2 does not address the presence of laminar flaws in a FSWOL, the procedure and personnel qualifications for UT examination, and the NDE acceptance standards associated with the laminar flaws in a FSWOL. Flaw acceptance criteria as specified in ASME Code, Section XI will be used as an alternative for the subject FSWOL. UT examination procedures and personnel qualifications will meet the ASME Code, Section XI, Appendix VIII requirements. Laminar flaw evaluation shall comply with the acceptance criteria specified in Section IWB-3514-3 of the ASME Code, Section XI requirements.

3.4.6 ASME Code Case N-504-2 does not include implementation of Appendix Q of the ASME Code, Section XI for the ISI and subsequent additional examinations of the FSWOL. SNC stated in Appendix 8 of its February 26, 2008, submittal that, as an alternative, Appendix Q, with modifications, will be used as part of ISI and subsequent additional examinations for the subject FSWOL.

3.4.7 ASME Code Case N-504-2, Requirement (h) specifies that a system hydrostatic test be performed in accordance with ASME Code, Section XI, IWA-5000 if the flaw penetrates the original pressure boundary. As an alternative, leak testing in accordance with IWA-5000 will be performed.

3.5 Licensee's Proposed Alternatives to ASME Code Case N-638-1

3.5.1 In lieu of performing UT of the full 1.5T band of the FSWOL, the licensee proposed to examine the length of the FSWOL that is shown in Figure 1 of Appendix 2 of the February 26, 2008 submittal.

3.5.2 The interpass temperatures shall be determined by temperature measurement (e.g., pyrometers, temperature indicating crayons, thermocouples). As an alternative, heat flow calculations in conjunction with a measurement of maximum interpass temperature on a test coupon will be used to determine the interpass temperature.

3.5.3 With respect to ASME Code Case N-638-1, Paragraph 3(d), SNC stated that they would follow this paragraph except that "The interpass temperature of QW-406.3 need not be applied. This is identical wording to N-638-2, which has been approved by ASME."

3.5.4 ASME Code Case N-638-1, Paragraph 2.1(j) requires that the average Charpy V notch values of heat affected zone (HAZ) test coupon shall exceed the average value of the

base metal test coupon. If this criterion is not met, as an alternative, the licensee would use the provisions that are specified in paragraph NB-4335.3 of the ASME Code, Section III, 2001 Edition through 2003 Addenda which would allow adjustment to Charpy V notch test temperature at which the aforementioned criterion is met.

3.5.5 ASME Code Case N-638-1, Paragraph 4.0(b) specifies that the final weld surface shall be examined using surface and UT examinations no sooner than 48 hours after the weld reaches ambient temperature. As an alternative, the licensee would perform surface and volumetric examinations 48 hours after the third layer is installed.

3.6 Licensee's Basis for Use of ASME Code Cases N-504-2 and N-638-1

A FSWOL repair is proposed for the RV N9 CRD return line nozzle (P No. 3) to a nickel-based alloy cap (P No. 43) weld. The nozzle material is SA-508 Class 2 low alloy steel and the cap is Alloy 600 (SB-166). The existing weld material is Alloy 82 with Alloy 182 buttering. The FSWOL will be designed consistent with the requirements of ASME Code Case N-504-2, ASME Code Case N-638-1, IWB-3640, and Appendix C from the 2001 Edition through 2003 Addenda of ASME Code, Section XI.

3.7 Licensee's Basis for Alternatives to ASME Code Case N-504-2:

3.7.1 ASME Code Case N-504-2, Requirement (b) requires that the FSWOL be low carbon (0.035% maximum) austenitic stainless steel. The licensee proposed to use a consumable welding wire highly resistant to SCC for the overlay material. This alternative material, designated as UNS N06052, F-No. 43, is a nickel-based alloy weld filler material, commonly referred to as Alloys 52/52M, and will be deposited using the machine gas tungsten arc welding (GTAW) process with cold wire feed. The licensee also proposed to use a nickel-based alloy weld electrode, designated as UNS W86152, F-43, also commonly referred to as Alloy 152, and will be deposited using the shielded metal arc welding (SMAW) process. Alloys 52/52M/152 contain about 30 wt% chromium, which imparts excellent corrosion resistance to the material. With its higher chromium content, Alloy 52/52M provides a level of resistance to SCC consistent with the requirements of the ASME Code Case.

