April 2, 2007

Mr. James J. Sheppard
President and Chief Executive Officer
STP Nuclear Operating Company
South Texas Project Electric
Generating Station
P. O. Box 289
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT, UNITS 1 AND 2 - REQUEST FOR RELIEF NO. RR-ENG-2-43 FOR REMAINDER OF SECOND 10-YEAR INSERVICE INSPECTION INTERVAL RE: APPLICATION OF WELD OVERLAYS IN PRESSURIZER NOZZLE SAFE END WELDS (TAC NOS. MD1414, MD1415, MD1416, MD1417, MD1418, MD1419, MD1420, MD1421, MD1422, AND MD1423)

Dear Mr. Sheppard:

The Nuclear Regulatory Commission (NRC) staff has reviewed and evaluated the information provided by South Texas Project Nuclear Operating Company (the licensee) in its letter dated May 1, 2006, as supplemented by letters dated August 22, September 19, and September 28, 2006. The licensee requested the approval of relief request RR-ENG-2-43, for South Texas Project (STP), Units 1 and 2, in which the licensee requested relief from certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, for the current second 10-year inservice inspection (ISI) interval. Specifically, the licensee relief request would allow application of full-structural weld overlays in pressurizer nozzle safe end welds that diverge from the requirements of Section XI of the ASME Code.

Based on the information provided in the licensee's submittal, as supplemented, the NRC staff concludes that the licensee has provided acceptable alternatives to the requirements of the ASME Code in relief request RR-ENG-2-43. The NRC staff concludes that the alternatives proposed by the licensee provide an acceptable level of quality and safety. Therefore, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), paragraph 50.55a(a)(3)(i), the alternatives are authorized for the STP, Units 1 and 2, for the remainder of their second 10-year ISI interval.

On October 2, 2006, the NRC staff verbally authorized the use of relief request RR-ENG-2-43 for STP Unit 1 during its refueling outage which ended in Fall 2006 . The NRC staff found that the licensee's proposed alternatives provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a(a)(3)(i). This letter and attached safety evaluation provide the written follow-up the NRC staff's basis for the verbal authorization.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector. The NRC staff's safety evaluation is enclosed.

Sincerely,

/RA/

David Terao, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Enclosure: Safety Evaluation

cc: See next page

All other ASME Code, Section XI, requirements for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector. The NRC staff's safety evaluation is enclosed.

Sincerely,

/RA/

David Terao, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Enclosure: Safety Evaluation

cc: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

APPLICATION OF WELD OVERLAYS IN PRESSURIZER NOZZLE SAFE END WELDS

STP NUCLEAR OPERATING COMPANY

SOUTH TEXAS PROJECT, UNITS 1 AND 2

DOCKET NOS. 50-498 AND 50-499

1.0 INTRODUCTION

By letter dated May 1, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML061280504), as supplemented by letters dated August 22, September 19, and September 28, 2006 (ADAMS Accession Nos. ML062410250, ML062690505, and ML062850090, respectively), South Texas Project Nuclear Operating Company (STPNOC, the licensee) submitted relief request RR-ENG-2-43 for South Texas Project (STP), Units 1 and 2, in which the licensee requested relief from certain requirements of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), for the current second 10-year inservice inspection (ISI) interval. Specifically, the licensee's relief request would allow application of full-structural weld overlays in pressurizer nozzle safe end welds that diverge from the requirements contained in Section XI of the ASME Code.

2.0 REGULATORY EVALUATION

Pursuant to paragraph 50.55a(g)(4) of Title 10 of the *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. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The ISI Code of record for STP for the second 10-year ISI interval, which ends September 24, 2010 for Unit 1 and October 8, 2010 for Unit 2, is the 1989 Edition of the ASME Code with no Addenda.

In accordance with 10 CFR 50.55a(g)(6)(ii)(c)(1), the implementation of Supplements 1 through 8, 10, and 11 of Appendix VIII to Section XI, 1995 Edition with the 1996 Addenda of the ASME Code, was required on a phased schedule ending on November 22, 2002. Supplement 11 was required to be implemented by November 22, 2001.

