June 12, 2007

Mr. Richard M. Rosenblum
Senior Vice President and Chief Nuclear Officer
Southern California Edison Company
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, CA 92674-0128

SUBJECT: SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3 - RE: THIRD 10-YEAR INSERVICE INSPECTION INTERVAL REQUEST ISI-3-25, USE OF STRUCTURAL WELD OVERLAYS AND ASSOCIATED ALTERNATIVE REPAIR TECHNIQUES (TAC NOS. MD2579 AND MD2580)

Dear Mr. Rosenblum:

By letter dated July 14, 2006, as supplemented by letters dated September 29 and October 23, 2006, Southern California Edison Company (SCE, the licensee) submitted Relief Request ISI-3-25 requesting relief from certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, requirements at San Onofre Nuclear Generating Station, Units 2 and 3.

ISI-3-25 requests relief from the requirements of the ASME Code pursuant to paragraph 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* (10 CFR). Modifications to ASME Code Cases N-504-2 and N-638-1, and Supplement 11, to the 1995 Edition including 1996 Addenda of the ASME Code, Section XI, were submitted specifically for the purpose of performing preemptive full structural weld overlays on pressurizer surge nozzle safe-ends and their adjoining welds. The relief request is for the remainder of the third 10-year inservice inspection (ISI) program interval which began on August 18, 2003, and ends on August 17, 2013.

The Nuclear Regulatory Commission (NRC) staff has completed its review of this submittal and concludes that the ISI program relief request ISI-3-25 provides an acceptable level of quality and safety. The NRC staff authorizes the alternatives proposed by SCE in accordance with 10 CFR 50.55a(a)(3)(i), for the remainder of the third 10-year ISI program interval. 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.

The staff's safety evaluation is enclosed. If you have any questions, please contact N. Kalyanam, Project Manager, 301-415-1480.

Sincerely,

/RA/

Thomas G. Hiltz, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-361 and 50-362

Enclosure: Safety Evaluation

cc w/encl: See next page

The staff's safety evaluation is enclosed. If you have any questions, please contact N. Kalyanam, Project Manager, 301-415-1480.

Sincerely,

/RA/

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Docket Nos. 50-361 and 50-362

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cc w/encl: See next page

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ADAMS Accession No.: ML071380013 *No legal objection - with comment

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San Onofre Nuclear Generating Station
Units 2 and 3

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM RELIEF REQUEST ISI-3-25

SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3

SOUTHERN CALIFORNIA EDISON

DOCKET NOS. 50-361, 50-362

1.0 INTRODUCTION

By letter dated July 14, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML061990111), as supplemented by letters dated September 29 and October 23, 2006 (ADAMS Accession Nos. ML062760233 and ML062980203, respectively), Southern California Edison (the licensee) submitted relief request ISI-3-25. Pursuant to paragraph 50.55a(a)(3)(i) of Title 10 of *Code of Federal Regulations* (10 CFR), the licensee requested relief from the repair requirements of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Code Cases N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1 (N-504-2)," N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW [Gas Tungsten Arc Weld] Temper Bead Technique (N-638-1)," and Appendix VIII, Supplement 11 to the 1995 Edition including 1996 Addenda of the ASME Code, Section XI. The modifications would be used to perform preemptive full structural weld overlays on pressurizer surge nozzle safe-ends and adjoining welds at San Onofre Nuclear Generating Station, Units 2 and 3 (SONGS 2 and 3).

2.0 REGULATORY EVALUATION

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 (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. 10 CFR 50.55a(g)(4)(i) requires that inservice examinations of components and system pressure tests conducted during the initial 10-year inspection interval 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) on the date 12 months before the issuance of the operating license. The regulation at 10 CFR 50.55a(g)(4)(ii) requires that inservice examinations and system pressure tests during successive 10-year inspection intervals comply with the requirements of the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months before the start of the 10-year inspection interval, subject to the limitations and modifications listed therein. The ISI Code of record for SONGS 2 and 3 for the third

10-year ISI interval which began on August 18, 2003, and ends on August 17, 2013, is the 1995 Edition through the 1996 Addenda of the ASME Code, Section XI.

Pursuant to 10 CFR 50.55a(g)(4)(iv), ISI items may meet the requirements set forth in subsequent editions and addenda of the ASME Code that are incorporated by reference in 10 CFR 50.55a(b), subject to the limitations and modifications listed therein, and subject to Commission approval. Portions of editions and addenda may be used provided that related requirements of the respective editions and addenda are met.