3.7.2 ASME Code Case N-504-2, Requirement (e) requires the first two layers of the FSWOL to have a ferrite content of at least 7.5 FN (Ferrite Number). The composition of nickel-based Alloy 52/52M is such that delta ferrite does not form during welding because Alloy 52/52M welds are 100% austenitic and contain no delta ferrite due to the high nickel composition (approximately 60 wt% nickel). Consequently, delta ferrite measurements will not be performed for this overlay.

3.7.3 ASME Code Case N-504-2, Requirement (f)(2) allows four axial flaws each less than 1.5 inches in length in FSWOL. Design of the subject FSWOL does not allow any reportable axial flaws.

3.7.4 ASME Code Case N-504-2, Requirement (a) requires ASME Code, Section III acceptance criteria for the nondestructive examination (NDE) of the FSWOL. Since the NDE acceptance criteria in ASME Code, Section III are based on Radiographic

examination (RT) than Ultrasonic testing (UT), as an alternative, the licensee proposed UT examination acceptance criteria per ASME Code, Section XI for the subject FSWOL. UT examination procedures and personnel qualifications will meet the requirements specified in the ASME Code, Section XI, Appendix VIII, under the Performance Demonstration Initiative (PDI) program. The FSWOL and the adjacent base material for at least ½ inch from each side of the FSWOL shall be examined using the liquid penetrant testing (PT) method and the acceptance criteria for the examination shall comply with the requirements specified in section NB-5000 of the ASME Code, Section III.

3.7.5 ASME Code Case N-504-2 does not address laminar flaws and the NDE acceptance standards associated with the laminar flaws in FSWOLs. Flaw acceptance criteria as specified in ASME Code, Section XI will be used as an alternative for the subject FSWOL. Laminar flaw evaluation shall comply with the acceptance criteria specified in Section IWB-3514-3 of the ASME Code, Section XI requirements. Laminar flaws shall not exceed 10 percent of the weld surface area with a linear dimension in excess of 3 inches. The reduction in coverage of volume due to the presence of laminar flaws for UT examination shall not exceed 10 percent. Additionally, uninspectable volume is dependent on the coverage achieved with the angle beam examination of the FSWOL. Any uninspectable volume in the FSWOL beneath a laminar flaw shall be assumed to contain the largest radial planar flaw that could exist within that volume. The licensee stated that it will remove any unacceptable indications and re-weld the area. This assumed flaw shall meet the preservice examination standards of Table IWB-3514-2. Both axial and circumferential planar flaws shall be assumed in applying the acceptance standards and wall thickness “tw” shall be the thickness of the FSWOL. If the preservice acceptance criteria as specified in Table IWB-3514-2 are not met, the assumed flaw shall be evaluated per IWB-3640. If the assumed flaw is not acceptable for continued service per IWB-3640, the flaw shall be removed or reduced to a size acceptable per IWB-3640.

3.7.6 ASME Code Case N-504-2 does not include implementation of Appendix Q of the ASME Code, Section XI for the ISI and subsequent additional examinations of the FSWOL. As an alternative, the licensee proposed to perform ISI examinations of the FSWOL in accordance with the requirements specified in Appendix Q, paragraphs Q-4300 and Q-4310 of the ASME Code, Section XI 2004 Edition with 2005 Addenda (with modifications). The volume of the FSWOL that would undergo UT examination will be per Figure Q-4300-1 in Appendix Q of the ASME Code, Section XI, and this examination was designed to identify any crack growth or new cracking in the upper 25% of the original weld or base material. The licensee intended to add UT examination of the FSWOL to the inspection plan and the subject FSWOL shall be subsequently examined using UT methods during the first or second refueling outage following the FSWOL application. The licensee would repair cracks in the FSWOL that were characterized as SCC. Non-SCC cracks in the FSWOL will be evaluated per of the acceptance criteria of IWB-3600 of the ASME Code, Section XI. If the requirements of Table IWB-3514-2 in the ASME Code, Section XI could not be satisfied, the acceptance criteria of IWB-3600 shall be satisfied. The licensee further stated that it would repair unacceptable indications in the FSWOL or the portion of the FSWOL containing the unacceptable indication in accordance with IWA-4000.

