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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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South Texas Project
Unit 1
Docket No. STN 50-498
Proposed Alternative to ASME Section XI Requirements for
Weld Overlay Hold-Time (RR-ENG-2-48)

In accordance with the provisions of 10 CFR 50.55a(a)(3)(i), the South Texas Project requests NRC approval of an alternative approach to the requirements of ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components." ASME Section XI Code Case N-638-1 requires a 48-hour hold-time after the weld overlay temperature reaches ambient conditions following completion of the weld overlay. Under the proposed alternative, the examination will be performed no sooner than 48 hours after completion of the third temperbead layer over the ferritic base material.

The proposed alternative approach will provide an acceptable level of quality and safety.

The overlay will be applied during the South Texas Project Unit 1 spring 2008 refueling outage. The discussion in Attachment 1 provides the basis and justification for the proposed alternative. To support preparation for the upcoming outage, NRC approval of this proposed alternative is requested by December 31, 2007.

A similar request from the Callaway plant was submitted August 14, 2006 (Adams Accession No. ML062360200) and followed up with correspondence dated March 26, 2007 (ML070990115). Approval for the change was given in a telephone conference on April 5, 2007.

There are no commitments included in the attached request.

If there are any questions, please contact either Mr. P. L. Walker at (361) 972-8392 or me at (361) 972-7030.

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PLW

Attachment: Proposed Alternative to ASME Section XI Requirements for Weld Overlay Hold-Time (RR-ENG-2-48)

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STI: 32172627

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SOUTH TEXAS PROJECT

PROPOSED ALTERNATIVE TO ASME SECTION XI REQUIREMENTS FOR WELD OVERLAY HOLD TIME

(RELIEF REQUEST RR-ENG-2-48)

1.0 ASME Code Components Affected

System: Reactor Coolant System

Identifiers: Unit 1

6"RC1003BB1 (Pressurizer Spray Line Nozzle Safe End Welds)

6"RC1004NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC1009NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC1012NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC1015NSS (Pressurizer Relief Line Nozzle Safe End Welds)

Function: There are six low alloy steel nozzles for each pressurizer. Each has an Alloy 82/182 weld connecting the low alloy steel nozzle to an austenitic stainless steel (SS) safe end, and an SS weld connecting the safe end to SS piping. One nozzle located on the bottom of the pressurizer connects the surge line from the Loop 4 hot leg to the pressurizer – the weld overlay for this nozzle has been completed. Of the remaining five nozzles, one nozzle at the top of the pressurizer receives flow from the Loop 1 and Loop 4 cold legs for pressurizer spray. Four nozzles at the top of the pressurizer provide a relief path to the pressurizer relief tank for overpressure protection. The pressurizer design data are attached.

Code Class: Class 1

2.0 Applicable Code Edition and Addenda

The South Texas Project Inservice Inspection program for the second ten-year interval complies with the requirements of ASME Section XI, 1989 Edition and the 1995 Edition with 1996 Addenda for application of Section XI, IWA-2300, Appendix I, Appendix VII, and Appendix VIII.

Design and fabrication are in accordance with ASME Section III, 1974 Edition.

3.0 Applicable Code Requirements

Paragraph 4.0(b) of Code Case N-638-1 states that examination of the final weld surface and the band around the weld area (at least 1-1/2 times the component thickness or 5-inches, whichever is less) using surface and ultrasonic methods is to be performed when the completed weld has been at ambient temperature for at least 48 hours.

4.0 Reason for Request

Examination requirements of Code Case N-638-1 effectively prolong the process of applying pressurizer nozzle weld overlays. The additional 48 hours has the potential for delaying completion of other tasks such that the actual duration of the outage is extended, with no apparent benefit.

5.0 Proposed Alternatives

Examination of the final weld surface and the band around the weld area (at least 1-1/2 times the component thickness or 5-inches, whichever is less) shall be performed using surface and ultrasonic methods. Examination of the weld overlay covering the ferritic base material and examination of the adjacent ferritic base material shall be performed no sooner than 48 hours after completion of the third temperbead layer over the ferritic base material. This removes the requirement for a hold time of 48 hours after ambient temperature is reached following completion of the weld overlay before examination can be performed.

6.0 Basis for Use

Application of a weld overlay requires welding on the low alloy steel nozzle material with Alloy 52M (ERNiCrFe-7a). Temper bead welding will be used for this purpose using the guidance of Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique." Code Case N-638-1 describes the process for welding similar and dissimilar metals using the ambient temperature machine gas tungsten arc weld (GTAW) temper bead method. Code Case N-638-1 was conditionally approved for generic use in NRC Regulatory Guide 1.147, Revision 14.

