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, UNIT 3 - RE: RELIEF REQUEST ISI-3-24, REQUEST FOR RELIEF FROM REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE CONCERNING FOUR REACTOR COOLANT SYSTEM PRESSURIZER, DISSIMILAR METAL, AND NOZZLE-TO-SAFE-END WELDS STRUCTURAL OVERLAY AND ALTERNATIVE REPAIR TECHNIQUES (TAC NO. MD2469)

Dear Mr. Rosenblum:

By letter dated June 30, 2006, as supplemented by letters dated September 29, October 23, and November 20, 2006, Southern California Edison Company (SCE, the licensee) submitted Relief Request ISI-3-24 to use alternatives to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, 1995 Edition through 1996 Addenda, IWA-4000, for repair/replacement activities related to the performance of structural weld overlays on four (three safety nozzle-to-safe end and spray nozzle-to-safe end) high safety-significant Class 1 reactor coolant system pressurizer, dissimilar metal, and nozzle-to-safe-end welds at San Onofre Nuclear Generating Station, Unit 3. This reduces dependence on the Alloy 82/182 welds as a pressure boundary weld and to mitigate any potential primary water stress-corrosion cracking in the future. The relief request is for one operational cycle during 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 licensee's proposed use for repair/replacement activities related to the performance of structural weld overlays on the four welds provide an acceptable level of quality and safety for one operational cycle during the third 10-year ISI program interval. The NRC staff authorizes the alternative proposed by SCE in accordance with paragraph 50.55a(a)(3)(i) of Title 10 of *Code of Federal Regulations*. 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.

Due to the immediate need of this relief request, verbal authorization for the use of this relief request was granted on December 1, 2006.

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

Sincerely,

/RA/

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

Docket No. 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, at 301-415-1480.

Sincerely,

/RA/

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF ISI-3-24

SOUTHERN CALIFORNIA EDISON

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 3

DOCKET NO. 50-362

1.0 INTRODUCTION

By letter dated June 30, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML061840464), and supplemented by letters dated September 29, October 23, and November 20, 2006 (ADAMS Accession Nos. ML062760233, ML062980203, and ML063280023, respectively), Southern California Edison (SCE, the licensee) proposed modifications under Relief Request No. ISI-3-24, for the San Onofre Nuclear Generating Station, Unit 3 (SONGS 3), to the repair requirements of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1" (N-504-2), ASME Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW [Gas Tungsten Act Weld] Temper Bead Technique, Section XI, Division 1" (N-638-1), and proposed alternatives to Appendix VIII, Supplement 11 to the 1995 Edition including the 1996 Addenda of the ASME Code, Section XI. The proposed approach would be used to perform full structural preemptive weld overlays (PWOLs) on pressurizer spray, and safety nozzle-to-safe-end welds. The subject welds were fabricated using Ni-Cr-Fe Alloy 82/182 weld material to butter the nozzle weld geometry-ends and to weld the safe ends. This weld material has demonstrated a propensity for primary water stress-corrosion cracking (PWSCC) in the fleet. The licensee intends to mitigate the effects of cracking on specific SONGS 3 welds by applying full structural PWOLs prior to the onset of PWSCC. This safety evaluation will be referring to the full structural configuration only for PWOLs.

2.0 REGULATORY EVALUATION

Pursuant to 50.55a(g)(4) of Title 10 of *Code of Federal Regulations* (10 CFR), 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 ASME Code of record for SONGS 3 is the 1995 Edition of the ASME Code with the 1996 Addenda for its third 10-year ISI interval which began on August 18, 2003, and ends on August 17, 2013.

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 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 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, Appendix VIII, Supplement 11, and modified implementation of N-638-1, and N-504-2, for the deposition of PWOLs for the remaining service life of the components including the period of extended operation.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Requirements for Which Relief Is Requested

Under the rules of IWA-4000, 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.