With regard to re-examination requirements of the subject FSWOL, the examination volumes that show no indication of crack growth or no new cracking shall be placed into a population to be examined on a sampling basis. The sampling method will require 25% of this population to be examined once every ten years. The subject FSWOL shall be reexamined during the first or second refueling outage when examinations reveal crack growth or new cracking in the upper 25% of the original weld or base materials. When the examination of a FSWOL shows no additional indication of crack growth or new cracking, the subject weld shall be placed into a population to be examined on a sample basis where 25% of this population shall be examined once every ten years. A FSWOL with acceptable non-SCC flaws shall be reexamined during the first or second refueling outage following discovery of the growth or new cracking. A FSWOL that, upon examination, shows no additional indication of crack growth or new cracking shall be placed into a population to be examined on a sample basis. Twenty-five percent of this population shall be examined once every ten years.

The licensee's proposed alternative included evaluation of crack growth due to stress corrosion and fatigue in the FSWOL and in the upper 25% of the original weld or base metal in accordance with IWB-3640. If the flaw was at or near the boundary of two different materials, evaluation of flaw growth in both materials is required. If examinations reveal crack growth or new cracking in the upper 25% of the original weld or base materials, the as-found flaw (postulated 75% through wall, plus the portion of the flaw in the upper 25% of the original weld or base metal) would be used to re-evaluate the crack growth analysis. The size of all flaws would be projected to the end of the design life of the FSWOL. For unacceptable indications, the FSWOL shall be removed, including the original defective weldment, and corrected by a repair/replacement activity in accordance with IWA-4000.

If ISI examinations reveal an unacceptable indication, crack growth into the FSWOL design thickness, or axial crack growth beyond the specified examination volumes, additional FSWOLs, equal to the number scheduled for the current inspection period, shall be examined prior to return to service. If additional unacceptable indications are found in the second sample, a total of 50% of the total population of FSWOLs shall be examined prior to operation. If additional unacceptable indications are found, the entire remaining population of FSWOLs shall be examined prior to return to service.

3.7.7 Leak testing in accordance with ASME Code, Section XI IWA-5000 will be performed.

3.8 Licensee's Basis for Alternatives to ASME Code Case N-638-1:

3.8.1 According to Paragraph 1.0(d) of the ASME Code Case N-638-1 the band around the weld area shall have a width of 1.5 times the thickness of the weld [1.5T] or 5 inches, whichever is less. The weld area shall be examined using surface and ultrasonic methods no sooner than 48 hours after the weld is cooled to ambient temperature. The licensee intended to perform surface examinations and UT per ASME Code, Section XI, Appendix I requirements after the completion of third temper bead layer. ASME Code, Section XI, IWA-4634 requires UT of the weld only, and the licensee determined not to perform UT of the full 1.5T band of the FSWOL. The length of the FSWOL that will be examined is shown in Figure 1 of Appendix 2 of the February 26, 2008 submittal. The

licensee's justification for using the proposed alternative with respect to the length of the FSWOL that will be examined and the staff's evaluation are discussed in Section 3.10.1 of this SE.

3.8.2 The interpass temperatures shall be determined by temperature measurement (e.g., pyrometers, temperature indicating crayons, thermocouples). As an alternative, if it is not possible to measure temperature by the aforementioned tools, heat flow calculations in conjunction with a measurement of maximum interpass temperature on a test coupon shall be used to determine the interpass temperature. The test coupon shall be made using maximum heat input of the welding procedure to be used in production and the thickness of the test coupon shall be equal to or greater than the thickness of the item to be welded.

3.8.3 With respect to ASME Code Case N-638-1, Paragraph 3(d), SNC stated that they would follow this paragraph except that "The interpass temperature of QW-406.3 need not be applied. This is identical wording to N-638-2, which has been approved by ASME."

3.8.4 The licensee proposed to use the provisions which allows the use of an adjusted temperature for the procedure qualification. The procedure qualification shall be determined in accordance with NB-4335.3 of Section III, 2001 Edition with 2002 Addenda. Reference nil ductility temperature or lowest service temperature of the materials for which the welding procedure will be used shall be increased by a temperature equivalent to that of the adjustment temperature.

3.8.5 As an alternative, the licensee in Appendix 7 of the February 26, 2008 of the submittal proposed to perform surface and volumetric examinations 48 hours after the third layer is installed. Electric Power Research Institute (EPRI) has documented their technical basis in a report—1012558, "Repair and Replacement Applications Center: Temperbead Welding Applications 48-Hour Hold Requirements for Ambient Temperature Temperbead Welding." In this report EPRI states that hydrogen can be introduced only on the first weld layer as it is in contact with ferritic base metal (nozzle). Presence of hydrogen is significantly reduced in the second and third weld layers because the hydrogen is dissipated due the heat associated with the second and third weld layers. Additionally, NDE that is to be performed 48 hours after the third weld layer provides sufficient time for detecting hydrogen cracking.