Pursuant to 10 CFR 50.55a(a)(3), alternatives to requirements may be authorized by the Nuclear Regulatory Commission (NRC) if the licensee demonstrates that: (i) the proposed alternative provides 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 alternatives to the implementation of the ASME Code, Section XI, Appendix VIII, Supplement 11, and modifications to N-504-2 and N-638-1, for the deposition of preemptive full structural weld overlays.

3.0 TECHNICAL EVALUATION

3.1 Requirements for Which Relief Is Requested

Under the requirements of IWA-4610(a), the area to be welded plus a band around the area of at least one and one-half times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 350 degrees Fahrenheit (°F) for the shielded metal arc weld (SMAW) process and 300 °F for the GTAW process during welding.

Code Cases N-638-1 and N-504-2, with conditions as specified in Regulatory Guide (RG) 1.147, Revision 14, and ASME Section XI, 1995 Edition including Addenda through 1996.

3.2 Licensee's Proposed Modifications to N-504-2

The licensee proposed to use N-504-2 with the following modifications for full structural weld overlays:

- Use of a nickel-based alloy weld material, Alloy 52/52M rather than the low-carbon (0.035 percent maximum) austenitic stainless steel.

- Relaxation from the requirement to perform delta ferrite measurements to meet the 7.5 Ferrite Number (FN) requirement of N-504-2. The FN requirement cannot be met because the Alloy 52/52M weld material is 100 percent austenitic and contains no delta ferrite.

3.3 Licensee's Basis for Relief

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee stated that the weld overlay has been designed consistent with the requirements of N-504-2 with the specific thickness and length computed according to the guidance provided in the subject Code Case. The licensee stated

that Alloy 52/52M material is highly resistant to primary water stress-corrosion cracking (PWSCC) and that industry operational experience has shown that PWSCC in Alloy 82/182 will blunt at the interface with stainless steel base metal, ferritic base metal, or Alloy 52/52M weld metal. The 360 degree structural weld overlay will control growth in any PWSCC crack and maintain weld integrity. The weld overlay will induce compressive stress in the weld, thus impeding growth of any reasonably shallow cracks.

The weld metal used will be Alloy 52/52M, which is an austenitic nickel alloy. These filler materials were selected for their improved resistance to PWSCC. Alloys 52 and 52M contain about 30 percent chromium that imparts excellent corrosion resistance. The existing Alloy 82/182 weld and the Alloy 52/52M/152 overlay are nickel-based and have ductile properties and toughness similar to austenitic stainless steel piping welds at pressurized-water reactor operating temperature. These filler materials are suitable for welding over the ferritic nozzle, Alloy 82/182 weld, and the austenitic stainless steel pipe or safe-end materials.

Paragraph (e) of N-504-2 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 is 100 percent austenitic and contains no delta ferrite due to the high nickel composition (approximately 60 percent nickel).

3.4 Staff Evaluation of Modifications to N-504-2

Alternatively, the component may be evaluated and accepted in accordance with the design rules of either the Construction Code, or Section III, when the Construction Code was not Section III. N-504-2 is being used by the licensee to perform full structural weld overlays on the SONGS Units 2 and 3 reactor coolant system welds listed in Section 2.0 of its July 14, 2006, submittal as a preemptive measure against cracking due to PWSCC.

Under the rules of IWA-4410, in 1995 Edition with the 1996 Addenda, 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 a later different Construction Code, 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 IWA-4611. Alternatively, the component may be evaluated and accepted in accordance with the appropriate flaw evaluation provisions of Section XI or the design provisions of the Owner's Requirements and either the Construction Code or Section III. N-504-2 is being used by the licensee to perform PWOLs for pressurizer spray and relief nozzle-to-safe-end welds. N-504-2 was conditionally approved by the staff for use under RG 1.147, Revision 14, "Inservice Inspection ASME Code Case Acceptability, ASME Code Section XI, Division 1." Therefore, the use of N-504-2 as an alternative to the mandatory ASME Code repair provisions is acceptable to the staff, provided the licensee has complied with all conditions and provisions of the ASME Code Case.

The first proposed modification to the 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 percent maximum) austenitic stainless steel. In lieu of the stainless steel weld material, Alloy 52/52M, a consumable welding wire highly resistant to PWSCC, was proposed for the

overlay weld material. The NRC staff notes that the use of Alloy 52/52M material is consistent with weld filler material used to perform similar weld overlays at operating boiling-water reactor (BWR) facilities. The NRC staff notes that the licensee is performing a full structural overlay on dissimilar metal welds made of Alloy 182 material. For material compatibility in welding, the NRC staff considers Alloy 52/52M a better choice of filler material than austenitic stainless steel material for this weld joint configuration. Alloy 52/52M contains about 28 percent - 30 percent chromium which would provide excellent resistance to PWSCC in 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 for the weld overlays as a modification to the requirements of N-504-2, paragraph (b) is acceptable as it will provide an acceptable level of quality and safety.