Additionally, 10 CFR 50.55a(g)(6)(ii)(c)(2) requires licensees implementing the 1989 Edition and earlier editions of paragraph IWA-2232 of Section XI of the ASME Code to implement the 1995 Edition with the 1996 Addenda of Appendix VIII and supplements to Appendix VIII of Section XI of the ASME Code.

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) proposed 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), proposing 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 pre-emptive full-structural weld overlays and full-structural weld overlay repairs.

3.0 TECHNICAL EVALUATION

3.1 Components for which Relief is Requested

The request for relief is applicable to the safe end welds for the six ASME Code Class 1 pressurizer spray, relief, safety, and surge nozzles in each STP unit, as specified in the licensee's May 1, 2006, application.

3.2 ASME Code Requirements from which Relief is Requested

ASME Code, Section XI, Article 4000, specifies requirements for repair and replacement of pressure-retaining components. Certain requirements of IWA-4000 can be accomplished using the methodology of ASME Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1," and the methodology of ASME Code Case N-638-1, "Similar and Dissimilar Metal Welding using Ambient Temperature Machine GTAW [Gas Tungsten Arc Welding] Temper Bead Technique, Section XI, Division I."

Code Case N-504-2 allows the use of a weld overlay to enhance pipe integrity. This Code Case has been endorsed in NRC Regulatory Guide (RG) 1.147, Revision 14, for generic use with the condition that the provisions of Section XI, nonmandatory Appendix Q, "Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments," must also be met.

Code Case N-638-1 provides for welding dissimilar metals. This Code Case has been endorsed in RG 1.147, Revision 14, for generic use with the condition that ultrasonic testing (UT) examination shall be demonstrated for the repaired volume using representative samples, which contain construction-type flaws. The acceptance criteria of NB-5330 of Section III edition and addenda apply to all flaws identified within the repaired volume.

ASME Code, Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," provides requirements for UT procedures, equipment, and personnel for UT of the completed weld overlay.

3.3 Code Case N-504-2

3.3.1 Licensee's Proposed Alternative to Code Case 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/152, rather than the low carbon (0.035-percent maximum) austenitic stainless steel.

- Relaxation of the requirement to perform delta ferrite measurements to meet the 7.5 Ferrite Number requirement of N-504-2. The Ferrite Number requirement cannot be met because the Alloy 52/52M/152 weld material is 100-percent austenitic and contains no delta ferrite.

- If a flaw or evidence of a flaw is observed, a system leakage test and a UT examination of the weld overlay will be performed instead of hydrostatic testing, this test will be consistent with ASME Code Case N-416-2, as modified by nonmandatory Appendix Q.

3.3.2 Licensee's Basis for Alternative to Code Case N-504-2

The licensee stated that the weld overlay has been designed to be 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/152 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/152 weld metal. The 360° 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/152, which is an austenitic nickel alloy. These filler materials were selected for their improved resistance to PWSCC. Alloys 52 and 52M contain about 28 - 31.5-percent chromium which imparts excellent corrosion resistance. The existing Alloy 82/182 weld and the Alloy 52M/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, the Alloy 82/182 weld, and the austenitic stainless steel materials.

Paragraph (e) of N-504-2 requires as-deposited delta ferrite measurements of at least 7.5 Ferrite Number for the weld reinforcement. The licensee proposed not to perform delta ferrite measurements for this overlay because the deposited Alloy 52/52M/152 is 100-percent austenitic and contains no delta ferrite due to the high-nickel composition (approximately 60-percent nickel).

The licensee stated that the application of Code Case N-416-2 for a system leakage test instead of a system hydrostatic test (if a flaw or evidence of a flaw is observed) requires performance of nondestructive examination (NDE) in accordance with the methods and acceptance criteria of the applicable subsection of the 1992 Edition of ASME Code, Section III. ASME Code, Section III, Subsection NB, Article 5000, for examination does not address the structural weld overlay-type configuration and appropriate NDE cannot be determined adequately. The NDE requirements of nonmandatory Appendix Q will be followed for the required NDE in lieu of ASME Code, Section XI.

