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

January 21, 2010

Mr. Barry S. Allen
Site Vice President
FirstEnergy Nuclear Operating Company
Davis-Besse Nuclear Power Station
Mail Stop A-DB-3080
5501 North State Route 2
Oak Harbor, OH 43449-9760

SUBJECT: DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1 - RELIEF REQUEST RR-A33 FOR THE APPLICATION OF FULL STRUCTURAL WELD OVERLAYS ON DISSIMILAR METAL WELDS OF REACTOR COOLANT PIPING (TAC NO. ME0478)

Dear Mr. Allen:

By letter to the U.S. Nuclear Regulatory (NRC) dated January 30, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML090350070), as supplemented by letters dated July 13, 2009 (ADAMS Accession No. ML091950627), November 23, 2009 (ADAMS Accession No. ML093360333), and December 15, 2009 (ADAMS Accession No. ML100040016), the FirstEnergy Nuclear Operating Company (FENOC or the licensee) submitted a request to the NRC for the use of alternatives to certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI requirements at Davis-Besse Nuclear Power Station, Unit 1.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(i), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety. The licensee requested NRC staff review and approval of Relief Request RR-A33 to allow the installation of full structural weld overlays (FSWOLs) on the dissimilar metal welds (DMW) at the reactor coolant pump nozzles, reactor core flood nozzles, and reactor coolant system cold-leg drainline nozzles at the Davis-Besse Nuclear Power Station (DBNPS).

On the basis of its review, the NRC staff has determined that Relief Request RR-A33, dated November 23, 2009, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the use of Relief Request RR-A33, dated November 23, 2009, for the FSWOLs on the DMW at the reactor coolant pump discharge and suction nozzles, reactor core flood nozzles, and reactor coolant system cold-leg drainline nozzles at the DBNPS. The subject relief request is authorized for the third 10-year inservice inspection interval which commenced on September 21, 2000, and will end on September 20, 2012.

If you have any questions, please contact the Davis-Besse Project Manager, Mr. Stephen Sands, at 301-415-3154.

Sincerely,

Stephen J. Campbell, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-346

Enclosure:
As stated

cc w/encl: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST RR-A33

FULL STRUCTURAL WELD OVERLAY OF REATOR COOLANT SYSTEM PIPING

DAVIS-BESSE NUCLEAR POWER STATION

FIRSTENERGY NUCLEAR OPERATING COMPANY

DOCKET NO. 50-346

1.0 INTRODUCTION

By letter dated January 30, 2009 (Agencywide Documents and Access Management System (ADAMS) Accession No. ML090350070), the FirstEnergy Nuclear Operating Company (FENOC or the licensee), requested U.S. Nuclear Regulatory (NRC) staff review and approval of Relief Request RR-A33 to allow the installation of full structural weld overlays (FSWOLs) on the dissimilar metal welds (DMWs) of the reactor coolant pump nozzles, reactor core flood nozzles, and reactor coolant system cold-leg drainline nozzles at the Davis-Besse Nuclear power Station (DBNPS). The proposed relief request is an alternative to the requirements of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI.

By letters dated July 13, 2009 (ADAMS Accession No. ML091950627), and November 23, 2009 (ADAMS Accession No. ML093360333), the licensee responded to the staff's request for additional information and updated Relief Request RR-A33. In an electronic mail dated December 15, 2009 (ADAMS Accession No. ML100040016), the licensee corrected a typographic error in Section A1.4(d) of Relief Request RR-A33.

In the November 23, 2009, submittal, the licensee also requested to apply optimized weld overlays on the DMWs of the reactor coolant pump discharge nozzles as presented in Relief Request RR-A32. The licensee will inspect the DMWs of the reactor coolant pump discharge nozzles prior to install the weld overlays. If there are no indications or indications are not 50 percent through-wall of the pipe thickness (initiated from the inside surface of the pipe), the licensee will install the optimized weld overlays (OWOLs) on the reactor coolant pump discharge nozzles. If the indication(s) exceed the 50 percent through wall, the FSWOL will be installed at the reactor coolant pump discharge nozzles.

Relief Request RR-A33 in the November 23, 2009, letter, with the correction made dated December 15, 2009, is the final version upon which this safety evaluation is based. The NRC review of Relief Request RR-A32 is discussed in a separate safety evaluation.