The second proposed modification to the N-504-2 provisions involved 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 material is 100 percent austenitic and contains no delta ferrite due to the high nickel composition (approximately 60 percent nickel). N-504-2 allows the use of weld overlay 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 only applicable to weld overlay repair of austenitic stainless steel piping. Therefore, the material requirements regarding the carbon content limitation (0.035 percent maximum) and the delta ferrite content of at least 7.5 FN, as delineated in N-504-2, paragraph (e), apply to austenitic stainless steel weld overlay materials. These requirements are not applicable to Alloy 52/52M, a nickel-based material which the licensee will use for the weld overlays. Based on the discussion above, the staff concludes that the modifications to N-504-2 paragraph (e) will provide an acceptable level of quality and safety, and are therefore, acceptable.

3.5 Licensee's Proposed Modifications to N-638-1

The licensee proposed to use N-638-1 with the following modifications for full structural weld overlays:

1. The maximum area of an individual weld based on the finished surface over the ferritic material will be approximately 300 square inches.

2. Full ultrasonic testing (UT) of the 1.5T band on the ferritic side of the overlay(s) will not be performed. UT will be performed on the actual weld overlay, meeting the requirements of N-504-2 and Nonmandatory Appendix Q.

3. In lieu of weld-attached thermocouples and recording instruments, process temperatures will be monitored with non-attached devices, such as contact pyrometers.

3.6 Licensee's Basis for Relief

For the first modification, the licensee stated that the one-half base metal thickness limitation, which also includes the 100-square-inch surface area limitation under 1.0(a) of N-638-1, applies only to excavations and repairs, and is not applicable to the weld overlays that are the subject

of this relief request. The staff agrees that the 100-square-inch surface area limitation is not applicable to this configuration which consists of an overlay rather than an excavation of ferritic material. There have been a number of temper-bead weld overlay repairs applied to safe-end to nozzle welds in the nuclear industry and a similar 300-square-inch full structural weld overlay was recently approved by the staff for the Susquehanna Steam Electric Station and D.C. Cook Nuclear Plant.

For the second modification, the licensee stated that in lieu of the requirement to perform a UT of the 1.5T band next to the overlay, the post-overlay NDEs will be performed in accordance with the requirements of N-504-2. The licensee stated that N-638-1 applies to any type of welding where a temper-bead technique is to be employed and is not specifically written for a weld overlay repair. The licensee stated that if the cracking were to occur, it would be beneath the heat-affected zone (HAZ) of the weld overlay instead of the 1.5T area that is not covered by the overlay. Finally, UT of the 1.5T band is not feasible because of the nozzle configuration; therefore, meaningful UT information cannot be obtained.

For the third modification, the licensee stated that preheat and interpass temperatures will be monitored with a contact pyrometer. Due to the location of the repair and area radiation dose rates, the placement of welded thermocouples for monitoring weld interpass temperature is determined to be not beneficial based on dose savings.

3.7 Staff Evaluation of Modification to N-638-1

Under the requirements of IWA-4610(a), the area to be welded plus a band around the area of at least one and one-half times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 350 °F for the SMAW process and 300 °F for the GTAW process during welding. N-638-1 allows the use of machine GTAW with ambient temperature preheat and no postweld heat treatment when draining the vessel is impractical. N-638-1, paragraph 1(a) limits the size of the repair to 100-square-inch maximum. However, because of the diameter of the components, the maximum area of the weld overlays on the ferritic material will not exceed 300 square inches on the ferritic material, according the information provided by the licensee.

N-638-1 limits the size of the repair to a maximum of 100 square inches and a depth not greater than one-half the ferritic base metal thickness or 3/8 inch. Some of the reasons for these limits are distortion of weld and base metal, cracking in the weld and base metal, and high residual stresses when a large repair excavation is being performed in the ferritic material of a dissimilar metal weld. In the application of the preemptive weld overlay for this relief request, there is no large excavation in the ferritic portion of the material, therefore, the 100-square-inch limitation does not significantly contribute to cracking when the ferritic material is overlaid rather than excavated. The staff has approved overlays up to 300 square inches over ferritic materials in configurations similar to the licensee's at Susquehanna and D.C. Cook. The overlay of tough, nickel-based alloy material results in the deposition of compressive stresses in the original 82/182 weld materials thereby providing reasonable assurance of the continued structural integrity of the component, and is therefore, acceptable.