Weld overlay by GTAW will be performed at the South Texas Project in accordance with Code Case N-638-1, with some exceptions. The exceptions are:

- The maximum area of an individual weld based on the finished surface over the ferritic material shall not exceed 200 square inches. (Code Case N-638-1, paragraph 1.0(a))
- The ultrasonic test coverage area will be defined using Code Case N-504-2 and Appendix Q. The band around the welded area will only receive a surface examination. (Code Case N-638-1, paragraph 4.0(b))

These exceptions were approved in NRC correspondence dated April 2, 2007, "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" (ADAMS Accession No. ML070810264).

The presence of monatomic hydrogen in a hardened base metal heat-affected-zone microstructure that has not been adequately tempered may result in delayed heat-affected-zone cracking. The 48-hour hold time is specified to allow sufficient time for hydrogen cracking to occur (if it is to occur) in the heat-affected zone (HAZ) of ferritic materials prior to performing NDE so that NDE would be able to detect it.

Based on extensive research and industry experience, the Electric Power Research Institute (EPRI) has provided a technical basis for starting the 48-hour hold after completion of the third temper bead weld layer rather than waiting for the weld overlay to cool to ambient temperature. EPRI has documented their technical basis in Technical Report 1013558, "Temper Bead Welding Applications – 48 Hour Hold Requirements for Ambient Temperature Temperbead Welding" (ADAMS Accession No. ML070670060). The EPRI report addresses previous concerns regarding the 48-hour hold time prior to final NDE examinations. Areas of concern imposing the 48-hour hold time addressed through this report include: material microstructure; sources for hydrogen introduction; tensile stress and temperature; and diffusivity and solubility of hydrogen in steels. The report concludes there is no technical basis for waiting 48 hours after the weld overlay cools to ambient temperature before beginning to perform final NDE of the completed weld overlay.

The ferritic nozzle base material heat-affected zone of the first Alloy 52M layer is the only region susceptible to potential hydrogen-delayed cracking. Code Case N-504-2 and Appendix Q require liquid penetrant examination (PT) prior to installation of the weld overlay. Cleaning the base metal for PT provides assurance, in addition to typical welding process controls, that deleterious hydrogen from surface contamination is not introduced in the first layer of the weld overlay. Examination of the volume and area required by Code Case N-504-2 and Appendix Q is adequate for detection of hydrogen-delayed cracks occurring in the vicinity of the first layer HAZ.

Hydrogen contamination to deleterious levels from outside sources is unlikely when applying the ambient temperature temperbead machine GTAW process with the associated methodologies specified for welding control, cleanliness, and examination. As compared to flux-type welding processes, machine GTAW with argon shielding is an inherently low-hydrogen process that provides optimum temperbead welding controls to ensure adequately tempered base metal HAZ with high fracture toughness. The low hydrogen and tempering characteristics of the machine GTAW process are documented in EPRI GC-111050, "Ambient Temperature Preheat for Machine GTAW Temperbead Applications."

Weld layers beyond the third layer are not designed to provide tempering to the ferritic HAZ when performing ambient temperature temper bead welding. The technical data provided by EPRI in their report is based on testing performed on SA-508 Class 2 low-alloy steels and other P-Number 3, Group 3 materials. The South Texas Project pressurizer nozzles are manufactured from SA-508 Class 2 carbon steel.

After evaluating all of the issues relevant to hydrogen cracking such as microstructure of susceptible materials, availability of hydrogen, applied stresses, temperature, and diffusivity and solubility of hydrogen in steels, EPRI concluded that: "...[t]here appears to be no technical basis for waiting 48 hours after cooling to ambient temperature before beginning the NDE of the completed weld. There should be no hydrogen present, and even if it were present, the temper bead welded component should be very tolerant of the moisture...." EPRI also notes that over 20 weld overlays and 100 repairs have been performed using temper bead techniques on low alloy steel components over the last 20 years. During this time, there has never been an indication of hydrogen cracking identified by NDE performed after the 48-hour hold or by subsequent ISI.

