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

November 10, 2008

Mr. Randall K. Edington
Executive Vice President Nuclear/
Chief Nuclear Officer
Mail Station 7602
Arizona Public Service Company
P. O. Box 52034
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SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 - RELIEF REQUEST NOS. 18 AND 36 RE: THIRD 10-YEAR INSERVICE INSPECTION PROGRAM INTERVAL (TAC NOS. MD8712, MD8713, AND MD8714)

Dear Mr. Edington:

By letter dated May 8, 2008, Arizona Public Service Company (APS, the licensee) submitted Relief Request (RR) Nos. 18 and 36 requesting relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) requirements at Palo Verde Nuclear Generating Station (PVNGS) for the third 10-year inservice inspection (ISI) program interval. The third 10-year ISI program intervals for PVNGS, Units 1, 2, and 3 began on July 18, 2008, March 18, 2007, and January 11, 2008, respectively.

Specifically, the licensee requested relief from the requirements of ASME Code, Section XI. In RR 18, the licensee proposed alternatives to the gas tungsten arc weld (GTAW) machine temper bead welding requirements to potentially repair flaws in reactor pressure vessel (RPV) upper head penetration nozzles or associated J-groove welds for the third 10-year program intervals for PVNGS, Units 1, 2, and 3. In RR 36, the licensee proposed alternatives from the requirements that defects be removed or reduced to an acceptable size for the third 10-year ISI program intervals for PVNGS, Units 1 and 3. RR 36 was submitted specifically for the purpose of performing preemptive full structural weld overlays on hot-leg dissimilar metal welds.

For RR 18, the NRC staff has reviewed the licensee's proposed alternative to use GTAW ambient temperature temper bead welding for RPV head penetration nozzle J-groove weld repairs and determined that the proposed alternative provides an acceptable level of quality and safety. The staff has also determined that compliance with the ASME Code-required volumetric examinations of the repair weld would result in hardship without a compensating increase in the level of quality and safety, and that the licensee's proposed alternative weld repairs provides reasonable assurance of structural integrity. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i) and 10 CFR 50.55a(a)(3)(ii), the NRC staff authorizes the proposed alternative for PVNGS, Units 1, 2 and 3, for the third 10-year ISI program interval.

In addition, the NRC staff has reviewed the licensee's proposed alternative for RR 36 and determined that the proposed alternative will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the proposed alternative for the installation of full structural weld overlay on the dissimilar metal welds for PVNGS, Units 1 and 3, for the third 10-year ISI program interval.

The licensee's submittal dated May 8, 2008, also contained RR 34, which was reviewed and approved by the NRC staff by letter dated October 2, 2008.

A copy of the Safety Evaluation is enclosed. All other ASME Code, Sections III and XI, requirements for which relief has not been specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Sincerely,

Michael T. Markley

Michael T. Markley, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, 50-529,
and 50-530

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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

INSERVICE INSPECTION PROGRAM RELIEF REQUEST NOS. 18 AND 36

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3

ARIZONA PUBLIC SERVICE COMPANY

DOCKET NOS. STN 50-528, STN 50-529, AND STN 50-530

1.0 INTRODUCTION

By letter dated May 8, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML081350714), Arizona Public Service Company (APS, the licensee) requested approval of Relief Request (RR) No. 18 to utilize an alternative method to the temper bead welding requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, IWA-4600 and IWA-4630, for the reactor pressure vessel (RPV) head penetration J-groove welds at Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3 for the third 10-year inservice inspection (ISI) program intervals.

Also by letter dated May 8, 2008, APS requested approval of RR 36 in order to perform preemptive full structural weld overlays on hot-leg dissimilar metal welds at PVNGS, Units 1 and 3 for the third 10-year ISI program intervals. Specifically, APS RR 36 proposes alternatives to ASME Code, Section XI, Articles IWA-4400 and IWA-4420 which requires that defects be removed or reduced to an acceptable size.

2.0 REGULATORY EVALUATION

The ISI of the ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by paragraph 50.55a(g) of Title 10 of the *Code of Federal Regulations* (10 CFR), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i).
Paragraph 50.55a(a)(3) to 10 CFR states in part that alternatives to the requirements of paragraph (g) may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if the licensee demonstrates that: (i) the proposed alternatives would 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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection 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 PVNGS, Units 1, 2, and 3 is the 2001 Edition, 2003 Addenda, of Section XI of the ASME Code. The third 10-year ISI program intervals for PVNGS, Units 1, 2, and 3 began on July 18, 2008, March 18, 2007, and January 11, 2008, respectively.

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 the ASME Code, Section XI, 1995 Edition with the 1996 Addenda, 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 the ASME Code, Section XI to implement the 1995 Edition with the 1996 Addenda of Appendix VIII and supplements to Appendix VIII of the ASME Code, Section XI.

The licensee submitted the subject RR 18, pursuant to 10 CFR 50.55a(a)(3)(i) and (ii), which proposed alternatives to the gas tungsten arc weld machine temper bead welding and nondestructive examination requirements of IWA-4600 and IWA-4630 of the ASME Code, Section XI.