3.3.3 Staff Evaluation of the Proposed Alternative to Code Case N-504-2

As stipulated in IWA-4120, in editions and addenda up to and including the 1989 Edition with the 1990 Addenda, repairs shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. IWA-4400 allows the use of later Editions and Addenda of the Construction Code, or of Section III, either in their entirety or portions thereof. ASME Code Cases may also be used.

In addition to the above requirements, defects shall be removed or reduced in size in accordance with ASME Code, Section XI, IWA-4300. Alternatively, the component may be evaluated and accepted in accordance with the design rules of Section III.

N-504-2 is being used by the licensee to perform full-structural weld overlays on the Unit 1 and 2 pressurizer welds listed in its May 1, 2006, submittal as a pre-emptive measure against cracking due to PWSCC or as a repair measure if cracks are found using Performance Demonstration Initiative (PDI) qualified NDE procedures.

N-504-2 was conditionally approved by the Nuclear Regulatory Commission (NRC) staff in RG 1.147, Revision 14. The condition specified in this RG required the use of nonmandatory Appendix Q, which identifies the NDE methods, volume, and acceptance criteria for the weld overlay.

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 be low carbon (0.035 percent maximum) austenitic stainless steel. Instead of the stainless steel weld material, Alloy 52/52M/152, 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/152 material is consistent with weld filler material used to perform similar weld overlays at operating boiling-water reactor (BWR) facilities. The NRC staff further 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/152 a better choice of filler material than austenitic stainless steel material for this weld joint configuration.
Alloy 52/52M/152 contains about 28 percent - 30 percent chromium, which provides 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 consisting of dissimilar metal welds joining austenitic to ferritic materials. Therefore, the licensee's proposed use of Alloy 52/52M/152 for

the weld overlays as a modification to the requirements of N-504-2, paragraphs (b) and (e) is acceptable to the NRC staff 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 Ferrite Number for the weld reinforcement. The licensee proposed not to perform delta ferrite measurements for this overlay because the deposited Alloy 52/52M/152 material is 100-percent austenitic and contains no delta ferrite due to the high-nickel composition (approximately 60-percent nickel). The NRC staff agrees that the N-504-2 provisions requiring as-deposited delta ferrite measurements are not applicable to Alloy 52/52M/152, a nickel-based material, which the licensee will use for the weld overlays.

The third modification requested by the licensee is to use a system leakage test instead of a hydrostatic test under IWA-5000. Paragraph (h) of N-504-2 states that the completed repair shall be pressure tested in accordance with IWA-5000 and if the flaw penetrated the original pressure boundary prior to pressure testing, a system hydrostatic test shall be performed. The licensee's proposal to perform a system leakage test instead of a hydrostatic test is supported by Code Case N-416-2, approved by the NRC staff for use at STP in a letter dated February 16, 2001 (ML010510230), and also by the NRC staff's position with respect to Code Case N-416-3, "Alternative Pressure Test Requirement for Welded or Brazed Repairs, Fabrication Welds or Brazed Joints for Replacement Parts and Piping Subassemblies, or Installation of Replacement Items by Welding or Brazing, Classes 1, 2, and 3, Section XI, Division 1." The staff notes that Code Case N-416-3 was unconditionally approved for use in RG 1.147, Revision 14 . The RG states that if a Code Case is implemented by a licensee and a later version of the Code Case is approved by the NRC, and it is listed in Tables 1 and 2 of the RG, the licensee may use either the later version or the previous version, so it is acceptable to the NRC staff for STP to conduct a system leakage test in lieu of a hydrostatic test.

N-416-2 states that: "...a system leakage test may be used provided the following requirements are met:"

> (a) NDE shall be performed on welded repairs and fabrication and installation joints in accordance with the methods and acceptance criteria of the applicable Subsection of the 1992 Edition of Section III.

The acceptance criteria in Section III do not allow the presence of cracks, regardless of length, and are geared more towards construction-type welds. The licensee will conduct a system pressure test and post-repair NDE examinations, which are required by N-504-2, utilizing the appropriate PDI procedures discussed later in this safety evaluation (SE). The post-repair examination volume includes the full thickness of the weld overlay plus 25 percent of the underlying base metal thickness. The specimen sets for PDI qualification for weld overlay examinations include construction-type flaws. Therefore, use of PDI-qualified personnel and procedures for the examination of the weld overlay will result in the reliable detection of construction-type flaws and meets the intent of compliance with the applicable subsection of the 1992 Edition of Section III.