A DMW is defined as a weld that joins two pieces of metals that are not of the same material. The DMW itself is made of nickel-based Alloy 82/182 material, which is susceptible to primary water stress-corrosion cracking (PWSCC) in the pressurized-water reactor environment. For the proposed alternative, the weld overlay is a process by which a PWSCC-resistant weld metal is deposited on the outside surface of the Alloy 82/182 DMWs to form a new pressure boundary.

2.0 REGULATORY EVALUATION

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code, incorporated by reference in 10 CFR 50.55a(b), 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

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

The ASME Code of record for the current third 10-year ISI interval at the DBNPS is the 1995 Edition through the 1996 Addenda of the ASME Code, Section XI.

3.0 PROPOSED RELIEF REQUEST RR-A33

3.1 Component Affected

The affected components are the following DMWs:

Four reactor coolant pump inlet nozzle DMWs are RC-MK-A-67-1-FW134B, RC-MK-A-67-3-FW105B, RC-MK-A-67-1-FW105A, and RC-MK-A-67-2-FW134A. Each of these DMWs is ASME Code Class 1, examination category B-J, Code Item Number B9.11. The DMWs join the pump inlet nozzles that are made of A-351, Grade CF8M (P-8) cast stainless steel material, with a 90-degree pipe elbow which is made of A-516 Grade 70 (P-1) cast stainless steel material but internally clad with SA 240-304L stainless steel material. The piping has a nominal inside diameter of 28 inches.

Four reactor coolant pump discharge nozzle DMWs are RC-MK-B-59-1-SW143B, RC-MK-B-44-1-SW69B, RC-MK-B-61-1-SW69A, and RC-MK-B-56-1-SW143A. Each of these DMWs is ASME Code Class 1, Examination category B-J, Code Item Number B9.11. The DMWs join the pump discharge nozzles that are made of A-376, Type 316 (P-8) stainless steel, with a 24-degree pipe elbow which is made of A 516, Grade 70 (P-1) carbon steel and internally clad with SA 240-304L stainless steel material. The piping has a nominal inside diameter of 28 inches.

Two reactor vessel core flood nozzle DMWs are RC-RPV-WR-53-Y and RC-RPV-WR-53-W. Each of these DMWs is ASME Code Class 1, Examination category B-F, ASME Code Item Number B5.10. The DMWs join the reactor vessel nozzles that are made of SA-508 Class 2

(P-3) low alloy steel internally clad with SA 371-ER 308L stainless steel, with a safe-end which is made of SA-336 F8M (P-8) stainless steel material. The piping has a nominal inside diameter of 12 5/8 inches.

Three reactor coolant system cold-leg drainline DMWs are RC-40-CCA-18-3-FW9, RC-40-CCA-18-7-FW25, and RC-40-CCA-18-5-FW18. Each of these DMWs is ASME Class 1, Examination category B-J, Code Item Number B9.21. The DMWs join the nozzles that are made of A-105, Grade 2 (P-1) carbon steel internally clad with SA-371 ER 308L stainless steel, with a pipe elbow which is made of SA-403, WP316(P-8), stainless steel material. The piping has a nominal inside diameter of 2 1/2 inches.

3.2 Applicable Code Edition and Addenda

ASME Code, Section XI, 1995 Edition through 1996 Addenda

3.3 Applicable Code Requirements

IWA-4410(a) of ASME Code Section XI states: "Repair/replacement activities shall be performed in accordance with the Owner's Requirements and the original Construction Code of the component or system, except as provided in IWA-4410(b), (c), and (d)."

IWA-4410(b) of ASME Code Section XI states in part: "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(b)."

IWA-4410(c) of ASME Code Section XI states: "Alternatively, the applicable requirements of IWA-4600 may be used for welding and the applicable requirements of IWA-4700 may be used for heat exchanger tube plugging and sleeving."

ASME Code Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," Supplement 11 provides requirements for the qualification requirements for the ultrasonic examination of Overlaid Wrought Austenitic Piping Welds.