The licensee submitted the subject RR 36, pursuant to 10 CFR 50.55a(a)(3)(i), which proposed alternatives to the implementation of the ASME Code, Section XI, Appendix VIII, Supplement 11, and modifications to ASME Code Cases N-504-2 and N-638-1, for the deposition of preemptive full structural weld overlays.

3.0 TECHNICAL EVALUATION

3.1 Relief Request 18

RR 18, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique," is described in Enclosure 1 to the licensee's submittal dated May 8, 2008.

3.1.1 Components Affected

97 Control Element Drive Mechanism (CEDM) nozzle penetrations and one reactor head vent nozzle penetration

3.1.2 Code Requirements for Which Relief Is Requested (as stated by the licensee)

> Subarticle IWA-4411 of ASME Section XI, 2001 Edition, 2003 Addenda states: "Welding, brazing, and installation shall be performed in accordance with the Owner's Requirements and, except as modified below, in accordance with Construction Code of the item." IWA-4411(e) states, "The requirements of

IWA-4600(b) may be used when welding is performed without the postweld heat treatment required by the Construction Code."

Subarticle IWA-4600(b) of ASME Section XI, 2001 Edition, 2003 Addenda establishes alternative repair welding methods for performing temper bead welding. IWA-4600(b)(1), states in part that when postweld heat treatment is not to be performed, the welding methods of IWA-4600, IWA-4630 or IWA-4640 may be used in lieu of the welding and nondestructive examination requirements of the Construction Code or Section III, provided the requirements of IWA-4610 are met.

IWA-4630 applies to dissimilar materials such as welds that join P-Number 43, nickel alloy to P-Number 3, low alloy steels. According to IWA-4630, "Repairs to welds that join P-No. 8 or P-No. 43 material to P-Nos. 1, 3, 12A, 12B, and 12C material may be made without the specified postweld heat treatment, provided the requirements of IWA-4630 through IWA-4634 are met. Repairs made to this paragraph are limited to those along the fusion line of a nonferritic weld to ferritic base material where 1/8-inch or less of nonferritic weld deposit exists above the original fusion line after defect removal."

Temper bead repairs of the Reactor Pressure Vessel (RPV) head penetration nozzle J-welds are performed in accordance with IWA-4600 and IWA-4630 whenever the repair cavity is within 1/8-inch of the ferritic base materials of the RPV head. When the Gas Tungsten Arc Welding (GTAW) process is used in accordance with IWA-4600 and IWA-4630, then temper bead welding is performed as follows:

- Only the automatic or GTAW machine process using cold wire feed can be used. Manual GTAW cannot be used.

- A minimum preheat temperature of 300°F [degrees Fahrenheit] is established and maintained throughout the welding process. Interpass temperature cannot exceed 450°F.

- The weld cavity is buttered with at least three (3) layers of weld metal.

- Heat input of the initial three layers is controlled to within +/-10% of that used for the first six layers during procedure qualification testing.

- After the first three weld layers, repair welding is completed with a heat input that is equal to or less than that used in the procedure qualification for weld layers seven and beyond.

- Upon completion of welding, a postweld soak or hydrogen bake-out at 450°F (minimum) for a minimum of 4 hours is required.

- Preheat, interpass, and postweld soak temperatures are monitored using thermocouples and recording instruments.

- The repair weld and preheated band are examined in accordance with IWA-4634 after the completed weld has cooled to ambient temperature.

3.1.3 Licensee's Proposed Alternative to Code (as stated by the licensee)

Pursuant to 10CFR50.55a(a)(3)(i), APS proposes alternatives to the GTAW-machine temper bead welding requirements of IWA-4600 and IWA-4630 of ASME Section XI. Specifically, APS proposes to perform ambient temperature temper bead welding in accordance with Attachment 1 to this letter [the licensee's May 8, 2008, submittal], "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique," as an alternative to IWA-4600 and IWA 4630.

APS has reviewed the proposed ambient temperature temper bead welding techniques of Attachment 1 [of the licensee's May 8, 2008, submittal] against the GTAW-machine temper bead welding requirements of IWA-4600 and IWA-4630. This review was performed to identify differences between Attachment 1 and IWA-4600 and IWA-4630. Based upon this review, APS proposes alternatives to the following ASME Section XI requirements of IWA-4600 and IWA-4630:

Note: The item numbers for the following paragraphs have been adjusted to match with items in section 3.1.5, since all the numbered items from the licensee's letter dated May 8, 2008, have not been used by this safety evaluation.

1. IWA-4600(b) specifies that repairs to base materials and welds identified in IWA-4630 may be performed without the specified postweld heat treatment of the construction code or ASME Section III provided the requirements of IWA-4600 and IWA-4630 are met. IWA-4630 includes temper bead requirements applicable to the Shielded Metal Arc Welding (SMAW) and the machine or automatic GTAW processes. As an alternative, APS proposes to perform temper bead weld repairs using the ambient temperature temper bead technique described in the attachment to this enclosure [of the licensee's May 8, 2008, submittal]. Only the machine or automatic GTAW process can be used when performing ambient temperature temper bead welding in accordance with the attachment.