The second modification requested by the licensee is that full UT of the 1.5T band required under Paragraph 4.0(b) will not be performed. The staff notes that the postweld overlay

examination area, as defined under Appendix Q, is one-half inch on either side of the overlay for surface examination and the completed overlay for ultrasonic examination. The licensee specifically states that it will comply with Appendix Q, a condition to the use of N-504-2, which was imposed by the staff under RG 1.147, Revision 14. The issue of cracking and/or distortion of the weld and base metal were not specifically addressed in the code case development work. Since the weld overlays are fabricated from austenitic materials with inherent toughness, no cracking in the overlays is expected to occur due to the shrinkage associated with the weld overlay. With respect to the ferritic portion of the overlays, many temper-bead weld overlays have been applied in the nuclear industry to these nozzle-to-safe-end locations. In no instance has there been any reported cracking due to the weld overlay application. The stiffness and high toughness inherent in the low-alloy steel material is expected to protect against any cracking and limit any distortion that might occur in the low-alloy steel material.

In addition to the above, any cracking which might occur should be detected by the final NDE of the weld overlay required under Appendix Q, which provides additional assurance of the deposition of a defect-free, structurally sound overlay. The assessment of the shrinkage stresses on the piping, plus postweld NDE volumes under Appendix Q, provide reasonable assurance that defect-free welds will result in maintaining the structural integrity of the piping. The staff concludes that the testing under Appendix Q will provide an acceptable level of quality and safety; therefore, the staff finds the proposed modification to the 1.5T band UT requirement under N-638-1 to be acceptable.

The third modification requested by the licensee is to manually record process temperatures using calibrated instruments such as contact pyrometers. Paragraph 4.0(b) of N-638-1 states that when weld-attached thermocouples and recording instruments are used, the area from which the thermocouples have been removed will be ground and examined using a surface examination. Published literature clearly identifies grinding as a method of cold working which acts as a crack initiation site for PWSCC-sensitive materials. The opportunity to reduce the amount of cold work in these materials is considered an effective tool to prevent cracking. The licensee's modification to monitor process temperatures with contact instrumentation that eliminates welding and grinding is considered a good practice and an effective remedy to minimize cold work. Based on the discussion above, the staff concludes that the modification to monitor process temperatures with calibrated contact temperature monitoring devices will provide an acceptable level of quality and safety, and therefore, is acceptable.

In its submittal, the licensee states that it is using ASME Code, Section XI, acceptance criteria for weld overlays in lieu of ASME Section III/Construction Code acceptance criteria as specified in ASME Code Case N-638-1. ASME Section III flaw acceptance standards are derived from the capability of radiography to detect and size flaws originating from the fabrication process used during new facility construction. The ASME Section III acceptance criteria do not allow for the presence of any cracks or crack-like indications, regardless of their size, and are geared more towards volumetric flaws. The capability of radiography is a function of density differences such as 2 percent or greater changes in density. The density changes normally associated with cracks, depending on orientation, are much less than the detection capability of radiography. There is an inherent, unknown tolerance in the Section III acceptance criteria for radiography which encompasses tight cracks and densities below the detection capabilities of radiography. Flaws detected using radiography are not precise enough for applying Section XI crack-growth analyses, as flaw depth cannot be measured with radiography. Section III

radiography is not applicable for evaluating flaws for continued plant operations because of the difficulty associated with depth sizing flaws.

The weld overlays in this request are to mitigate PWSCC in dissimilar metal welds at SONGS 2 and 3. The application of N-504-2 is for applying austenitic Alloy 52/52M weld metal on austenitic base material. The application of N-638-1 is to apply austenitic weld metal on ferritic base material using a controlled heat input that relieves welding stresses and prevents crack-sensitive microstructure in the ferritic material. The purpose of N-638-1 is to establish an austenitic surface for the application of N-504-2 to complete the structural weld overlay. The N-638-1 applied weld metal is sandwiched between base metal and N-504-2 weld metal. Locating a flaw in N-638-1 weld metal using Section III radiography would be extremely difficult.