3.4 Reason for Request

The licensee proposes to mitigate the PWSCC susceptibility of the DMWs in reactor coolant pump inlet and discharge nozzles, the cold-leg drain nozzles, and the reactor vessel core flood nozzles by installing a FSWOL on each of the DMWs. This approach provides an alternative to inspection alone as a means to assure the structural integrity of these locations. The licensee may choose to apply preemptive FSWOLs without performance of an ultrasonic examination prior to the design and application of the weld overlay contingent upon authorization from the NRC.

Currently, there are no generically-accepted criteria for a licensee to apply a FSWOL to Alloy 82/182 weld material. The edition and addenda of ASME Code Section XI applicable to DBNPS does not contain requirements for weld overlays. Dissimilar metal weld overlays have been applied to other components at the DBNPS using the modified requirements of ASME Code Cases N-504-2, "Alternative Rules for Repair of Class 1, 2 and 3 Austenitic Stainless Steel Piping" and N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature

Machine GTAW Temper Bead Technique". However, since N-504 (and its later versions) is written specifically for stainless steel pipe-to-pipe weld full structural overlays, and N-638-1 contains unnecessary restrictions and requirements, an alternative is desired. This relief request describes the proposed requirements to use to design and install FSWOLs on reactor vessel nozzle and reactor coolant piping DMW welds.

3.5 Proposed Alternative and Basis for Use

The licensee proposes as an alternative to the ASME Code requirements, the use of Relief Request RR-A33 to perform FSWOLs. This alternative is based on the methodology contained in ASME Code, Section XI, Code Case N-740-2, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items."

Appendix VIII, Supplement 11 of the 1995 Edition through the 1996 Addenda of the ASME Code, Section XI, specifies requirements for performance demonstration of ultrasonic examination procedures, equipment, and personnel used to detect and size flaws in full structural overlays of wrought austenitic piping welds. Relief is requested to allow use of the Performance Demonstration Initiative (PDI) program implementation of Appendix VIII for qualification of ultrasonic examinations used to detect and size flaws in the preemptive structural weld overlays of this request.

The use of this alternative is requested on the basis that the proposed requirements will provide an acceptable level of quality and safety. The licensee plans to apply a full structural Alloy 52M overlay to each of the Alloy 82/182 DMWs identified above, unless optimized weld overlays are applied as proposed within the licensee's Relief Request RR-A32. Electric Power Research Institute (EPRI) Materials Reliability Program MRP-169 provides the basis and requirements for the weld overlay techniques. The MRP-169 design requirements that apply to the DBNPS are detailed in Attachment 1, "Background and Technical Basis For Davis-Besse Reactor Coolant Pump Dissimilar Melal Weld Overlays," of Relief Request RR-A33; and the implementation requirements that apply are detailed in Attachments 1 and 2 ("Requirements Applicable To Davis-Besse Nozzle Weld Overlays") of Relief Request RR-A33, dated November 23, 2009.

ASME Code Case N-740-2 has been approved recently by the ASME Code Committee to specifically address FSWOLs on nickel alloy DMWs. ASME Code Case N-740-2 also incorporates the latest approved versions of ASME Code Case N-638. However, ASME Code Case N-740-2 has not yet been accepted by the NRC in Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division I". ASME Code Case N-504-3, which provides requirements for weld overlay of stainless steel piping, has been conditionally accepted in Revision 15 of Regulatory Guide 1.147 with the condition that the provisions of ASME Code Section XI, Appendix Q, "Weld Overlay Repair of Class 1, 2 and 3 Austenitic Stainless Steel Piping Weldments," must be met.

The licensee states that the proposed alternative provides an acceptable methodology for preventing PWSCC and for reducing defects that may be observed in these welds to an acceptable size. The use of weld overlay filler metals that are resistant to PWSCC (e.g., Alloy 52/52M), weld overlay procedures that create compressive residual stress profiles in the original weld, and post overlay preservice and inservice inspection requirements provide assurance that structural integrity of the DMWs is maintained for the life of the plant. The weld overlays shall also meet the applicable stress limits from the ASME Code, Section III, "Rules for

Construction of Nuclear Facility Components." Crack growth evaluations for PWSCC and fatigue of as-found (or conservatively postulated) flaws shall demonstrate that structural integrity will be maintained. Rupture of the large primary loop piping at the DBNPS has been eliminated as the structural design basis per the currently under NRC review leak-before-break application. By letter dated September 28, 2009 (ADAMS Accession No. ML092790438), the licensee submitted the leak-before-break analysis to show that the effects of the weld overlay do not invalidate the conclusions of the existing design basis.