In addition, the ASME Section XI Code Committee published Technical Basis Paper RRA 05-08 (ADAMS Accession No. ML070790679) supporting the 48-hour hold time alternative. The ASME report points out that introduction of hydrogen to the ferritic HAZ is limited to the first weld layer since this is the only weld layer that makes contact with the ferritic-base material. While the potential for the introduction of hydrogen to the ferritic HAZ is negligible during subsequent weld layers, these layers provide a heat source that accelerates the dissipation of hydrogen from the ferritic HAZ in non-water backed applications. Furthermore, the solubility of hydrogen in austenitic materials such as Alloy 52M is much higher than that of ferritic materials while the diffusivity of hydrogen in austenitic materials is lower than that of ferritic materials. As a result, hydrogen in the ferritic HAZ tends to diffuse into the austenitic weld metal, which has a much higher solubility for hydrogen. This diffusion process is enhanced by heat supplied in subsequent weld layers. The ASME Technical Basis Paper concludes that there is sufficient delay time to facilitate the detection of potential hydrogen cracking when NDE is performed 48 hours after completion of the third weld layer.

The high affinity of fully austenitic Alloy 52M filler metal for monatomic hydrogen combined with a low diffusion coefficient keeps diffusion of deleterious hydrogen into the low alloy ferritic base material to negligible levels. Furthermore, only welding in contact with the low alloy ferritic base material has potential for introducing deleterious monatomic hydrogen into a hardened untempered HAZ. Each successive temperbead layer has a decreasing propensity for introducing hydrogen into the ferritic base material due to increasing distance from the susceptible base metal HAZ. After three layers, the temperbead process adequately tempers the martensite formed in the ferritic base material by the first layer. Tempering by the third weld layer decreases the hardness and increases the fracture toughness in the potentially susceptible ferritic base material HAZ, thus mitigating susceptibility to delayed hydrogen cracking.

Additionally, the interpass temperature controls of Code Case N-638-1 maintain the temperature near or at ambient temperature between the relatively short and infrequent localized welding heat cycles. N-638-1 requires a 350°F interpass temperature for the first three layers to ensure adequately high cooling rates to promote a base metal HAZ microstructure with high fracture toughness. A 350°F interpass temperature is required for the fourth and subsequent layers to protect against sensitization of the austenitic groove weld and austenitic base materials, and to maintain an acceptable microstructure in the Alloy 52M overlay weld metal. The 350°F interpass temperature control maintains the ferritic base metal HAZ at relatively low temperatures, which effectively contributes to time at or near ambient temperature. For times during the welding process when temperatures are above ambient, the elevated temperatures are beneficial and enhance diffusion of hydrogen out of the ferritic base material HAZ. Therefore, it is both reasonable and conservative to include the temperbead welding time following completion of the third layer in the total 48-hour hold time required prior to performing final examination of the ferritic base material and of the weld overlay on the ferritic base material.

ASME Code Case N-638-3, which does not require examination of the band around the repair area, has been published in Supplement 9 to the 2004 Edition of ASME Section XI. Also, the Boiler and Pressure Vessel Main Committee in August 2006 approved a revision to N-638-3 which permits the 48-hour hold to start following completion of the third temperbead layer.

In summary, the inherent low hydrogen nature of the prescribed ambient temperature temperbead machine GTAW process, the relatively low susceptibility of hydrogen-induced cracking in ferritic base material HAZ when using nickel alloy filler metals, and performance of the Appendix Q and N-504-2 final examination (as modified) 48 hours after completion of the third layer over the ferritic base material provide substantial assurance against the potential for delayed hydrogen cracking in the ferritic base material HAZ.

7.0 <u>Duration of Proposed Alternative</u>

This proposed alternative is for application as needed during the remainder of the current inspection interval which ends September 24, 2010 for Unit 1. The duration of the proposed alternative is the remaining service life of the affected components.

8.0 Implementation

The structural WOL will be installed during the South Texas Project Unit 1 Spring 2008 refueling outage as a preventive measure against flaw development or means of repair for any flaws that may be present in the dissimilar metal welds. NRC approval of the proposed alternative to the 48-hour hold time criterion of Code Case N-638-1 is requested by December 31, 2007, to support scheduling of activities during the outage.

PRESSURIZER DESIGN DATA

Pressurizer Spray Line, nominal pipe size	6 inches
Pressurizer Spray Line, nominal thickness	0.719 inch
Pressurizer Safety and Relief Line, nominal pipe size	6 inches
Pressurizer Safety and Relief Line, nominal thickness	0.719 inch
Design Pressure	2,485 psig
Design Temperature	680° F
Nozzle Material	SA-508 Class 2 steel
Safe End Material	SA-182 F316L
Existing Nozzle Weld Material (Connects the low alloy steel nozzle to the austenitic stainless steel safe end)	Alloy 82/182