Based on the discussion above, the NRC staff concludes that the modifications to N-504-2 will provide an acceptable level of quality and safety, and are therefore, acceptable.

3.4 Code Case N-638-1

3.4.1 Licensee's Proposed Alternative to Code Case N-638-1

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

- The maximum area of an individual weld based on the finished surface over the surge line nozzle ferritic material will not exceed 200 in^2.

- Full 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 ASME Code, Section XI, nonmandatory Appendix Q-4100.

- The condition specified for this code case as specified in RG 1.147, Revision 14, does not apply and post welding NDE will be completed in accordance with the condition specified under N-504-2, which is nonmandatory Appendix Q.

3.4.2 Licensee's Basis for Alternative to Code Case N-638-1

For the first modification, the licensee stated that the one-half base metal thickness limitation, which also includes the 100 in^2 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. Therefore, the 100 in^2 surface area limitation is not applicable to this configuration. 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 in^2 full-structural weld overlay was recently approved for the Susquehanna Steam Electric Station (ML051220568). The licensee also stated that weld shrinkage caused by application of the overlays will be measured and evaluated for any system impacts, as required by N-504-2, paragraph (g)(3).

For the second modification, the licensee stated that instead 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 weld overlay instead of the 1.5T area that is not covered by the overlay. Finally, it stated that a similar relief was granted for Millstone Unit 3 in an NRC SE dated January 20, 2006 (ML053260012).

For the third modification, the licensee stated that with the modifications described, the NRC RG 1.147, Revision 14, condition on use of N-638-1 is not applicable and will not be applied.

3.4.3 Staff Evaluation of the Proposed Alternative to Code Case N-638-1

N-638-1 allows the use of machine GTAW with ambient temperature preheat and no post weld heat treatment when draining the vessel is impractical. N-638-1, paragraph 1(a) limits the size of the repair to 100 in^2 maximum. However, because of the diameter of the components, the maximum area of the weld overlays on the ferritic material will exceed 100 in^2 but will not

exceed 200 in^2 on the ferritic material, according to the information provided by the licensee. The licensee is applying a 360°, full-structural pre-emptive weld overlay (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 post-weld heat treatment under the Construction Code, the industry developed a temper bead welding technique which was published as N-638-1. The NRC 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 relieve stresses and temper the heat affected zones 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 NRC staff agrees that the need for the preheat and post-weld heat treatment specified by the ASME Construction Code is not necessary to produce a sound weld using the temper bead process in N-638-1.

The licensee intends to follow the methodology of N-638-1, except paragraph 1.0(a), which requires the maximum area of an individual weld, based on the finished surface, be limited to 100 in^2 and the depth of the weld to exceed one-half of the ferritic-base metal thickness. This condition is not being met because the design for the weld overlay covers an area up to 200 in^2, which exceeds the limitations of N-638-1. The licensee will perform an evaluation, as noted in Section 3.3.3 of this SE, to determine the effect of exceeding the 100-in^2 area limitation for temper bead welding onto a low-alloy steel nozzle. This evaluation will be conducted under the guidance of N-504-2 and will be completed prior to startup. As noted in Section 3.3.3 of this SE, the NRC staff finds acceptable the licensee's exception to the 100-in^2 criterion.

The staff notes that several similar weld overlays have been applied to BWR facilities (such as Nine Mile Point 2, Perry, and Duane Arnold) with similar geometry and overlay dimensions. Electric Power Research Institute (EPRI) has performed studies to qualify weld overlays for application in BWRs, and in these applications, the studies have not identified any issues with shrinkage stresses or weld contraction stresses. The South Texas weld overlay design is generally similar to the design applied in BWR feedwater, core spray, and recirculation nozzles. In addition, no clear basis has been documented by the ASME Code Working Group on Welding and Special Repair Processes (the group responsible for N-638-1) for the 100-in^2 area limitation. Published literature shows that compressive stress remains on the inside surface near the weld, which supports mitigation of some degradation mechanisms, such as PWSCC. Thus, the residual stresses remain in compression on the inside surface of the weld as the nozzle overlay area increases. This supports mitigation of the degradation mechanism. Thus, increasing the overlay area is acceptable to the NRC staff for this specific application, i.e., to support the mitigation of the PWSCC degradation mechanism and for enhancement of NDE of the geometries involved.