3.6 Duration of Proposed Alternative

The provisions of this alternative are applicable to the third ten-year inservice inspection interval for the DBNPS which commenced on September 21, 2000, and will end on September 20, 2012. The weld overlays installed in accordance with the provisions of this alternative shall remain in place for the design life of the repair established as described in Attachments 1 and 2 of Relief Request RR-A33.

3.7 Staff Evaluation

The NRC staff has approved the use of Code Case N-504-3, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Section XI, Division 1," in Regulatory Guide 1.147, Revision 15. In accordance with Regulatory Guide 1.147, Revision 15, the ASME Code, Section XI, Appendix Q, shall be used when Code Case N-504-3 is used. The NRC staff has also approved the use of Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW [gas tungsten arc welding] Temper Bead Technique Section XI, Division 1," in Regulatory Guide 1.147. The NRC staff uses the requirements of ASME Code Cases N-504-3, N-638-1 and Appendix Q to evaluate RR-A33.

3.8 General Requirements

General requirements of the FSWOL design in Section A1.2, "Residual Stress Improvement," of Attachment 1 to RR-A33, dated November 23, 2009, are consistent with the general requirements of Code Case N-504-3 and Appendix Q of the ASME Code, Section XI. The requirements in Section A1.2 of RR-A33 include certain material specification and surface condition of the applicable base metal (i.e., carbon steel, stainless steel and Alloy 82/182) and weld overlay filler metal (i.e., Alloy 52M), and the chromium content of the weld overlay deposits.

The staff noted that during recent weld overlay campaigns in the industry, some licensees have experienced hot cracking in the first Alloy 52M layer covering the stainless steel buffer layer which is deposited on the stainless steel safe-end and pipe segment. The staff asked the licensee to discuss whether a stainless steel buffer layer will be applied on the safe end and/or pipe and discuss measures that will be implemented to prevent hot cracking from occurring during overlay installation at DBNPS. By letter dated November 23, 2009, the licensee responded that a stainless steel buffer layer is planned to be applied to the stainless steel safe-end or nozzle. The licensee is also monitoring the investigation taking place to review the hot cracking issue experienced at another site, and reviewing the lessons learned for applicability. The staff finds that the licensee is aware the hot cracking problems and is following the industry operating experience on this welding issue.

Figure 5-3, "Schematic Configuration for FSWOL for Core Flood Nozzles," Section 5, "Proposed Alternative and Basis for Use," of RR-A33 shows the proposed FSWOL covering the core flood nozzle, the DMW, and safe-end. Figure 5-3 does not show the weld that joins the safe-end with the pipe. The staff asked the licensee to clarify whether the proposed FSWOL will cover the weld that joins the safe end and the pipe as well as cover a part of the core flood pipe. This question also applies to Figure 5-4, "Schematic Configuration For FSWOL for RCP Cold-Leg Drain Line Nozzles," in RR-A33 regarding the cold-leg drainline configuration. In the July 13, 2009, letter, the licensee responded that the FSWOL will cover only the nozzle to safe-end weld. The safe-end to core flood pipe weld is not affected by the overlay. Only the nozzle to elbow weld will be covered in the cold-leg drainline application. The staff finds that the licensee has clarified the scope of the weld overlay on the cold-leg drainline and core flood piping.

Section A1.2.2(d)(3), Attachment 1, of RR-A33 states that "...The filler material used shall meet the minimum requirements for delta ferrite...." The staff asked the licensee to discuss the minimum requirements for delta ferrite and the identification of the weld material. In the July 13, 2009, letter, the licensee clarified that the delta ferrite requirements contained in Section A2.1(d)(3), Attachment 1, of RR-A33 have been included in Section A1.2.2(d)(3), Attachment 1, of RR-A33. The specific stainless steel weld material type to be used will be evaluated and selected upon completion of the investigation into hot cracking issues at other facilities. The staff finds that the revised Section A1.2.2(d)(3), Attachment 1, in RR-A33 is acceptable because it is consistent with paragraph (e) of ASME Code Case N-504-3. The staff finds acceptable that the weld metal for the austenitic stainless steel filler metal is not specified in A1.2.2(d)(3), Attachment 1, of RR-A33 until the industry resolves the hot cracking issue.