2. IWA-4610(a) specifies that the weld area plus a band around the repair area of at least 1½ times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 300°F for the GTAW process during welding; maximum interpass temperature shall be 450°F. As an alternative, APS proposes that the weld area plus a band around the repair area of at least 1½ times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 50°F for the GTAW process during welding; maximum interpass temperature shall be 350°F.

3. IWA-4633.2(c) specifies that the completed weld shall have at least one layer of weld reinforcement deposited and then this reinforcement shall be removed by mechanical means. As an alternative, the proposed ambient temperature temper bead technique does not include a reinforcement layer.

4. IWA-4633.2(d) specifies that, after at least 3/16-inch of weld metal has been deposited, the weld area shall be maintained at a temperature of 450°F (minimum) for a minimum of four (4) hours (for P-No. 3 materials). As an alternative, the licensee's proposed ambient temperature temper bead technique does not include a postweld soak.

5. IWA-4634 specifies that prior to welding, surface examination shall be performed on the area to be welded. Surface examination and acceptance criteria shall comply with IWA-4611.2. For GTAW, the nondestructive examinations shall be performed after the completed weld has cooled to ambient temperature. The examination of the welded region shall include both volumetric and surface examination.

   APS will perform the liquid penetrant examination of the completed repair weld and preheated band as required by IWA-4634. As an alternative to the volumetric examination of IWA-4634, APS proposes the following examinations for repair welds in RPV penetration nozzle J-welds.

   - Repair welds will be progressively examined by the liquid penetrant method in accordance with NB-5245 of ASME Section III. The liquid penetrant examinations will be performed in accordance with NB-5000. Acceptance criteria shall be in accordance with NB-5350.

   This request for alternative is specific to localized weld repair of RPV head penetration nozzle J-groove welds where 1/8-inch or less of Inconel weld metal exists between the J-groove weld repair cavity and the ferritic base material of the RPV head. See Figures 1 and 2 [of Attachment 1 of the licensee's May 8, 2008, submittal]. Flaws in the J-groove weld will be removed prior to performing any temper bead repairs in accordance with this relief request.

3.1.4 Licensee's Basis for Relief (as stated by the licensee)

The RPV heads are manufactured from P-Number 3, Group 3 low alloy steels. If repairs are performed in accordance with ASME Section III, APS would have two options: (1) perform a weld repair that includes a postweld heat treatment (PWHT) at 1100°F - 1250°F in accordance with NB-4622.1; or (2) perform a temper bead repair using the SMAW process in accordance with NB-4622.1. Each option is discussed below.

1. PWHT of the RPV head is an impractical option that would permanently damage the RPV head assembly. ASME Section III NB-4600 requires PWHT to be performed at 1100° - 1250°F. PWHT of the RPV head will result in ovalization and misalignment of CEDM penetrations and changes in clearances.

2. NB-4622.11 provides temper bead rules for repair welding of dissimilar materials using the SMAW process. Because NB-4622.11 does not include temper bead rules for the machine or automatic Gas Tungsten Arc Welding (GTAW) process, a manual temper bead process must be used. However, a manual SMAW temper bead repair is not a desirable option due to radiological considerations. First of all, scaffolding must be built and heating blankets, thermocouples, and insulation must be installed. Secondly, the manual SMAW temper bead welding process is a time and dose intensive process. Each weld layer is manually deposited in a high dose and high temperature (350°F) environment. The manual SMAW temper bead process of NB-4622.11 also requires that the weld crown of the first weld layer be mechanically removed by grinding. Upon completing repair welding, heating blankets, thermocouples, insulation, and scaffolding must be removed. Thermocouples and heating blanket mounting pins must be removed by grinding. The ground areas must be subsequently examined by the magnetic particle or liquid penetrant examination.

APS estimates that the dose associated with an SMAW temper bead repair on the RPV head to be at least 20 to 25 REM [roentgen equivalent man] more than the proposed method of repair per weld repair. In addition, APS estimates the dose associated with the set-up and disassembly of the elevated preheat and postweld soak to be at least 15 REM.

APS has not requested an alternative to NB-4622.11; rather, this request proposes an alternative to IWA-4600 and IWA-4630. Owners are allowed by ASME Section XI IWA-4411(e) and IWA-4600(b) to perform temper bead repairs of dissimilar materials. IWA-4411(e) and IWA-4600(b) provide requirements and controls for performing such repairs.

IWA-4600(b) and IWA-4630 of ASME Section XI establish requirements for performing temper bead welding of "dissimilar materials". According to IWA-4633.2, either the automatic or GTAW machine process or SMAW process may be used. When using the GTAW machine process, a minimum preheat temperature of 300°F must be established and maintained throughout the welding process while the interpass temperature is limited to 450°F. Upon completion of welding, a postweld soak is performed at minimum of 450°F for a minimum of 4 hours.