3.9 Staff Evaluation of Alternatives to N-504-2

Under the rules of ASME Code, Section XI, IWA-4220, repairs shall be performed in accordance with the licensee's design specification and the original Construction Code. Later editions and addenda of the Construction Code or of ASME Code, Section III, either in their entirety or portions thereof, and ASME Code Cases may be used. In addition to the above, defects shall be removed or reduced in size in accordance with ASME Code, Section XI, IWA-4400. ASME Code Case N-504-2 was used by the licensee to perform a FSWOL on the HNP-1 N9 CRD return line nozzle-to-cap weld. ASME Code Case N-504-2 was conditionally approved by the NRC staff for use under RG 1.147, Revision 14. Therefore, the use of N-504-2 as an alternative to the

mandatory ASME Code repair provisions is acceptable to the NRC staff, provided that all conditions and provisions specified in RG 1.147, Revision 14 are complied with.

In response to the NRC staff RAI (1), the licensee in letter dated February 28, 2008, stated that consistent with its previous relief requests for Farley Nuclear Plant and Vogtle Electric Generating Plant, it would use ASME Code Case N-504-2 in lieu of ASME Code Case N-504-3 at HNP-1. Since ASME Code Case N-504-2 is still valid and not annulled in the RG 1.147, in a conference call with the licensee on February 28, 2008, the staff accepted this substitution for the subject repair.

3.9.1 The first proposed modification to the ASME Code Case N-504-2 provisions involves the use of a nickel-based alloy weld material rather than the low carbon austenitic stainless steel. The licensee stated that Paragraph (b) of N-504-2 requires that the reinforcement weld material shall be low carbon (0.035% maximum) austenitic stainless steel. In lieu of the stainless steel weld material, Alloy 52/52M, a consumable welding wire, and Alloy 152, a covered electrode, which are highly resistant to SCC, were proposed for the overlay weld material. The NRC staff notes that the use of 52/52M/152 materials are consistent with weld materials used to perform similar FSWOLs at other operating boiling water reactor (BWR) facilities. The NRC staff also notes that the licensee is performing the subject FSWOL on dissimilar metal welds made of Alloy 82/182 material. For material compatibility in welding, the NRC staff considers that Alloy 52M is a better choice of filler material than austenitic stainless steel material for this weld joint configuration. Alloy 52/52M/152 contains about 30% chromium which would provide excellent resistance to SCC if exposed to the reactor coolant environment. This material is identified as F-No. 43 Grouping for Ni-Cr-Fe, classification UNS N06052 filler metal and has been previously approved by the NRC staff for similar applications. Therefore, the licensee's proposed use of Alloy 52/52M/152 for the FSWOL as a modification to the requirements of N-504-2, Paragraphs (b) and (e) is acceptable as it will provide an acceptable level of quality and safety.

3.9.2 The second proposed modification to the N-504-2 provisions involves Paragraph (e) of N-504-2 which requires as-deposited delta ferrite measurements of at least 7.5 FN for the weld reinforcement. The licensee proposed that delta ferrite measurements will not be performed for this overlay because the deposited Alloy 52/52M/152 material is 100% austenitic and contains no delta ferrite due to the high nickel composition (approximately 60% nickel). N-504-2 allows the use of FSWOL repair by deposition of weld reinforcement on the outside surface of the pipe in lieu of mechanically reducing the defect to an acceptable flaw size. However, N-504-2 is designed for FSWOL repair of austenitic stainless steel piping. Therefore, the material requirements regarding the carbon content limitation (0.035% maximum) and the delta ferrite content of at least 7.5 FN, as delineated in N-504-2, Paragraphs (b) and (e), apply only to austenitic stainless steel FSWOL materials to ensure its resistance to SCC. These requirements are not applicable to Alloy 52/52M/152, a nickel-based material that would be used for the FSWOL. Therefore, the NRC staff agrees with the technical basis for the requested alternative.

3.9.3 ASME Code Case N-504-2, Requirement (f)(2) allows four axial flaws each less than 1.5 inches in length in the FSWOL. The proposed alternative design of the subject FSWOL

does not allow presence of any reportable axial flaws. The NRC staff reviewed the licensee's proposed alternative and concludes that since axial flaws are not allowed, extra ligament in the FSWOL is retained which would otherwise be compromised due to the presence of the axial flaws. This in turn enhances the structural integrity of the FSWOL and, therefore, this alternative provides an acceptable level of quality and safety.