3.9 Crack Growth Considerations and Design

Section A1.3, Attachment 1, of Relief Request RR-A33 provides the requirements for the overlay design and the crack growth calculation. Some of the requirements in Section A1.3, "Inspectability Consideration," do not appear in Code Case N-504-3 because the Section A1.3 requirements have followed some of the requirements in ASME Code Case N-740-2, which the staff has not yet approved. However, the requirements in Section A1.3 are more stringent and provide detailed specifications than ASME Code Case N-504-3 and Appendix Q to the ASME Code, Section XI. For example, Section A1.3(a) provides more detailed requirements regarding the initial flaw size that should be assumed in the crack growth calculations than that of ASME Code Case N-504-3 and Appendix Q of the ASME Code, Section XI.

Also, Section A1.3(a)(4) of RR-A33 requires that for cast austenitic stainless steel items, a 100 percent through-wall flaw shall be assumed unless the subsequent inservice inspection schedule is modified as discussed in Section A1.4(c)(4) of RR-A33. The staff finds that assuming an initial 100 percent through-wall flaw in the cast austenitic steel component is more conservative than an initial design basis 75 percent through-wall flaw that is generally assumed for materials other than cast austenitic steel. Therefore, the 100 percent through-wall flaw for cast austenitic stainless steel component is acceptable.

Therefore, the staff finds that Section A1.3, Attachment 1, Relief Request RR-A33 satisfies and in some cases exceeds the requirements of Code Case N-504-3 and Appendix Q of the ASME Code, Section XI.

3.10 Examination and Inspection

Section 1.4, Attachment 1, of Relief Request RR-A33, dated November 23, 2009, provides requirements for acceptance, preservice, and inservice examinations of the installed weld overlay. The staff notes that the licensee applied examination requirements of the ASME Code Case N-770, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler F-5 Material With or Without the Application of Listed Mitigation Activities," in Section A1.4(c) of RR-A33. The staff has not yet approved ASME Code Case N-770. However, the staff is proposing to incorporate ASME Code Case N-770 into 10 CFR 50.55a as part of the current rulemaking of incorporating the 2005 edition through 2008 addenda of the ASME Code. Once the final rule of 10 CFR 50.55a is issued, licensees need to examine the overlaid DMWs in accordance with ASME Code Case N-770 and associated conditions imposed as required in the final rule. The licensee stated that it recognizes that ASME Code Case N-770 is subject to 10 CFR 50.55a rulemaking by the NRC and future inservice examinations of the overlaid DMWs at the DBNPS will be performed in accordance with the rulemaking.

Section A1.4(c)(8) of RR-A33, dated January 30, 2009, included two options to handle the issues of ultrasonic testing (UT) of cast austenitic stainless steel components (i.e., reactor coolant pump inlet nozzles). Option 1 is to assume a 100 percent initial flaw in the DMW. Option 2 is to assume a 75 percent initial flaw in the DMW with an increase inspection schedule. The staff allows either option to be implemented by licensees. In the July 13, 2009, letter, the licensee responded that Section A1.4(c)(8) has been deleted from RR-A33 and the ISI requirements have been revised. The ISI frequency is determined based on the methodology contained in ASME Code Case N-770 for the ISI of welds mitigated by FSWOL as described in RR-A33, Section A1.4(c)(4). ASME Code Case N-770 recognizes the inability to ultrasonically interrogate the cast stainless steel material and provides additional requirements for the inservice inspection frequency. The staff finds that A1.4(c)(4) of RR-33 is acceptable because it satisfies the stringent requirements of assuming a 100 percent through-wall flaw assumption.

Sections A1.4(a)(2) and (a)(3), Attachment 1 of RR-A33 require that if ambient temperature temper bead welding is used, the liquid penetrant examination and ultrasonic examination will be commenced 48 hours after completing the third layer of the weld overlay. The proposed 48-hour hold time deviates from that of ASME Code Case N-638-1. ASME Code Case N-638-1 specifies that prior to performing nondestructive examination (NDE), a 48-hour hold time is required after the weld overlay cools to ambient temperature, not after completing the third weld layer. This 48-hour hold is specified to allow sufficient time for hydrogen cracking to occur (if it is to occur) in the heat affected zone of the ferritic materials prior to performing the final NDE. However, EPRI has provided a technical basis for starting the 48-hour hold after completing the third temper bead weld layer rather than waiting for the weld overlay to cool to ambient temperature. This technical basis is documented in EPRI Report 1013558, "Temper Bead Welding Applications - 48-hour Hold Requirements for Ambient Temperature Temper Bead Welding."