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

SONGS 3 has requested proposed modifications to several requirements associated with weld overlay NDE requirements established in ASME Code Case N-638-1 and the conditions applied in RG 1.147 for Code Case N-638-1 and N-504-2. The requirements for which modifications are proposed are: (1) UT of the completed structural weld overlay will be accomplished in accordance with ASME Code, Section XI, Appendix VIII, Supplement 11 modified to comply with the Performance Demonstration Initiative (PDI), (2) the acceptance criteria stated in the applicable code cases in relation to the respective positions contained in RG 1.147, Rev. 14 will not be utilized. Use of acceptance criteria of ASME Code, Section XI, Code Case N-504-2 and Nonmandatory Appendix Q in lieu of those of NB-5330 of ASME Code, Section III will be used, and (3) an ultrasonic examination and surface examination of the band around the final weld surface that is at least 1.5 times the component thickness or 5 inches in width, as specified in Code Case N-638-1, will not be performed. As an alternative, the UT coverage area will be defined using Code Case N-504-2 and Appendix Q, Q-4100, and a surface examination of a

band at least 0.5 inch outward from the toe of the weld overlay around the entire circumference of the nozzle and pipe will be performed, and (4) the acceptance criteria of N-504-2, Paragraph (i) will be used for the weld overlay surface examination and the band 0.5 inch outward from the toe of the weld overlay around the entire circumference of the nozzle and pipe.

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

The licensee proposes using N-504-2 for full structural PWOLs for the subject components with the following modifications:

- 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 ASME Code Case. The chromium content of Alloys 52 and 52M is 28 - 31.5 percent. Alloy 52M contains higher Niobium content (0.5 - 1 percent) than Alloy 52, which improves the weldability of the material and pins the grain boundaries, thus preventing separation between the grains and hot tearing during weld-puddle solidification. The licensee also stated that these filler materials are selected for their improved resistance to PWSCC. Alloy 52 and 52M both contain about 30 percent chromium (roughly twice that of Alloy 82/182), imparting excellent corrosion resistance. The existing Alloy 82/182 weld and the Alloy 52/52M overlay are austenitic and have ductile properties and toughness similar to austenitic stainless steel piping welds at operating temperature of pressurized water reactors. Furthermore, these filler materials are suitable for welding over the ferritic nozzle, Alloy 82/182 weld, and the austenitic stainless steel pipe, welds, and safe ends.

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). The licensee further stated that the filler material selected for these repairs is fully austenitic and is, therefore, exempt from delta ferrite content requirements.

3.4 Staff Evaluation of Modifications to N-504-2

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 52/52M material is consistent with weld filler material used to perform similar weld overlays at operating boiling-water reactor (BWR) facilities. The Electric Power Research Institute (EPRI) has performed studies in qualifying weld overlays (full structural, design, and barrier overlays) for application in BWRs, and in these applications, the studies have not identified any issues associated with shrinkage stress or weld contraction stresses. The similarities of design between BWR nozzles and the full structural weld PWOLs in the licensee's relief request provide reasonable assurance that there is a correlation in the performance of weld shrinkage and weld contraction stresses in the subject weld. The staff concludes that the proposed use of Alloy 52/52M weld material for the full structural PWOLs provide an acceptable level of quality and safety and is, therefore, acceptable.

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. 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 designed for 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, paragraphs (b) and (e), apply only to austenitic stainless steel weld overlay materials to ensure its resistance to intergranular stress-corrosion cracking. These requirements are not applicable to Alloy 52/52M, a nickel-based material which the licensee will use for the weld overlays.

The NRC staff notes that the licensee is performing full structural PWOLs on dissimilar metal welds made of Alloy 182 material. For material compatibility in welding, the NRC staff considers that Alloy 52/52M is a better choice of filler material than austenitic stainless steel material for this weld joint configuration. Alloy 52/52M contains about 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, paragraphs (b) and (e) is acceptable as it will provide an acceptable level of quality and safety. Based on the discussion above, the staff concludes that the modifications to N-504-2 will provide an acceptable level of quality and safety, and is, therefore, acceptable.

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

The licensee proposes using N-638-1 for full structural PWOLs for the subject components with the following modifications:

- Full ultrasonic testing (UT) of the 1.5T band will not be performed which is a modification to Paragraph 4.0(b).

- Contact pyrometers will be used to monitor welding temperature which is a modification to Paragraph 4.0(c).

3.6 Licensee's Basis for Relief

The licensee stated that it is not possible to perform a meaningful UT of the required band of base material because of the existing nozzle configuration. The Code Case 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. It is believed that for this type of repair, any major base material cracking would take place in the heat-affected zone (HAZ) directly below the weld overlay or in the underlying Inconel 82/182 weld deposit. Therefore, the licensee assumed that if this cracking were to occur, it would be identified by the UT of the weld overlay and that not performing the required UT on the base material should be considered acceptable.