Many flaws that are not detected or accurately sized with radiography have a high likelihood of being detected and sized with UT, depending on orientation. These flaws are normally detected with UT during the Section XI pre-service inspection. Also the pre-service UT is used to characterize flaws detected during the Section III radiography examination. The flaws of concern are the ones that cause failure immediately or grow to failure in the future. The Section XI pre-service acceptable flaw standards were developed to consider the materials in which the flaw indications are detected, the orientation and size of the indications, and ultimately their potential structural impact of the flaw on the component. The flaws detected during pre-service inspections are subjected to periodic ISI as established in Appendix Q, Q-4300. This includes inspection frequencies for monitoring existing crack growth and identifying new cracks. Thus, the established pre-service NDE acceptance criteria in Code Case N-504-2 for weld overlays made with Alloy 52/52M weld metal also applies to the portion of the weld overlay made during the application of N-638-1 as modified by this safety evaluation.

3.8 ASME Code, Section XI, Requirements for Which Relief Is Requested

The licensee requested relief from the requirements of ASME Code, Section XI, Appendix VIII, Supplement 11, "Qualification Requirements for Full Structural Overlaid Wrought Austenitic Piping Welds," 1995 Edition including the 1996 Addenda, as amended by 10 CFR 50.55a(b)(2)(xxiv). The specific Supplement 11, paragraphs are 1.1(b), 1.1(d)(1), 1.1(e)(1), 1.1(e)(2), 1.1(e)(2)(a)(1), 1.1(e)(2)(a)(2), 1.1(e)(2)(a)(3), 1.1(e)(2)(b)(1), 1.1(e)(2)(b)(2), 1.1(e)(2)(b)(3), 1.1(f)(1), 1.1(f)(3), 1.1(f)(4), 2.0, 2,1, 2.2(d), 2.3, 3.1, 3.2(a), and 3.2(b).

3.9 Licensee's Proposed Alternative and Bases

Pursuant to the provisions in 10 CFR 50.55a(a)(3)(i), the licensee proposed alternatives that will be implemented through use of the Electric Power Research Institute (EPRI) Performance Demonstration Initiative (PDI) program weld overlay examination qualification requirements, for the remainder of the third 10-year ISI interval.

3.10 Staff Evaluation

The U.S. nuclear utilities created the PDI program to implement the performance demonstration requirements contained in Appendix VIII of Section XI of the ASME Code. To this end, PDI has

developed a program for qualifying equipment, procedures, and personnel for examinations of weld overlays in accordance with the UT criteria of Appendix VIII, Supplement 11. Prior to the Supplement 11 program, EPRI maintained a performance demonstration program for weld overlay qualification under the Tri-party Agreement[1]. Instead of having two programs with similar objectives, the NRC staff recognized the PDI program for weld overlay qualifications as an acceptable alternative to the Tri-party Agreement[2].

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[3, 4]. The differences are in flaw location within test specimens and fabricated flaw tolerances. The changes in flaw location permitted using test specimens from the Tri-party Agreement, and the changes in fabricated flaw tolerances provide UT acoustic responses similar to the responses associated with intergranular stress corrosion cracking. Based on the discussions at these public meetings, the staff determined that the PDI program provides an acceptable level of quality and safety.

Evaluations of the differences identified in the PDI program with Supplement 11, Paragraphs 1.1(b), 1.1(d)(1), 1.1(e)(1), 1.1(e)(2), 1.1(e)(2)(a)(1), 1.1(e)(2)(a)(2), 1.1(e)(2)(a)(3), 1.1(e)(2)(b)(1), 1.1(e)(2)(b)(2), 1.1(e)(2)(b)(3), 1.1(f)(1), 1.1(f)(3), 1.1(f)(4), 2.0, 2,1, 2.2(d), 2.3, 3.1, 3.2(a), and 3.2(b) are as follows:

Paragraph 1.1(b) of Supplement 11 states limitations to the maximum thickness for which a procedure may be qualified. The ASME Code states that “The specimen set must include at least one specimen with overlay thickness within minus 0.10-inch to plus 0.25-inch of the maximum nominal overlay thickness for which the procedure is applicable.” The ASME Code requirement addresses the specimen thickness tolerance for a single specimen set, but is confusing when multiple specimen sets are used. The PDI proposed alternative states that “the specimen set shall include specimens with overlay not thicker than 0.10-inch more than the minimum thickness, nor thinner than 0.25-inch of the maximum nominal overlay thickness for which the examination procedure is applicable.” The proposed alternative provides clarification on the application of the tolerance. The tolerance is unchanged for a single specimen set; however, the proposed alternative clarifies the tolerance for multiple specimen sets by providing

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1 The Tri-party Agreement is between NRC, EPRI, and the Boiling Water Reactor Owners Group (BWROG), “Coordination Plan for NRC/EPRI/BWROG Training and Qualification Activities of NDE (Nondestructive Examination) Personnel,” July 3, 1984.