After evaluating the issues relevant to hydrogen cracking such as microstructure of susceptible materials, availability of hydrogen, applied stresses, temperature, and diffusivity and solubility of hydrogen in steels, EPRI concluded that "There appears to be no technical basis for waiting the 48 hours after cooling to ambient temperature before beginning the NDE of the completed weld. There should be no hydrogen present, and even if it were present, the temper bead welded component should be very tolerant of the moisture." The EPRI report also notes that over 20 weld overlays and 100 repairs have been performed over the last 20 years. During this time, there has never been an indication of hydrogen cracking by the NDE performed after the 48-hour hold or by subsequent ISI. The staff finds that the proposed 48-hour hold time starts from the completion of the third weld layer is acceptable because hydrogen cracking would not be a concern for the temper bead welding. Section A1.4(d) of RR-A33 referenced Section A1.4(c)(4). The referred to section should have been A1.4(c)(5). In an electronic mail dated December 15, 2009 (ADAMS Accession No. ML10040016), the licensee corrected the typographic error in Section A1.4(d) of Relief Request RR-A33.

The staff finds that the proposed requirements in Section A1.4, Attachment 1 of Relief Request RR-A33 satisfy the intent of ASME Code Case N-504-3 and Appendix Q of the ASME Code, Section XI. In addition, Section A1.4 of RR-A33 provides more detailed specifications than that of ASME Code Case N-504-3 and Appendix Q.

3.11 <u>Ambient Temperature Temper Bead Welding</u>

Section A2.1, Attachment 1, of RR-A33, dated November 23, 2009, provides requirements for the ambient temperature temper bead welding which follow the requirements of ASME Code Case N-638-1 with a few modifications, as discussed below.

Paragraph A2.2(b), Attachment 1, of RR-A33 states that the maximum area of the weld overlay based on the finished surface over the ferritic base material may be greater than 600 square inches, but less than 700 square inches. Code Case N-638-1 allows only 100 square inches over the ferritic base material. The NRC staff asked the licensee to justify the 700 square-inch surface area. In the letter dated November 23, 2009, the licensee submitted a finite element sensitivity analysis similar to that performed by the EPRI. This sensitivity analysis (Enclosure Q, Calculation 0800777.309, Rev. 0, "Sensitivity Study of Extension of Temperbead Surface Area Limitation for Weld Overlay Repairs Over Ferritic Materials (from 500 to 1,000 Square Inches)," of the November 23, 2009 letter) modeled temper bead weld overlay areas of 500, 750 and 1000 square inches in order to bound the 700 square inch value. The analysis demonstrates favorable residual stress distribution on the inside surface of the pipe with minimal radial shrinkage and distortion, and reveals that increasing the weld overlay coverage areas improves the residual stress on the inside surface of the pipe. The staff finds that the 700 square inch weld area on ferritic material using ambient temperature temper bead welding is acceptable.

The staff noted that the model in the industry's stress analysis for the 500 square-inch area is based on a straight pipe. However, a pipe elbow exists at the reactor coolant pump nozzles and cold-leg drainline nozzle at the DBNPS. An elbow may present different stress distribution and there is a potential for stress risers within the overlay material on the elbow. The staff asked the licensee to explain whether the stress analysis of the nozzle is applicable to the elbows in the subject piping. In the July 13, 2009, letter, the licensee responded that the residual stress and radial displacement is determined at the DMW using a computer model with the same component geometry as the weld overlay application. The elbow configuration and the cladding are modeled. The residual stress and radial displacement is evaluated comparing the pre-weld overlay component to the post-weld overlay component. The areas the model examines includes the DMW and surface area deposited over the carbon steel for at least two selected different area coverages on the carbon steel. The residual stress analysis uses the same component geometry as the ferritic base material to which the ambient temper bead process is to be applied. The residual stress is shown to be beneficial for the increased overlay size, both length and thickness, and the radial displacement is shown to be insignificant with a negligible difference as a result of increased overlay length or thickness.