Due to the location of the repair and area radiation dose rate, the placement of welded thermocouples for monitoring weld-interpass temperature is determined not to be beneficial based on dose savings. Therefore, the welded thermocouples are not planned for use to monitor interpass temperature during welding.

3.7 Staff Evaluation of Modifications to N-638-1

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

To eliminate the need for preheat and postweld heat treatment under the Construction Code, the industry developed a temper-bead welding technique which was published as N-638-1. The NRC staff recently endorsed N-638-1 in RG 1.147, Revision 14. The temper-bead technique carefully controls heat input and bead placement which allows subsequent welding passes to stress-relieve and temper the HAZ 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 postweld heat treatment specified by the ASME Construction Code is not necessary to produce a sound weld using the temper-bead process in N-638-1.

The first modification requested by the licensee is that full UT of the 1.5T band will not be performed which is required under Paragraph 4.0(b). The licensee stated that an ultrasonic examination of the area 0.5 inch axially beyond the dissimilar metal weld onto the base material will be performed. The issue of cracking and/or distortion of the weld and base metal were not specifically addressed in the ASME 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 its supplemental letter dated September 29, 2006, the licensee stated that any cracking which might occur should be detected by the final nondestructive examination (NDE) of the weld overlay which provides additional assurance of a defect-free, structurally sound overlay. The staff concludes that the UT examinations required by N-504-2 and Appendix Q will assure that defect-free welds will result, and is therefore, acceptable to the staff.

The use of ASME Code, Section XI, Appendix VIII, Supplement 11 modified to comply with the PDI is acceptable, in that the PDI methodology uses construction type flaws in the standards used to qualify equipment, procedures, and personnel. Therefore, the requirement established in RG 1.147 for the use of Code Case N-638-1 is met.

ASME Code, Section III flaws 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 Code, Section III, acceptance criteria does 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 ASME Code, 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 ASME Code, Section XI, crack-growth analyses, as flaw depth cannot be measured with radiography. ASME Code, 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 3, an operating power plant. The application of Code Case N-504-2 is for applying austenitic (Alloy 52/52M) weld material 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 microstructures 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 ASME Code, 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 ASME Code, Section XI, pre-service inspection. Also, the pre-service UT is used to characterize flaws detected during the ASME Code, Section III, radiography examination. The flaws of concern are the ones that cause failure immediately or grow to failure in the future. The ASME Code, 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/Appendix Q for weld overlays made with Alloy 52/52M weld metal should also be applied to the portion of the weld overlay made during the application of N-638-1 as an adequate level of safety and quality will be maintained.

Using Code Case N-638-1, the temper-bead weld is for filling a cavity in base metal which is inspectable in four directions. The licensee's application, however, is for structural weld overlay 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 on 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 requires only a surface examination of the tapered area of the weld overlay. In addition to verifying the soundness of the weld, the purpose of the ultrasonic examination is to assure that delayed cracking that may be caused by hydrogen introduced during the temper-bead welding process or cracking in unannealed ferritic material are not present. In the unlikely event 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 weld overlay taper and band beyond the toe of the overlay on the ferritic material is acceptable in that it provides an adequate level of safety and quality.

The second modification requested by the licensee is to manually record process temperatures using calibrated instruments such as contact pyrometers. Paragraph 4.0(c) 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.

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 EPRI 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

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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).

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 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 the 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 this 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.

Based on the evaluation of the differences in the PDI program to the requirements in Supplement 11, the NRC staff concludes that differences provide an acceptable level of quality and safety and, therefore, the differences to Supplement 11 are acceptable.

4.0 CONCLUSION

Based on the discussion above, the staff concludes that the ASME Code Case N-504-2 and N-638-1 modifications proposed in Relief Request ISI-3-24, for the preemptive full structural overlay of the SONGS 3 pressurizer welds listed in its submittal dated June 30, 2006, and supplemented by letters dated September 29, October 23, and November 20, 2006, 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 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 its third ISI interval.

Due to the immediate need of this relief request, the NRC staff granted the verbal authorization for the use of this relief request on December 1, 2006.

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

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