The IWA-4600(b) and IWA-4630 temper bead welding process is a time and dose intensive process. Heating blankets are attached to the RPV head; typically a capacitor discharge stud welding process is used. Thermocouples must also be attached to the RPV head using a capacitor discharge welding process to monitor preheat, interpass and postweld soak temperatures. Prior to heat-up, thermal insulation is also installed. Upon completion of repair welding (including the postweld soak), the insulation, heating blankets, studs, and thermocouples must be removed from the RPV head. Thermocouples and stud welds are removed by grinding. Ground removal areas are subsequently examined by the liquid penetrant or magnetic particle method. A significant reduction in dose could be realized by utilizing an ambient temperature temper bead process. Because the ASME Code does not presently include rules for ambient temperature temper bead welding, APS proposes the alternative described in [section 3.1.3 above].

Evaluation of the Ambient Temperature Temper Bead Technique (as stated by the licensee)

Research by the Electric Power Research Institute (EPRI) and other organizations on the use of an ambient temperature temper bead operation using the GTAW machine process is documented in EPRI Report GC-111050. According to the EPRI report, repair welds performed with an ambient temperature temper bead procedure utilizing the GTAW machine welding process exhibit mechanical properties equivalent or better than those of the surrounding base material. Laboratory testing, analysis, successful procedure qualifications, and successful repairs have all demonstrated the effectiveness of this process.

The effects of the ambient temperature temper bead welding process of Attachment 1 [of the licensee's May 8, 2008, submittal] on mechanical properties of repair welds, hydrogen cracking, and restraint cracking are addressed below [Section 5A, "Evaluation of the Ambient Temperature Temper Bead Technique," of the licensee's May 8, 2008, submittal].

3.1.5 NRC Staff Evaluation

The NRC staff acknowledges the previous staff acceptance of a similar GTAW machine process to perform ambient temperature temper bead repair for CEDM nozzles at PVNGS, Units 1, 2, and 3, as documented in its letter dated July 1, 2003 (ADAMS Accession No. ML031830660). The staff based its review of the licensee's proposed alternative as applicable to the updated ASME Code of record for the third 10-year ISI program intervals at each of the PVNGS units. The staff reviewed RR 18 using the basis of 10 CFR 50.55a(a)(3)(i) and (ii): (i) the proposed alternatives would provide an acceptable level of quality and safety, and (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

1. IWA-4600(b)(1) states, in part, that repairs may be performed to dissimilar base materials and welds without the specified postweld heat treatment of ASME Code, Section III provided the requirements of IWA-4610 and IWA-4630 are met. The temper bead rules of IWA-4610 and IWA-4630 apply to dissimilar materials such as P-No. 43 to P-No. 3 base materials welded with F-No. 43 filler metals. When using the GTAW machine process, the IWA-4600 and IWA-4630 temper bead process is based

fundamentally on an elevated preheat temperature of 300 °F, a maximum interpass temperature of 450 °F, and a postweld soak of 450 °F.

The licensee's proposed alternative in Attachment 1 of its May 8, 2008, submittal also establishes requirements to perform temper bead welding on dissimilar material welds that join P-No. 43 to P-No. 3 base materials using F-No. 43 filler metals. However, the temper bead process of Attachment 1 of the licensee's submittal is an ambient temperature technique which only utilizes the GTAW machine or GTAW automatic process.

The NRC staff reviewed the licensee's basis and the supporting information from EPRI Report CG-111050. The NRC staff finds the effects of the ambient temperature temper bead welding process on mechanical properties of repair welds, hydrogen cracking, and restraint cracking exhibit qualities equivalent or better than those of the surrounding base material. Therefore, the NRC staff finds the proposed ambient temperature temper bead technique, as described in Attachment 1 of the licensee's May 8, 2008, submittal, provides an acceptable level of quality and safety.

2. IWA-4610(a) states, in part, that the weld area plus a band around the repair area of at least 1 1/2 times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 300 °F for the GTAW process during welding while the maximum interpass temperature is limited to 450 °F.

The licensee's proposed ambient temperature temper bead technique also establishes a preheat band of at least 1 1/2 times the component thickness or 5 inches, whichever is less. However, the ambient temperature temper bead technique requires a minimum preheat temperature of 50 °F, and a maximum interpass temperature of 350 °F.

The NRC staff reviewed the licensee's basis for the suitability of an ambient temperature temper bead technique with reduced preheat and interpass temperatures, which is addressed in Section 5A, "Evaluation of the Ambient Temperature Temper Bead Technique," of the licensee's May 8, 2008, submittal. The NRC staff finds that the laboratory testing, analysis, qualifications, and operational experience using this technique have demonstrated an acceptable level of quality and safety.

IWA-4610(a) also states, in part, that thermocouples and recording instruments shall be used to monitor process temperatures.

The licensee proposes to monitor preheat and interpass temperatures using an infrared thermometer. Infrared thermometers are hand-held devices that can be used to monitor process temperature from a remote location.

The NRC staff has reviewed the licensee's proposed monitor including the technique in which it will be employed and associated error in data acquisition. The NRC staff finds the licensee's proposed alternative to use an infrared thermometer to monitor process temperatures provides an acceptable level of quality and safety.

3. IWA-4633.2(c), in part, requires that at least one layer of weld reinforcement shall be deposited on the completed weld and with this reinforcement being subsequently removed by mechanical means.