2 Letter from William H. Bateman to Michael Bratton, “Weld Overlay Performance Demonstration Administered by PDI as an Alternative for Generic Letter 88-01 Recommendations,” January 15, 2002 (ADAMS Accession No. ML020160532).

3 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).

4 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).

tolerances for both the minimum and maximum thicknesses. The proposed wording eliminates confusion while maintaining the intent of the overlay thickness tolerance. Therefore, the staff finds this PDI program alternative maintains the intent of the Supplement 11 requirements and is acceptable.

Paragraph 1.1(d)(1) requires that all base metal flaws be cracks. PDI determined that certain Supplement 11 requirements pertaining to location and size of cracks would be extremely difficult to achieve. For example, flaw implantation requires excavating a volume of base material to allow a pre-cracked coupon to be welded into this area. This process would add weld material to an area of the specimens that typically consists of only base material, and could potentially make ultrasonic examination more difficult and not representative of actual field conditions. In an effort to satisfy the requirements, PDI developed a process for fabricating flaws that exhibit crack-like reflective characteristics. Instead of all flaws being cracks, as required by Paragraph 1.1(d)(1), the PDI weld overlay performance demonstrations contain at least 70 percent cracks with the remainder being fabricated flaws exhibiting crack-like reflective characteristics. The fabricated flaws are semi-elliptical with tip widths of less than 0.002 inch. The licensee provided further information describing a revision to the PDI program alternative to clarify when real cracks, as opposed to fabricated flaws, will be used: "Flaws shall be limited to the cases where implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws." The NRC has reviewed the flaw fabrication process, compared the reflective characteristics between actual cracks and PDI-fabricated flaws, and found the fabricated flaws for this application provide assurance that the PDI program meets the intent of the Supplement 11 requirements. Therefore, the staff finds the proposed alternative to the Supplement 11 requirements is acceptable.

Paragraph 1.1(e)(1) requires that at least 20 percent but less than 40 percent of the flaws shall be oriented within ±20 degrees of the axial direction (of the piping test specimen). Flaws contained in the original base metal HAZ satisfy this requirement; however, PDI excludes axial fabrication flaws in the weld overlay material. PDI has concluded that axial flaws in the overlay material are improbable because the overlay filler material is applied in the circumferential direction (parallel to the girth weld); therefore, fabrication anomalies would also be expected to have major dimensions in the circumferential direction. The NRC finds, based upon engineering judgement, that this approach to implantation of fabrication flaws is reasonable for meeting the intent of the Supplement 11 requirements. Therefore, the staff concludes that the PDI's application of flaws oriented in the axial direction is acceptable.

Paragraph 1.1(e)(1) also requires that the rules of IWA-3300 shall be used to determine whether closely spaced flaws should be treated as single or multiple flaws. PDI treats each flaw as an individual flaw and not as part of a system of closely spaced flaws. PDI controls the flaws going into a test specimen set such that the flaws are free of interfering reflections from adjacent flaws. In some cases this permits flaws to be spaced closer than what is allowed for classification as a multiple set of flaws by IWA-3300, thus potentially making the performance demonstration more challenging than the existing requirements. Hence, the staff concludes that PDI's application for closely spaced flaws is acceptable.

Paragraph 1.1(e)(2) requires that specimens be divided into base metal and overlay grading units. The PDI program adds clarification with the addition of the word "fabrication" and ensures flaw identification by ensuring all flaws will not be masked by other flaws with the

addition of “Flaws shall not interfere with ultrasonic detection or characterization of other flaws.” PDI’s alternative provides clarification and assurance that the flaws are identified. Therefore, the staff finds this PDI alternative to the Supplement 11 requirements is acceptable.

Paragraph 1.1(e)(2)(a)(1) requires that a base grading unit shall include at least 3 inches of the length of the overlaid weld, and the base grading unit includes the outer 25 percent of the overlaid weld and base metal on both sides. The PDI program reduced the criteria to 1 inch of the length of the overlaid weld and eliminated from the grading unit the need to include both sides of the weld. The proposed change permits the PDI program to continue using test specimens from the existing weld overlay program which have flaws on both sides of the welds. These test specimens have been used successfully for testing the proficiency of personnel for over 16 years. The weld overlay qualification is designed to be a near-side (relative to the weld) examination, and it is improbable that a candidate would detect a flaw on the opposite side of the weld due to the sound attenuation and re-direction caused by the weld microstructure. However, the presence of flaws on both sides of the original weld (outside the PDI grading unit) may actually provide a more challenging examination, as candidates must determine the relevancy of these flaws, if detected. The staff determined, based on engineering judgement, that PDI’s use of the 1-inch length of the overlaid weld base grading unit and elimination from the grading unit the need to include both sides of the weld, as described in the PDI program alternative, is an acceptable alternative to the Supplement 11 requirements. Therefore, the staff finds this proposed alternative acceptable.