The subject carbon steel elbow at the DBNPS has a stainless steel cladding. The staff asked the licensee whether the current stress analysis contains stainless steel cladding on the inside of the pipe. In the July 13, 2009, letter, the licensee responded that the residual stress analysis includes the stainless steel cladding on the ferritic components and the staff finds this acceptable.

The staff finds that Section A2.1, Attachment 1, of RR-A33 satisfies Code Case N-638-1 and therefore, is acceptable.

3.12 Performance Demonstration Initiative Program

The U.S. nuclear utilities created the PDI program to implement performance demonstration requirements contained in Appendix VIII of Section XI of the ASME Code. To this end, the PDI program has developed a program for qualifying equipment, procedures, and personnel in accordance with the UT criteria of Appendix VIII, Supplement 11. Prior to the Supplement 11 program, EPRI was maintaining a performance demonstration program (the precursor to the PDI program) for weld overlay qualification under the Tri-party Agreement with the NRC, Boiling Water Reactor Owner's Group, and EPRI, in the NRC letter dated July 3, 1984 (not publicly available). Later, the NRC staff recognized the EPRI PDI program for weld overlay qualifications as an acceptable alternative to the Tri-party Agreement in its letter dated January 15, 2002, to the PDI Chairman (ADAMS Accession No. ML020160532).

The PDI program is routinely assessed by the staff for consistency with the current ASME Code and proposed changes. The PDI program does not fully comport with the existing requirements of Supplement 11. PDI presented the differences at public meetings in which the NRC participated (Memorandum from Donald G. Naujock to Terence Chan, "Summary of Public Meeting Held January 31 - February 2, 2002, with PDI Representatives," March 22, 2002 (ADAMS Accession No. ML010940402), and Memorandum from Donald G. Naujock to Terence Chan, "Summary of Public Meeting Held June 12 through June 14, 2001, with PDI Representatives," November 29, 2001, (ADAMS Accession No. ML013330156). Based on the discussions at these public meetings, the staff determined that the PDI program provides an acceptable level of quality and safety.

The NRC staff evaluated the differences between the PDI program and Supplement 11 in Attachment 2 of RR-A33. The staff noted that the PDI program discussed in Attachment 2 of RR-A-33 appears to be for the OWOL design because some requirements discuss a 50 percent through-wall flaw, which is for the OWOL design, instead of a 75 percent through-wall flaw, which is for the FSWOL design. In the July 13, 2009, letter, the licensee clarified that the examination of OWOLs is an extension of the existing PDI program that is based on ASME Code, Section XI, Appendix VIII, Supplement 11, for the examination of FSWOLs. The PDI program for the OWOL design decreases the flaw size used in PDI qualifications from 75 percent to 50 percent through-wall from the inside surface. As this change increases the qualified examination depth, it bounds the examination requirements for FSWOLs. The staff finds the licensee's clarification acceptable because if the PDI qualified UT can detect a 50 percent through-wall flaw originated from the inside surface, it would be qualified to detect a 75 percent through-wall flaw originated from the inside surface.

The NRC staff concludes that the justifications for the proposed PDI program to satisfy the ASME Code, Section XI, Appendix VIII, supplement 11 are reasonable and the PDI program provides an acceptable level of quality and safety and therefore, the proposed PDI program is acceptable.

3.13 Commitments

In Section 5 of RR A-33, the licensee stated that the following list of analyses and verifications shall be performed subject to the specific design, analysis, and inspection requirements that have been defined in this relief request.

1. Nozzle specific stress analyses shall be performed to establish a residual stress profile in the nozzle. Inside diameter weld repairs shall be assumed in these analyses to effectively bound any actual weld repairs that may have occurred in the nozzles. The analyses shall then simulate application of the weld overlays to determine the final residual stress profile. Post weld overlay residual stresses at normal operating conditions shall be shown to result in a stress state on the inside surface of each component, that assures that further crack initiation due to PWSCC is highly unlikely.