   The licensee's proposed alternative does not include the deposition and removal of a reinforcement layer. The NRC staff has reviewed the licensee's basis for not using a reinforcement layer. The NRC staff acknowledges that ASME Code Case N-638, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique," only requires the deposition and removal of a reinforcement layer when performing repair welds on similar (ferritic) materials. Repair welds on dissimilar materials are exempt from this requirement. Therefore, the NRC staff finds the licensee's proposed alternative to not use a weld reinforcement layer provides an acceptable level of quality and safety.

4. IWA-4633.2(d), in part, requires that the weld area shall be maintained at a minimum temperature of 450 °F for a minimum of 4 hours (for P-No. 3 materials) after at least 3/16-inch of weld metal has been deposited. This postweld soak assists diffusion of any remaining hydrogen from the repair weld. The licensee's proposed alternative does not require a postweld soak.

   The NRC staff has reviewed the licensee's basis for the removal of the postweld soak requirement. The GTAW machine welding process, as defined by the licensee's proposed alternative, is inherently free of hydrogen eliminating the need for a postweld soak. The NRC staff finds the licensee's basis acceptable and finds the use of the licensee's proposed ambient temperature temper bead technique without a postweld soak provides an acceptable level of quality and safety.

5. IWA-4634, in part, specifies that the repair weld shall be surface and volumetrically examined after the completed repair weld has been at ambient temperature.

   The NRC staff notes that it is almost impossible to perform an effective volumetric examination of the partial penetration J-groove welds for which this repair process is proposed. A volumetric examination is not practical due to weld configuration and access limitations. The licensee proposes an alternative to the volumetric examinations of IWA-4634, by progressively examining them by the liquid penetrant method in accordance with NB-5245 of ASME Code, Section III. The liquid penetrant examinations will be performed in accordance with NB-5000. Acceptance criteria shall be in accordance with NB-5350.

   The NRC staff notes that ASME Code, Section III does not require volumetric examination of the partial penetration J-groove welds. According to NB-3352.4(d)(1), "partial penetration welds used to connect nozzles as permitted in NB-3337.3 shall meet the fabrication requirements of NB-4244(d) and shall be capable of being examined in accordance with NB-5245." Based on the above, the NRC staff concludes that performing progressive examination by liquid penetrant method in accordance with NB-5245 of ASME Code, Section III provides reasonable assurance of the structural integrity of the weld and the required volume examination of the repair weld would result in hardship without a compensating increase in the level of quality and safety.

3.2 Relief Request 36

The licensee's proposed alternative, as described under RR-36, is to allow use of full structural weld overlays in the repair of dissimilar metal welds for the third 10-year ISI program intervals at PVNGS, Units 1 and 3.

3.2.1 ASME Code, Class 1 Component(s) Affected:

Category B-J welds on the pressurizer as identified in the Table below.

Unit 1	Description	Zone	Size	DM Weld Item Number	SM Weld Item Number
Hot Leg	SDC nozzle to safe end	21	16	6-11	21-20
Hot Leg	SDC nozzle to safe end	22	16	7-9	22-1
Unit 3	**Description**	**Zone**	**Size**	**DM Weld Item Number**	**SM Weld Item Number**
Hot Leg	SDC nozzle to safe end	21	16	6-11	21-20
Hot Leg	SDC nozzle to safe end	22	16	7-9	22-1

A dissimilar metal weld (DMW) is defined as a weld that joins two pieces of different type of metals. In the proposed alternative, the DMW joins the ferritic (i.e., low alloy steel) pressurizer nozzle to the austenitic stainless steel safe end or piping. The DMW itself is made of nickel-based Alloy 82/182. The proposed weld overlay repair is a process by which weld filler metal that is resistant to stress corrosion cracking is deposited on the outside surface of the degraded pipe including the original pipe weld.

3.2.3 Applicable Code Edition and Addenda

The ASME ISI Code of record for the third 10-year ISI intervals for PVNGS, Units 1 and 3 is the ASME Code, Section XI, 2001 Edition and Addenda through 2003. PVNGS, Units 1 and 3 entered the third 10-year ISI intervals on July 18, 2008, and January 11, 2008, respectively.

3.2.4 Applicable Code Requirements

IWA-4410 of the ASME Code, Section XI requires that repairs of welds shall be performed in accordance with Article IWA-4400. IWA-4420 requires that defects be removed or reduced to an acceptable size.

Attachment 2 of the licensee's May 8, 2008, submittal provides a comparison of its proposed alternative versus Code Cases N-504-2 and N-638-1. These Code cases are identified as conditionally acceptable in Table 2 of Regulatory Guide 1.147, Revision 14, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1" (ADAMS Accession No. ML052510117).

Hot-leg dissimilar welds greater than 14 inches in diameter are required to be inspected or mitigated at PVNGS in accordance with EPRI's "Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139)." The examinations are the same as the volumetric examinations specified in ASME Code, Section XI, Table IWB-2500-1, Category B-J.

3.2.5 Licensee's Reason for Request (as stated by the licensee)

Primary Water Stress Corrosion Cracking (PWSCC) has been identified as a degradation mechanism for Alloy 82/182 welds. While no PWSCCs have been detected in Palo Verde piping, there are geometric limitations such that the required examination volume cannot be met with qualified ultrasonic (UT) techniques.