3.9.4 ASME Code Case N-504-2, Requirement (a) requires ASME Code, Section III acceptance criteria for the NDE of the FSWOL. Since the NDE acceptance criteria in ASME Code, Section III are based on RT rather than UT as an alternative, UT examination acceptance criteria in ASME Code, Section XI will be used for the subject FSWOL. Substitution of the ASME Code, Section XI UT acceptance criteria for the ASME Code, Section III RT acceptance criteria will address laminar flaws in the FSWOL. Additionally, ASME Code, Section XI acceptance criteria are more applicable for the subject FSWOL as the weld being repaired contains pre-existing flaws. Penetrant Testing (PT) examination shall be performed on the FSWOL and ½ inch on either side of it 48 hours after the third layer is deposited.

The NRC staff reviewed the licensee's alternative to post-installation examination of the FSWOL and concludes that implementation of PDI-qualified UT procedures and inspection personnel will adequately detect weld defects in the FSWOL and the upper 25% of the original weld or base metal wall thickness. The NRC staff also agrees that the licensee's plan to subsequently remove any unacceptable indications will ensure structural integrity of the FSWOL. UT examination on the nozzle beyond the overlay shown in Figure 1 of Appendix 2 of the February 26, 2008, submittal will not provide any information regarding the area of the defect that required repair. Due to the nozzle blend radius, where the toe of the FSWOL resides, the UT return signal would be difficult to obtain and interpret. For the FSWOL type of repair, any ferritic steel base material cracking would occur in the Heat-affected zone (HAZ) directly below or adjacent to the FSWOL and not in the 1.5T examination band of ferritic material beyond the edges of the FSWOL. In addition, consistent with the Construction Code or ASME Code, Section III, NB-5300, the licensee proposed to inspect the FSWOL at least ½ inch from each side using the PT method. The NRC staff accepts the licensee's post-installation examination alternative for the FSWOL because it will adequately identify any weld defects in the FSWOL. Since the PT examination extends ½ inch beyond FSWOL it will assure that no defects have been created at the toe of the FSWOL. Therefore, this alternative provides an acceptable level of quality and safety.

3.9.5 With respect to presence of laminar flaws in the uninspectable volume of the FSWOL, the staff finds that the worst-case assumed flaw in an uninspectable volume may be accepted by IWB-3640 for the following reasons:

(1) The alternative requires that any uninspectable volume in the [FSWOL] beneath a laminar flaw shall be assumed to contain the largest radial planar flaw that could exist within that volume. This assumed flaw shall meet the preservice examination standards of Table IWB-3514-2. The NRC staff accepts this evaluation because the licensee proposed to use the largest flaw that could exist in the uninspectable volume of the FSWOL in its flaw evaluation methodology.

The NRC staff believes that this is a conservative assumption for a postulated flaw because there is a probability that the flaw may not exist in the uninspectable volume.

(2) If the assumed flaw is rejected by IWB-3640, the laminar flaw will be removed from the FSWOL, even though the flaw may or may not exist in the uninspectable volume.

(3) Paragraph 3(a)5 in the February 26, 2008, submittal provides an additional limitation that the total laminar flaw (i.e., lamination) shall not exceed 10% of the weld surface area and no linear dimensions of the laminar flaw area shall exceed 3.0 inches. These limitations will minimize the size of the uninspectable volume thus minimizing the size of the assumed flaw, if it exists.

(4) Industry experience has shown that repairs to welds may lead to future degradation. The repair of the flaw may cause more harm to the integrity of the FSWOL itself than to allow the postulated flaw to remain in service.

Based on the above review, the NRC staff concludes that the licensee's proposal regarding the post-installation examination of the FSWOL is acceptable.

The licensee's PT and UT examination results of the FSWOL were submitted in a letter dated March 17, 2008, in which the licensee stated that "there were no indications recorded" during the PDI-qualified UT examination of the subject FSWOL. Four small indications were identified during the PT examination, and after their removal and subsequent re-examination revealed no unacceptable indications. The licensee further stated that it did not perform any repairs to the FSWOL.