N-504-2, paragraphs (g)(2) and (g)(3) require consideration of the residual stresses produced by the weld overlay with other applied loads on the system. Evaluation of other welds and components in the system considers potential increases in loading, including shrinkage effects,

due to all weld overlays in the reactor coolant system. These welds and components are to meet the applicable stress limits of the Construction Code. The staff considers this evaluation important in assuring that the reactor coolant system will not be adversely effected after PWOLs are deposited. In its supplemental letter dated August 22, 2006, the licensee committed to perform shrinkage stress effects analyses prior to startup. The weld shrinkage effects on the attached piping and support systems will be assessed prior to the weld overlay, based on estimated weld shrinkage. Confirmatory analyses based on actual weld shrinkage measurements after the weld overlay will be completed prior to plant startup.

Based on the preceding discussions and the licensee's commitment to complete the analyses required under N-504-2 g(2) and (3) prior to startup, the NRC staff concludes that increasing the PWOL beyond the 100 in^2 maximum up to 200 in^2, will provide an acceptable level of quality and safety and is, therefore, acceptable.

The second modification requested by the licensee is that full UT of the 1.5T band, which is required under paragraph 4.0(b) will not be performed. The staff notes that the post weld overlay area, as defined under Appendix Q, is one-half inch on either side of the overlay for surface examination and the completed overlay for UT examination. Appendix Q is a condition to the use of N-504-2, imposed by the staff under RG 1.147, Revision 14, which the licensee specifically states that it will comply with. 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 its letter dated August 22, 2006, the licensee stated that it will be measuring and evaluating axial shrinkage for impact on the materials and on the piping system after the weld overlay is deposited, which is in accordance with the requirements of N-504-2. Also, any cracking that might occur is expected to 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 post weld NDE volumes under Appendix Q, provides reasonable assurance that defect-free welds will result, maintaining the structural integrity of the piping.

The NRC staff concludes that the examination under Appendix Q will provide an acceptable level of quality and safety. Therefore, the staff authorizes the modification to the 1.5T band UT examination criterion contained in Code Case N-638-1.

The licensee requested relief from several of the NDE requirements established in Code Cases N-504-2 and N-638-1, and in RG 1.147. Specifically, the licensee requested to perform UT examination of the completed structural weld overlay in accordance with ASME Code, Section XI, Appendix VIII, Supplement 11, modified to comply with the PDI.

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

In addition, the licensee requested that the UT coverage area be defined using Code Case N-504-2 and Appendix Q instead of that defined by Code Case N-638-1. The band around the welded area will only receive a surface examination, not a UT examination. Using Code Case N-638-1, the temper bead weld for filling a cavity in the base metal is to be inspectible in four directions. However, the licensee's application is for structural weld overlay above the base metal, which results in a contour that is UT inspectible, 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 only requires a surface examination of the tapered area of the weld overlay. In addition to verifying the soundness of the weld, one purpose of the UT examination is to assure that delayed cracking is 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 heat affected zone 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 to the NRC staff in that it provides an adequate level of safety and quality.

The licensee has stated that the NDE requirements of nonmandatory Appendix Q will be followed for the required NDE in lieu of ASME Code, Section III. ASME Code, 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 Code, 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 toward 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 will be installed to mitigate PWSCC in dissimilar metal welds at STP, Units 1 and 2. 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 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 preservice inspection. Also, the preservice 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 preservice 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 preservice 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 preservice NDE acceptance criteria in Code Case N-504-2 and Appendix Q for weld overlays made with Alloy 52/52M weld metal also apply to the portion of the weld overlay made during the application of N-638-1 as modified by this SE. Based on the above discussion, the staff concludes that the acceptance criteria used by the licensee will provide an acceptable level of quality and safety, and is therefore acceptable.