APS has concluded that the application of a full-structural weld overlay (FSWOL) over the Alloy 82/182 welds is the most appropriate course of action to ensure the integrity of the reactor coolant pressure boundary. In addition, the overlays will be designed to improve the configurations for future examinations.

The 2001 Edition and through the 2003 Addenda of the Code does not provide rules for the design of weld overlays or for repairs without removal of flaws. In addition, Code Case N-504-2, which had been approved by the NRC for use and subsequently superseded [Regulatory Guide 1.147, Revision 15], does not provide the methodology for overlaying nickel alloy welds joining austenitic and ferritic base materials; therefore, APS proposes the following alternative.

3.2.5.1 Proposed Alternative and Basis for Use (as stated by the licensee)

A preemptive full-structural Alloy 52 overlay will be applied to each of the hot leg Alloy 82/182 dissimilar metal welds [at PVNGS Units 1 and 3] identified in this request [the licensee's May 8, 2008, submittal]. For a preemptive FSWOL, a flaw will be assumed. [If through-wall leakage is detected by visual examination on any of the PVNGS pressurizer or hot leg Alloy 82/182 safe-end welds, a contingency FSWOL will be applied.]

For the welds identified in section 1.0 [of the licensee's May 8, 2008, submittal], in lieu of performing ultrasonic examinations, the flaw will be assumed to be 100% through the original wall thickness for the entire circumference for preemptive as well as contingency full-structural weld overlay design.

Due to the proximity of the adjacent similar metal piping welds, preemptive or contingency overlay of the dissimilar metal welds may preclude the examination of the adjacent similar metal piping welds; therefore, the overlay will be extended over the adjacent similar metal piping welds, if required. However, which similar metal welds will be overlaid will be determined after designing the dimensions of the dissimilar metal weld overlay.

These similar metal welds will not be inspected prior to installing the overlay. [The selection and examination of the similar metal weld population is currently performed using an NRC-approved risk-informed program described in RR 32, dated November 3, 2006. The risk-informed application uses failure probability analysis, probabilistic risk assessment, and an expert panel evaluation to identify the piping components that require examination. The piping components selected for examination are only a small portion of the total population of similar metal welds; however, the basic intent of identifying and repairing flaws before piping integrity is challenged, is maintained by the risk-informed application. As a final step in the selection process, a statistical model was used to assure that a sufficient number of welds are being examined. The welds adjacent to the dissimilar metal welds were not selected for examination in the risk-informed application for PWSCC degradation mechanism and it is concluded that these adjacent similar metal welds do not need to be examined to maintain an acceptable level of quality and safety.] After the overlay is applied, these welds will be examined in accordance with the proposed alternative.

In lieu of using the existing IWA-4000 Repair Procedures in the 2001 Edition and Addenda through 2003 Section XI Code, APS proposes to use the following alternative for the design, fabrication, pressure testing, and examination of the weld overlays. This will provide an acceptable methodology for reducing a defect in austenitic nickel alloy welds to an acceptable size by increasing the wall thickness through deposition of a weld overlay.

The methodology is based upon ASME Code Case N-740 and only the applicable requirements of the Code Case are noted as alternatives. The proposed weld overlay will be of sufficient thickness and length to meet the applicable stress limits from ASME Section III, NB-3200. Crack growth evaluations for PWSCC and fatigue of any as-found flaws or any conservatively postulated flaws are intended to ensure that structural integrity will be maintained.

As a part of the design of the weld overlay, the weld length, surface finish, and flatness are specified in order to allow qualified ASME Code, Section XI, Appendix VIII UT examinations, as implemented through the EPRI Performance Demonstration Initiative (PDI) program, of the weld overlay and the required volume of the base material and original weld. The examinations specified in this proposed alternative, versus those limited examinations performed on the original dissimilar metal welds, will provide improved assurance of structural integrity.

Further, if no flaws are found in the outer 25 percent of the original wall thickness by the preservice UT examinations, the postulated 75 percent through-wall flaw for the preemptive overlays is conservative for crack growth evaluations. If flaws are found during the preservice examination in the upper 25 percent of the original weld or base materials, the licensee states:

> ... the as-found flaw (postulated 75 percent through wall, plus the portion of the flaw in the upper 25 percent) would be used for the crack growth analysis. The size of all flaws will be projected to the end of the design life of the overlay or until the next scheduled inservice inspection. Crack growth, including both stress corrosion and fatigue crack growth, shall be evaluated in the materials in accordance with IWB-3640. If the flaw is at or near the boundary of two different materials, evaluation of flaw growth shall consider the most limiting of the two materials.

Weld overlay repairs of dissimilar metal welds have been installed and performed successfully for many years in both pressurized-water reactor (PWR) and boiling-water reactor (BWR) applications. The alternative provides improved structural integrity and reduced likelihood of leakage from the reactor coolant pressure boundary. Accordingly, the licensee finds that use of the alternative provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a(a)(3)(i).