Paragraph 1.1(e)(2)(a)(2) requires, when base metal cracking penetrates into the overlay material, that a portion of the base grading unit shall not be used as part of the overlay grading unit. The staff finds that the PDI program adjusts for the changes in Paragraph 1.1(e)(2)(a)(2) and conservatively states that when base metal flaws penetrate into the overlay material, no portion of it shall be used as part of the overlay fabrication grading unit. The staff finds that the PDI program also provided clarification by the addition of the term “flaws” for “cracks” and the addition of “fabrication” to “overlay grading unit.” The staff concludes that the PDI program alternative provides clarification and conservatism and, therefore, is acceptable.

Paragraph 1.1(e)(2)(a)(3) requires that for unflawed base grading units, at least 1 inch of unflawed overlaid weld and base metal shall exist on either side of the base grading unit. This is to minimize the number of false identifications of extraneous reflectors. The PDI program stipulates that unflawed overlaid weld and base metal exists on all sides of the grading unit and flawed grading units must be free of interfering reflections from adjacent flaws which addresses the same concerns as the ASME Code. Hence, the staff concludes that the PDI’s application of the variable flaw-free area adjacent to the grading unit meets the intent of the Supplement 11 requirements and is, therefore, acceptable.

Paragraph 1.1(e)(2)(b)(1) requires that an overlay grading unit shall include the overlay material and the base metal-to-overlay interface of at least 6 square inches. The overlay grading unit shall be rectangular, with minimum dimensions of 2 inches. The PDI program reduces the base metal-to-overlay interface to at least 1 inch (in lieu of a minimum of 2 inches) and eliminates the minimum rectangular dimension. This criterion is necessary to allow use of existing examination specimens that were fabricated in order to meet NRC Generic Letter 88-01 (Tri-party Agreement, July 1984). This criterion may be more challenging to meet than that of the ASME Code because of the variability associated with the shape of the grading unit. Based

on engineering judgement, the staff concludes that PDI's application of the grading unit is an acceptable alternative to the Supplement 11 requirements and is acceptable.

Paragraph 1.1(e)(2)(b)(2) requires that unflawed overlay grading units shall be surrounded by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 inch around its entire perimeter. The PDI program redefines the area by noting unflawed overlay fabrication grading units shall be separated by at least 1 inch of unflawed material at both ends and sufficient area on both sides to preclude interfering reflections from adjacent flaws. The staff determined that the relaxation in the required area on the sides of the specimens, while still ensuring no interfering reflections, may provide a more challenging demonstration than required by the ASME Code because of the possibility for having a parallel flaw on the opposite side of the weld. Therefore, based on engineering judgement, the staff concludes that this PDI's application is an acceptable alternative to the Supplement 11 requirements.

Paragraph 1.1(e)(2)(b)(3) requirements are retained in the PDI program. In addition, the PDI program requires that initial procedure qualification contain three times the number of flaws required for a personnel qualification. To qualify new values of essential variables, the equivalent of at least one personnel qualification set is required. The staff concludes that PDI's additions enhance the ASME Code requirements and are, therefore, acceptable because it provides for a more stringent qualification criteria.

Paragraph 1.1(f)(1) requirements are retained in the PDI program, with the clarification change of the term "flaws" for "cracks." In addition, the PDI program includes the requirements that sizing sets shall contain a distribution of flaw dimensions to verify sizing capabilities. The PDI program also requires that initial procedure qualification contain three times the number of flaws required for a personnel qualification. To qualify new values of essential variables, the equivalent of at least one personnel qualification set is required. The staff concludes that PDI's additions enhance the ASME Code requirements and are, therefore, acceptable because it provides a more stringent qualification criteria.

Paragraphs 1.1(f)(3) and 1.1(f)(4) requirements are clarified by the PDI program by replacing the term "cracking" with "flaws" because of the use of alternative flaw mechanisms. The staff concludes that this clarification in the PDI program meets the intent of the ASME Code requirements and is acceptable.