3.5 Supplement 11

3.5.1 Licensee's Proposed Alternative to Supplement 11

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee requested relief from the weld overlay requirements in the following paragraphs to Section XI, Appendix VIII, Supplement 11 (only those items considered by the staff to be modifications to Appendix VIII, Supplement 11, are listed in this SE):

> Paragraph 1.1(b) limits the maximum thickness for which a procedure may be qualified. Also, 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.
>
> Paragraph 1.1(d)(1) requires that all base metal flaws be cracks in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75 percent through the base metal wall.
>
> Paragraph 1.1(e)(1) requires that at least 20% but not less than 40% of the flaws be oriented within ±20 degrees of the axial direction.
>
> Paragraph 1.1(e)(1) also requires that the rules of IWA-3300 be used to determine whether closely spaced flaws should be treated as single or multiple flaws. Specimens are divided into base and overlay grading units with each specimen containing one or both types of grading units.
>
> Paragraph 1.1(e)(2)(a)(1) requires that a base grading unit include at least 3 inches of the length of the overlaid weld and the outer 25% of the overlaid weld and base metal on both sides.

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 exist on either side of the base grading unit.

Paragraph 1.1(e)(2)(b)(1) requires that an overlay grading unit include the overlay material and the base metal-to-overlay interface of at least 6 in^{-2}. The overlay grading unit shall be rectangular, with minimum dimensions of 2 in.

Paragraph 2.3 requires 80 percent of the flaws to be sized at a specific location on the surface of the specimen identified to the candidate for the depth sizing test. For the remaining flaws, the regions of each specimen containing a flaw to be sized shall be identified to the candidate.

Paragraph 3.1 requires that examination procedures, equipment, and personnel be qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VII-S2-1 for both detection and false calls. The criteria shall be satisfied separately by the demonstration results for base grading units and for overlay grading units.

Paragraph 3.2(b) requires that all extensions of base metal cracking into the overlay material by at least 0.1 in are reported as being intrusions into the overlay material.

In lieu of the requirements of ASME Code, Section XI, 1995 Edition, 1996 Addenda, Appendix VIII, Supplement 11, as specified above, the PDI program as described in Table 4 of the licensee's May 1, 2006, submittal shall be used. The duration of the relief is for the remainder of the third 10-year ISI interval.

3.5.2 Licensee's Basis for Alternative to Supplement 11

The licensee stated that the UT examination of the completed PWOLs will be accomplished in accordance with ASME Code, Section XI, 1995 Edition with the 1996 Addenda, Appendix VIII, Supplement 11, with the modifications described in Table 4 of the May 1, 2006, submittal. These modifications were developed by the EPRI, PDI program to implement the requirements of Appendix VIII.

3.5.3 Staff Evaluation of the Proposed Alternative to Supplement 11

The U.S. nuclear utilities created the performance development initiative (PDI) program to implement performance demonstration requirements contained in Appendix VIII of Section XI of the ASME Code. To this end, the PDI program has developed a program for qualifying equipment, procedures, and personnel in accordance with the UT criteria of Appendix VIII, Supplement 11. Prior to the Supplement 11 program, EPRI was maintaining a performance demonstration program (the precursor to the PDI program) for weld overlay qualification under the Tri-party Agreement with NRC in the NRC letter dated July 3, 1984 (ADAMS Accession No. 8407090122). This NRC letter to EPRI defined a coordination plan for training and qualification activities of NDE personnel employed in performance of ultrasonic examination of piping

weldments during inservice inspection of BWR power plants. Instead of having two programs with similar objectives, the NRC staff recognized the EPRI PDI program for weld overlay qualifications as an acceptable alternative to the Tri-party Agreement in its letter dated January 15, 2002 to the PDI Chairman (ADAMS Accession No. ML020160532). Although the PDI program was developed during inservice inspection of BWR power plant, it is applicable to PWR power plants weld pverlay qualification; because the weld overlays in PWR power plants are identical to the weld overlays in BWR powerplants.

The PDI program does not fully comply with the existing requirements in Supplement 11. 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. The differences are discussed below.