3.2.6 NRC Staff Evaluation

The licensee provided details concerning requirements for the design and nondestructive examination (NDE) of the weld overlay in Enclosure 1 to RR 36 of the licensee's May 8, 2008, submittal, entitled "Proposed Alternative: Use of Full-Structural Weld Overlay in the Repair of Dissimilar Metal Welds." Attachment 1 to RR 36 of the licensee's May 8, 2008, submittal includes the requirements for the ambient temperature temper bead welding technique. Attachment 2 to RR 36 of the licensee's May 8, 2008, submittal provides a comparison between the APS proposed alternative and Code Cases N-504-2 and N-638-1. However, NRC has approved a later edition of ASME Code Case N-504. This later edition, revision 3, will be used to review and compare the licensee's proposed alternative.

The proposed methodology and associated requirements for the weld overlay are similar to Code Case N-740, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items Section XI, Division 1," of the ASME Code, Section XI. Code Case N-740 combines the requirements in Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Section XI, Division 1," and N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique Section XI, Division 1."

The NRC staff has conditionally endorsed Code Cases N-504-3 and N-638-1 in NRC Regulatory Guide 1.147, but not Code Case N-740. Therefore, the NRC staff evaluates the acceptability of RR 36 based on the requirements of Code Cases N-504-3 and N-638-1.

3.2.6.1 General Requirements

The licensee provided several general requirements for their proposed alternative. These included the use of Alloy 52 weld material to be used for the FSWOL. The NRC staff finds the proposed general requirements acceptable because the preemptive weld overlay materials are resistant to PWSCC (Alloy 52) and because the weld overlay will create low tensile or compressive residual stress profiles in the original weld which provide increased resistance to PWSCC. Further, the weld overlay is of sufficient thickness and length to meet the applicable stress limits from ASME Code, Section III, NB-3200.

3.2.6.2 Crack Growth Considerations and Design

The licensee stated that crack growth calculations would be performed to determine the lifetime of the mitigation as part of a design package. Flaw characterization and evaluation requirements would be based on a flaw in the original dissimilar metal weld with a depth of 75 percent and a circumference of 360 degrees that originates from the inside of the pipe. A 75 percent through-wall depth flaw is the largest flaw that could remain undetected during the

FSWOL preservice examination. This preservice examination will verify there is no cracking in the upper 25 percent of the original weld wall thickness, and thus verify that the assumption of a 75 percent through-wall crack is conservative. However, if any crack-like flaws are found during the preservice examination in the upper 25 percent of the original weld or base materials, the as-found flaw (postulated 75 percent through wall, plus the portion of the flaw in the upper 25 percent) would be used for the crack growth analysis. The size of all flaws will be projected to the end of the design life of the overlay or until the next scheduled inservice inspection. Crack growth, including both stress corrosion and fatigue crack growth, shall be evaluated in the materials in accordance with IWB-3640. If the flaw is at or near the boundary of two different materials, evaluation of flaw growth shall consider the most limiting of the two materials.

The NRC staff finds the crack growth consideration proposed by the licensee acceptable because the licensee is postulating in its analysis the existence of a 75 percent through-wall flaw. A 75 percent through-wall depth flaw is the largest flaw that could remain undetected during the FSWOL preservice examination. This proposed preservice examination will verify that there is no cracking in the upper 25 percent of the original weld wall thickness, and thus verify that the assumption of a 75 percent through-wall crack is conservative.

The NRC staff reviewed the licensee's proposed design of the FSWOL. The licensee detailed the design requirements in Section 5.2 of their submittal. The design thickness of the weld overlay shall be determined based on a flaw 100 percent through the original wall thickness for the entire circumference in the underlying pipe. Further the licensee will used the crack growth consideration using the assumptions and flaw characterization restrictions in section 5.2(a) of its May 8, 2008, submittal. In addition, the licensee noted that their design analysis shall be completed in accordance with IWA-4311. IWA-4311 provides analysis requirements for changes (i.e., weld overlay) that are made to the design or configuration of an item or system. The NRC staff finds the proposed design of the weld overlay acceptable because the overlay satisfies the design analysis requirements specified in ASME Code, Section XI, IWA-4311.

3.2.6.3 Examination and Inspection Requirements

The licensee stated that NDE methods shall be in accordance with IWA-2200, except as specified. Nondestructive examination personnel shall be qualified in accordance with IWA-2300. Ultrasonic examination procedures and personnel shall be qualified in accordance with Appendix VIII, Section XI, as implemented through the EPRI PDI.

The PDI Program Status for Code Compliance and Applicability developed in June 2005 indicates that the PDI Program is in compliance with Appendix VIII, 2001 Edition of Section XI as amended by 10 CFR 50.55a, Final Rule dated October 1, 2004. Ultrasonic examination will be performed to the maximum extent achievable.

PVNGS, Units 1 and 3 are scheduled to perform full-structural overlays during the upcoming refueling outages. The licensee does not plan to perform UT of the hot leg nozzles dissimilar metal welds or the adjacent similar metal welds on these units prior to the installation of the overlays. Therefore, the licensee intends to apply full-structural overlays designed for a worst case through-wall flaw that is 360 degrees in circumference.