3.9.6 As an alternative, the licensee proposed to implement Appendix Q of the ASME Code, Section XI for the ISI and subsequent additional examinations of the FSWOL. The licensee's proposed examination volume consists of scanning through the weld overlay and 25 percent through-wall of the base metal. The scans provide assurance that planar flaws, regardless of orientation, will be detected. The procedures and personnel will be qualified to Section XI, Appendix VIII, Supplement 11 of the ASME Code as administered by the PDI program. The qualification process assures that the UT procedure contains sufficient detail and the personnel have the necessary skills for detecting various types of flaws. The NRC staff finds that the licensee's proposed alternative examination adequately complies with the PDI program because it will follow ASME Code, Section XI as required by 10 CFR 50.55a.

With respect to flaw evaluation, since the overlay material is resistant to intergranular stress corrosion cracking (IGSCC), if an IGSCC indication grows to the FSWOL interface it is expected to stop growing. In addition, the proposed design of the FSWOL assumes a through-wall flaw that is 360 degrees around the circumference. Therefore, structural integrity of the welded joints will continue to be maintained because the overlay serves as the replacement pressure boundary regardless of crack growth beneath the overlay. The NRC staff accepts the licensee's proposed methodology for evaluating flaws in the FSWOL and in the upper 25% of the original weld or base material because: (1) the

licensee will repair cracks that are characterized as SCC in the FSWOL, (2) non-SCC flaws in the FSWOL and in the upper 25% of the original weld or base material will be evaluated per Table IWB-3514-2 and acceptance criteria specified in IWB-4600, and (3) crack growth rates can be effectively monitored by the licensee's proposed subsequent examinations of the FSWOL and the upper 25% of the original weld or base material and by the flaw evaluation methodology. Subsequent examinations of the FSWOL will effectively monitor the crack growth rates, and compliance with the ASME Code, Section XI flaw evaluation methodology will ensure that the presence of cracks in the FSWOL will not affect the structural integrity of the FSWOL.

3.9.7 The licensee's proposed modification to Paragraph (h) of ASME Code Case N-504-2 is to perform leak testing in accordance with ASME Code, Section XI (2001 Edition with the 2003 Addenda), IWA-5000. A precedent for use of a leak test at normal operating temperature and pressure in lieu of a hydrostatic test was set with ASME Code Case N-416-1 which was incorporated into the ASME Code, Section XI beginning in the 1998 Edition with the 1999 Addenda. HNP-1 is currently in its fourth ten-year ISI interval and the ISI Code of record for the fourth 10-year ISI interval is the ASME Code, Section XI, 2001 Edition, including Addenda through 2003. As the licensee's alternative is consistent with the current practice, the NRC staff accepts the licensee's basis for this alternative.

3.10 Staff Evaluation of Alternatives to N-638-1

The licensee applied a 360-degree FSWOL to reduce the susceptibility of the original weld to the initiation and growth of SCC and, ultimately, to maintain weld integrity. The FSWOL will fulfill all structural requirements, independent of the existing weld. Operational experience has also shown that SCC in Alloy 82/182 will blunt at the interface with stainless steel base metal, carbon steel base metal, or Alloy 52/52M/152 weld metal, if cracking were to occur.

The licensee, in its submittal dated February 26, 2008, stated that the surface area of the FSWOL may exceed the limitation of 100 square inches as mandated by Paragraph 1.0(a) of the ASME Code Case N-638-1. After further assessment, in its response to the staff RAI (2), in a letter dated February 28, 2008, the licensee confirmed that the maximum area of the subject FSWOL is 94 square inches. Since the area of the FSWOL is less than 100 square inches, the NRC staff concludes that the licensee complied with the requirements specified in Paragraph 1.0(a) of ASME Code Case N-638-1 and, therefore, this item need not be included as an alternative to ASME Code Case N-638-1.

To eliminate the need for preheat and post-weld heat treatment under the Construction Code, the industry developed requirements for implementation of a temper bead welding technique which were published in ASME Code Case N-638-1 and were endorsed by the staff in RG 1.147, Revision 14. The temper bead technique carefully controls heat input and bead placement, which allows subsequent welding passes to relieve stresses and temper the HAZs of the base material and preceding weld passes. The welding is

performed with low hydrogen electrodes under a blanket of inert gas. The inert gas shields the molten metal from moisture and hydrogen. Therefore, the need for the preheat and post-weld heat treatment specified by the ASME Construction Code is not necessary to produce a sound weld using a temper bead welding process.

ASME Code Case N-638-1 Limitation:

Use of ASME Code Case N-638-1 has been accepted in RG 1.147, Revision 14, with the following limitations, as providing an acceptable level of quality and safety. UT examinations shall be demonstrated for the repaired volume using representative samples which contain construction type flaws. The acceptance criteria of NB-5330 of the ASME Code, Section III edition and addenda approved in 10 CFR 50.55a apply to all flaws identified in the repair volume. The licensee will take an exception to this limitation.