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, "[t]he 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. While the tolerance is unchanged for a single specimen set, it 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 NRC staff finds this PDI Program revision 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 UT 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 staff has reviewed the flaw fabrication process, compared the reflective characteristics between actual cracks and PDI-fabricated flaws, and found the fabricated flaws acceptable for this application.

Paragraph 1.1(e)(1) requires that at least 20 percent but not less than 40 percent of the flaws be oriented within ±20 degrees of the axial direction of the piping test specimen. Flaws contained in the original base metal heat-affected zone 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. Based upon its engineering judgment, the NRC staff agrees with the PDI program and concludes that this approach to implantation of fabrication flaws is reasonable for meeting the intent of the Supplement 11 requirement and, therefore, the PDI application of flaws oriented in the axial direction is acceptable.

Paragraph 1.1(e)(1) also requires that the rules of IWA-3300 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. Hence, PDI's application for closely spaced flaws is acceptable to the NRC staff.

Paragraph 1.1(e)(2)(a)(1) requires that a base grading unit 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 redirection 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. Therefore, 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 revised PDI program alternative, is acceptable to the NRC staff.

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 should exist on either side of the base grading unit. This requirement is intended to minimize the number of false identifications of extraneous reflectors. The PDI program, which stipulates that unflawed overlaid weld and base metal exists on all sides of the grading unit and that flawed grading units must be free of interfering reflections from adjacent flaws, addresses the same concerns as the ASME Code. Hence, PDI's application of the variable flaw-free area adjacent to the grading unit is acceptable to the NRC staff.

Paragraph 1.1(e)(2)(b)(1) requires that an overlay grading unit include the overlay material and a base metal-to-overlay interface of at least 6 in^2. 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 PDI program criterion is necessary to allow the licensee to use existing examination specimens that were fabricated in order to meet NRC Generic Letter 88-01, "NRC Position on IGSCC [intragranular stress corrosion cracking] in BWR Austenitic Stainless Steel Piping," dated January 25, 1988. This criterion may be more challenging than the ASME Code criterion in Supplement 11 because of the variability associated with the shape of the grading unit. Based on its engineering judgment, the NRC staff concludes that the PDI application of the overlay grading unit is an acceptable alternative to the Supplement 11 requirement and is acceptable.

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Paragraph 2.3 states 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 requirement would be satisfied by detection and sizing tests to be separate. PDI revised the weld overlay program to allow sizing to be conducted either in conjunction with, or separately from, the flaw detection test. If a test is 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 five of the regions will similarly be determined. In addition, the 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 that candidates will not attempt to size a different flaw. The above clarification provides a basis for implementing sizing tests in a systematic, consistent manner that meets the intent of Supplement 11. As such, this method is acceptable to the NRC staff.

Paragraphs 3.1 and 3.2 of Supplement 11 state that 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. For a procedure to be qualified, the PDI program requires three times as many flaws to be detected (or sized) as required in Supplement 11 for the entire ultrasonic system. The personnel and equipment are still required to meet the requirements of Supplement 11. Therefore, the PDI program is acceptable to the NRC staff because it meets or exceeds ASME requirements for personnel, procedures, and equipment qualification.

Paragraph 3.2(b) requires that all extensions of base metal cracking into the overlay material by at least 0.10 inches be 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 of 0.125 inch as specified in the ASME Code. Since the ASME Code tolerance is close to the 0.10-inch value of paragraph 3.2(b), any crack extending beyond 0.10 inches into the overlay material would be identified as such from the characterized dimensions. The reporting of an extension in the

overlay material is redundant for performance demonstration testing because of the flaw sizing tolerance. Therefore, PDI's omission of highlighting a crack extending beyond 0.10 inches into the overlay material is acceptable to the NRC staff.

4.0 CONCLUSION

Based on the above evaluation, the NRC staff concludes that Relief Request RR-ENG-2-43, which proposed modifications to Code Cases N-504-2 and N-638-1, and alternatives to ASME Code, Appendix VIII, Supplement 11, provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes Relief Request RR-ENG-2-43 for the duration of the second 10-year ISI interval at South Texas Project, Units 1 and 2.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and authorized herein by the NRC staff remain applicable including third-party review by the Authorized Nuclear Inservice Inspector.

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