2. Fracture mechanics analyses shall be performed to predict crack growth. Crack growth due to PWSCC and fatigue crack growth in the original dissimilar metal weld shall be evaluated. The crack growth analyses shall consider all design loads and transients, plus the post weld overlay through wall residual stress distributions, and shall demonstrate that the assumed cracks shall not grow beyond the design bases for the weld overlays (that is, through the original dissimilar metal weld thickness) for the time period until the next scheduled inservice inspection. The crack growth analyses shall determine the time period for the assumed cracks to grow to the design basis for the weld overlays.

3. The stress analyses shall demonstrate that the application of the weld overlays does not impact the conclusions of the existing nozzle stress reports. ASME Code Section III stress and fatigue criteria shall be met for the regions of the overlays remote from observed (or assumed) cracks.

4. The original leak-before-break calculations will be updated with an evaluation demonstrating that due to the efficacy of the overlay for PWSCC mitigation, concerns for original weld susceptibility to cracking has been resolved. The effects of the mitigation on the leak-before-break analysis shall be evaluated to show the effects of application of weld overlays do not invalidate the conclusions of the existing design basis. By letter dated September 28, 2009, the licensee submitted the updated leak-before-break analysis as part of a license amendment request.

5. Shrinkage shall be measured during the overlay application. Shrinkage stresses arising from the weld overlays at other locations in the piping systems shall be demonstrated to not have an adverse effect on the systems. Clearances of affected supports and restraints shall be checked after the overlay repair, and shall be reset within the design ranges as required.

6. The total added weight on the piping systems due to the overlays shall be evaluated for potential impact on piping system stresses and dynamic characteristics.

7. The as-built dimension of the weld overlays shall be measured and evaluated to demonstrate that they equal or exceed the minimum design dimensions of the overlays.

The licensee stated that summaries of the results of the analyses listed in items one through four above will be submitted to the NRC prior to entry into Mode 4 following completion of the weld overlays. Items five though seven are performed following installation of the weld overlays and results shall be included in the design modification package closure documents. This information shall be available to NRC resident or Regional inspectors for review as needed.

The licensee stated that the following information will be submitted to the NRC within 14 days of completion of the final ultrasonic examination of the overlaid welds. Also included in the results will be a discussion of any repairs to the overlay material and/or base metal and the reason for the repair.

1. A listing of indications detected will be submitted. The recording criteria of the ultrasonic examination procedure to be used for the examination of the DBNPS overlays requires that all indications, regardless of amplitude, be investigated to the extent necessary to provide accurate characterization, identity, and location. Additionally, the procedure requires that all indications, regardless of amplitude, that cannot be clearly attributed to the geometry of the overlay configuration be considered flaw indications.

2. The disposition of all indications using the standards of ASME Code Section XI, IWB-3514-2 and/or IWB-3514-3 criteria and, if possible, the type and nature of the indications will be submitted. The ultrasonic examination procedure requires that all suspected flaw indications are to be plotted on a cross sectional drawing of the weld and that the plots should accurately identify the specific origin of the reflector.

The staff finds that the analyses and inspection results that the licensee committed to submit and available for review will provide assurance that the design and inspection of the FSWOL are within the ASME Code requirements and proposed RR-A33. Therefore, the proposed analyses and submittal of the inspection results are acceptable.

The NRC staff finds that the requirements of RR-A33 are either consistent with or exceed the intent of the provisions of ASME Code Cases N-504-3 and N-638-1 and Appendix Q of the ASME Code, Section XI. Therefore, proposed alternative in RR A-33 to apply the FSWOL will provide reasonable assurance of structural integrity of the subject piping.

4.0 CONCLUSION

On the basis of its review, the NRC staff has determined that RR-A33, dated November 23, 2009, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the use of RR-A33, dated November 23, 2009, for the FSWOLs of the DMW at the reactor coolant pump discharge and suction nozzles, reactor core flood nozzles, and reactor coolant system cold-leg drainline nozzles at the DBNPS. The subject relief request is authorized for the third 10-year ISI interval which commenced on September 21, 2000, and will end on September 20, 2012.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: JTsao, NRR

Date: January 21, 2010

If you have any questions, please contact the Davis-Besse Project Manager, Mr. Stephen Sands, at 301-415-3154.

Sincerely,

/RA/

Stephen J. Campbell, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-346

Enclosure:
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