3.10.1 According to Paragraph 1.0(d) of the ASME Code Case N-638-1 the band around the weld area shall have a width of 1.5 times the thickness of the weld [1.5T] or 5 inches, whichever is less. The licensee stated that full UT of the 1.5T band would not be performed as required under Paragraph 1.0(d) of ASME Code Case N-638-1. The length of the FSWOL that will be examined is shown in Figure 1 of Appendix 2 of the February 26, 2008 submittal. Using ASME Code Case N-638-1, the temper bead weld is for filling a cavity in the base metal. The licensee's application, however, is for a FSWOL above the base metal, which results in a contour that is UT inspectable except for the edge taper where the overlay transitions to the nozzle surface and onto the curvature of the nozzle. The proposed weld edge configuration has the same UT examination difficulties as are considered under ASME Code, Section XI, Appendix Q. Appendix Q only requires a surface examination of the tapered area of the FSWOL. In addition to verifying the soundness of the weld, a purpose of the UT is to assure that delayed cracking due to hydrogen introduced during the temper bead welding process or cracking in unannealed ferritic material does not occur. In the unlikely event that cracking does occur, it would be initiated on the surface on which the welding is actually performed or in the HAZ immediately adjacent to the weld. The most appropriate technique to detect surface cracking is the surface examination technique. Therefore, use of a surface examination in the area of the FSWOL taper and band beyond the toe of the FSWOL on the ferritic material is acceptable in that it provides an acceptable level of safety and quality.

3.10.2 ASME Code Case N-638-1, Paragraph 3.0(d) specifies the maximum interpass temperature for production welding. The licensee stated that the interpass temperatures shall be determined by temperature measurement (e.g., pyrometers, temperature indicating crayons, thermocouples). These tools will be used to verify preheat temperature and interpass temperature of every weld pass of the first three layers. If it was not possible to measure temperature by the aforementioned tools, as an alternative, heat flow calculations in conjunction with a measurement of maximum interpass temperature on a test coupon will be used to determine the interpass temperature. The test coupon will be made using maximum heat input of the welding procedure to be used in production and the thickness of the test coupon shall be equal to or greater than the thickness of the item to be welded. The NRC staff determined that the large mass of the

nozzle coupled with the low heat input gas tungsten arc weld (GTAW) process helps to ensure that the maximum interpass temperature will not be exceeded. Additionally, the alternate heat flow calculations, which take into account weld heat input, thickness of the weld joint, and thermal conductivity of the materials, will provide a good estimate of the interpass temperature. The NRC staff previously accepted this method of assessing the maximum interpass temperature in its SE for Farley Nuclear Plant and the Vogtle Electric Generating Plant, dated April 3, 2007, ADAMS Accession number ML070790240. Therefore, the NRC staff concludes that this type of monitoring of the interpass temperature provides an acceptable level of quality and safety.

3.10.3 ASME Code Case N-638-1, Paragraph 2.0 references the ASME Code, Section IX for weld procedure qualifications. One of the essential variables (QW-406.3) in ASME Code, Section IX is interpass temperature during the welding process. ASME Code, Section IX requires that the interpass temperature of the welding procedure qualification specimens be less than that of the production weld to avoid the need for requalification. However, ASME Code Case N-638-1 is inconsistent with this requirement as it allows the interpass temperature during production welding to be significantly higher than that of the specimens used to qualify the temper bead welding process. The NRC staff determined that weld procedure qualifications with a lower interpass temperature will result in a higher cooling rate which subsequently enhances the formation of a HAZ with lower notch toughness values. Successful weld procedure qualifications indicate compliance of HAZ Charpy V notch values with the ASME Code requirements. Since the production interpass temperature is higher than the value used in qualifications, it can be concluded that the HAZ notch toughness values of the vessel nozzle are bounded by the notch toughness values of the qualification test. Therefore, the NRC staff concludes that the ASME Code, Section IX essential variable stated above is not applicable to the ASME Code Case N-638-1.