Paragraph 2.0, "Conduct of Performance Demonstration," in Supplement 11 is clarified in PDI by the addition of the sentence, "[T]he overlay fabrication flaw test and the base metal flaw test may be performed separately." The staff concludes that the PDI program did not change the intent of the ASME Code but provided additional clarification. Therefore, this alternative in PDI is acceptable.

Paragraph 2.1, "Detection Test," in Supplement 11 states, in part, "... the candidate shall be made aware of the types of grading units (base or overlay) that are present for each specimen." In PDI, this is changed to "... the candidate shall be made aware of the types of grading units (base metal or overlay fabrication) that are present for each specimen." The staff concludes that the PDI program did not change the intent of the ASME Code but provided additional clarification. Therefore, this alternative in PDI is acceptable.

Paragraph 2.2(d) requirements are clarified by the PDI program by the addition of the terms "metal" and "fabrication". The staff determined that the clarifications provide acceptable classification of the terms they are enhancing. Therefore, the staff concludes that the PDI program, as clarified above, meets the intent of the ASME Code requirements and is acceptable.

Paragraph 2.3 requires that, for depth sizing tests, 80 percent of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate. This requires detection and sizing tests to be performed separately. The PDI revised the weld overlay program to allow sizing to be conducted either in conjunction with, or separately from, the flaw detection test. If performed in conjunction with detection and the detected flaws do not meet the Supplement 11 range criteria, additional specimens will be presented to the candidate with the regions containing flaws identified. Each candidate will be required to determine the maximum depth of flaw in each region. For separate sizing tests, the regions of interest will also be identified and the maximum depth and length of each flaw in the region will similarly be determined. In addition, PDI stated that grading units are not applicable to sizing tests, and that each sizing region will be large enough to contain the target flaw, but small enough such that candidates will not attempt to size a different flaw. The staff determined that the above clarification provides a basis for implementing sizing tests in a systematic, consistent manner that meets the intent of Supplement 11. Therefore, the staff concludes that the PDI's method is acceptable.

Paragraph 3.1 requires that examination procedures, equipment and personnel (as a complete ultrasonic system) are qualified for detection or sizing of flaws, as applicable, when certain criteria are met. The PDI program allows procedure qualification to be performed separately from personnel and equipment qualification. Historical data indicate that, if ultrasonic detection or sizing procedures are thoroughly tested, personnel and equipment using those procedures have a higher probability of successfully passing a qualification test. In an effort to increase this passing rate, PDI has elected to perform procedure qualifications separately in order to assess and modify essential variables that may affect overall system capabilities. For a procedure to be qualified, the PDI program requires three times as many flaws to be detected (or sized) as shown in Supplement 11 for the entire ultrasonic system. The personnel and equipment are still required to meet the Supplement 11 requirement. Therefore, the PDI program criteria exceeds the ASME Code requirements for personnel, procedures, and equipment qualification. The staff concludes that this PDI program criteria is acceptable.

Paragraph 3.2(a), in Supplement 11 states, "... The length of base metal cracking is measured at the 75% through-base-metal position." In PDI, this is changed to , "... The length of base metal flaws is measured at the 75% through-base-metal position." The staff concludes that the PDI program did not change the intent of the ASME Code but provided additional clarification. Therefore, this alternative in PDI is acceptable.

Paragraph 3.2(b) requires that all extensions of base metal cracking into the overlay material by at least 0.10 inch are reported as being intrusions into the overlay material. The PDI program omits this criterion because of the difficulty in actually fabricating a flaw with a 0.10-inch minimum extension into the overlay, while still knowing the true state of the flaw dimensions. However, the PDI program requires that cracks be depth-sized to the tolerance specified in the ASME Code which is 0.125 inch. Since the ASME Code tolerance is close to the 0.10-inch

value of Paragraph 3.2(b), any crack extending beyond 0.10 inch into the overlay material would be identified as such from the characterized dimensions. The staff determined that reporting of an extension in the overlay material is redundant for performance demonstration testing because of the flaw sizing tolerance. Therefore, the staff concludes that PDI's omission of highlighting a crack extending beyond 0.10 inch into the overlay material is acceptable.

4.0 CONCLUSION

Based on the discussion above, the staff concludes that the Code Case N-504-2 and N-638-1 modifications proposed in relief request ISI-3-25, for the preemptive full structural overlay of the welds listed in the July 14, 2006, submittal, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed modifications for the remaining service life of the subject welds.

Secondly, based on the discussion above, the staff concludes that the alternatives to ASME Code, Appendix VIII, Supplement 11, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed alternatives for the remainder of the third 10-year ISI interval.

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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