3.10.4 ASME Code Case N-638-1, Paragraph 2.1(j) requires that the average Charpy V notch values of the HAZ test coupon shall exceed the average value of the base metal test coupon. If this criterion was not met, either the weld procedure would be re-qualified or the licensee would implement the existing requirements in NB-4335.2 of ASME Code, Section III which allows the use of an adjustment temperature for weld procedure qualifications at which the average HAZ Charpy V notch value exceeds the average value of the base metal test coupon. The lowest service temperature is increased by a temperature equivalent to that of the adjustment temperature. The NRC staff accepts the licensee's proposal because either successful re-qualification of the welding procedure or implementation of the ASME Code, Section III provisions for the adjustment of lowest service temperature would ensure that the notch toughness of the HAZ of the CRD return line nozzle is not compromised due to temper bead welding.

3.10.5 ASME Code Case N-638-1, Paragraph 4.0(b) specifies that the final weld surface shall be examined using surface and UT methods no sooner than 48 hours after the weld reaches ambient temperature. EPRI research (Technical Report 1013558, *Temper bead Welding Applications - 48 Hour Hold Requirement for Ambient Temperature Temper bead Welding)* has shown that it is not necessary to wait until ambient temperature is reached before initiating the 48-hour hold in order to assure adequate hydrogen

removal. No further tempering or potential hydrogen absorption effects will occur after deposition of the third overlay layer. The described approach has previously been reviewed and approved by the NRC staff *(Safety Evaluation By the Office of Nuclear Reactor Regulation Related To ASME Code, Section XI, Alternatives for Union Electric Company Callaway Plant, Unit 1, Docket No. 50-483, July 10, 2007).* Therefore, the licensee's proposed alternative to perform the surface and UT examinations no sooner than 48 hours after the third layer of the weld overlay is installed provides an acceptable level of quality and safety.

3.11 Crack Growth Considerations and Design

Regarding crack growth consideration, the licensee's February 26, 2008 letter stated the following:

> *Crack growth calculations will be performed. Flaw characterization and evaluation requirements shall be based on the as-found flaw. The size of all flaws will be projected to the end of the design life of the overlay. Crack growth, including both stress corrosion and fatigue crack growth, shall be evaluated in the materials in accordance with IWB-3640. If the flaw is at or near the boundary of two different materials, evaluation of flaw growth in both materials is required. This report will be submitted within 90 days after plant startup.*

The licensee further stated that it will comply with the design requirements that are specified in Paragraphs (f) through (i) of ASME Code Case N-504-2. The thickness of the FSWOL shall be determined based on the assumption of a through-wall flaw, with a length of 360 degrees in the underlying pipe. The FSWOL would be applied so that the criteria of IWB-3640 would be met after the overlay is applied. A stress analysis that is consistent with the requirements of NB-3200 and NB-3600 of the ASME Code, Section III and the requirements of IWB-3000 of the ASME Code, Section XI would be performed to demonstrate that the pressure-retaining components will perform their intended design.

With regard to the welding residual stress evaluation for the FSWOL, responding to the NRC staff RAI (5), in its February 28, 2008, letter, the licensee confirmed that it would include the effect of water backing in its welding residual stress evaluation for the FSWOL. Since this evaluation is consistent with Paragraph (g)(2) of the ASME Code Case N-504-2, the NRC staff accepts the licensee's response and considers that its concern regarding RAI (5) is closed.

3.12 Staff Evaluation of Crack Growth Considerations and Design

The NRC staff reviewed the licensee's evaluation regarding the crack growth and design criteria of the FSWOL and finds them acceptable based on the following:

(a) The design criteria and crack growth considerations for the FSWOL comply with the requirements specified in ASME Code Case N-504-2,

(b) Paragraphs (f)(1) through (f)(3) in ASME Code Case N-504-2 allow different design criteria for the weld reinforcement of the FSWOL, and they are based on the

existence of circumferential and axial flaws in the original weld. The design of the weld reinforcement of the FSWOL meets ASME Code, Section XI, IWB-3640.

Based on the above, the NRC staff concludes that the licensee's proposed evaluation of crack growth for the FSWOL design will provide an acceptable level of quality and safety.

4.0 CONCLUSION

Based on the discussion above, the NRC staff concludes that the modifications proposed in the Relief Request ISI-GEN-ALT-08-01, Version 1.0 to perform a FSWOL for the CRD return line N9 nozzle, nozzle-to-cap weld joint dissimilar metal weld at HNP-1 will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the proposed Relief Request ISI-GEN-ALT-08-01, Version 1.0 for the installation of a FSWOL over the weld identified in the subject relief request is authorized for the HNP-1 fourth 10-year ISI interval which began January 1, 2006, and will end on December 31, 2015.

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.

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Date: August 26, 2008

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