For post-overlay examinations, there are two examinations to be performed after the overlay is installed, the acceptance examination of the overlay and the preservice examination. The purpose of the acceptance examination is to assure a quality overlay was installed. The purpose of the preservice examination is to provide a baseline for future examinations and to locate and size any cracks that might have propagated into the upper 25 percent of the original wall thickness and to evaluate them accordingly. While listed as two separate examinations, they will be performed during the same time period. An identification of the examination coverage of each overlay will be developed and available for NRC review prior to plant startup.

The licensee's proposed alternative NDE requirements cover the area that will be affected by the application of the overlay. The NRC staff reviewed the requirements stated in Attachment 1 to the RR 36 submittal. The NRC staff found the proposed surface and volumetric examinations provide adequate assurance that any defects produced by welding of the overlay or by extension of pre-existing defects will be identified. The NRC staff finds the examination and inspection requirements specified by the licensee acceptable because the licensee is proposing to perform a pre-weld overlay surface examination and post-weld nondestructive examination, followed by preservice examination of the weld overlay. In addition, an inservice examination will be performed during the next or following refueling outage. The proposed NDE methods shall be in accordance with ASME Code, Section XI, IWA-2200 and the NDE personnel shall be qualified in accordance with IWA-2300. Ultrasonic examination procedures and personnel shall be qualified in accordance with Appendix VIII, 2001 Edition of Section XI as amended by 10 CFR 50.55a, Final Rule dated October 1, 2004.

3.2.6.4 ASME Code Cases N-504-3 and N-638-1

As previously stated, the proposed methodology and associated requirements for the weld overlay proposed by the licensee are similar to Code Case N-740, of the ASME Code, Section XI. Code Case N-740 combines the requirements in Code Case N-504-2 and N-638-1.

The NRC staff has conditionally endorsed Code Cases N-504-3 and N-638-1, in Revision 15 of NRC Regulatory Guide 1.147, but not Code Case N-740. Therefore, the NRC staff also evaluated the acceptability of RR 36 based on the requirements of Code Case N-504-3 and N-638-1.

The review of Attachment 2 to RR 36 of the licensee's May 8, 2008, submittal revealed that the licensee is following the methodology of Code Case N-504-3 with the following modifications for the proposed full structural preemptive weld overlays:

- Use of a nickel-based alloy weld material, Alloy 52/52M rather than the low carbon (0.035 percent maximum) austenitic stainless steel.
- Relaxation from the requirement to perform delta ferrite measurements to meet the 7.5 Ferrite Number requirement of N-504-2. The Ferrite Number requirement cannot be met because the Alloy 52/52M weld material is 100 percent austenitic and contains no delta ferrite.

The first proposed modification to the N-504-3 provisions involves the use of a nickel-based alloy weld material, rather than the low carbon austenitic stainless steel. In lieu of the stainless steel weld material, Alloy 52 welding metal highly resistant to PWSCC, was proposed for the overlay weld material. The NRC staff notes that the use of Alloy 52 material is consistent with weld filler material used to perform similar weld overlays at other operating nuclear power plants. For material compatibility in welding, the NRC staff considers Alloy 52 a better choice of filler material than austenitic stainless steel material for this weld joint configuration. Alloy 52 material contains about 28-30 percent chromium which would provide 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 for the weld overlays as a modification to the requirements of N-504-3, and is acceptable as it will provide an acceptable level of quality and safety.

The second proposed modification to the N-504-3 provisions involved the requirement for as-deposited delta ferrite measurements of at least 7.5 Ferrite Number (FN) for the weld reinforcement. The delta ferrite measurements cannot be performed for this overlay because the deposited Alloy 52 material is 100 percent austenitic and contains no delta ferrite due to the high nickel composition (approximately 60 percent nickel). N-504-3 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-504-3 is only applicable to weld overlay repair of austenitic stainless steel piping. Therefore, the material requirements regarding the carbon content limitation (0.035 percent maximum) and the delta ferrite content of at least 7.5 FN, as delineated in N-504-3, apply to austenitic stainless steel weld overlay materials. These requirements are not applicable to Alloy 52, a nickel-based material which the licensee will use for the weld overlays. Based on the discussion above, the staff concludes that the modifications to N-504-3 will provide an acceptable level of quality and safety, and are therefore, acceptable.

With respect to the methodology of Code Case N-638-1, the licensee is following, in general, the methodology of the Case with the exception that the maximum area of an individual weld based on the finished surface over the ferritic material will be approximately 300 square inches.

Paragraph 1.0(a) of Code Case N-638-1 limits the maximum area of an individual weld to 100 square inches on the ferritic base material using temper bead welding. However, the proposed alternative allows the weld surface area up to 300 square inches on the ferritic base material. The technical justification for allowing weld overlays on ferritic materials with surface areas up to 500 square inches is provided in the white paper supporting the changes in ASME Code Case N-638-3 and EPRI Report 1011898, "Justification for the Removal of the 100 Square Inch Temper Bead Weld Repair Limitation." The EPRI report cites evaluations of a 12-inch diameter nozzle weld overlay to demonstrate adequate tempering of the weld heat affected zone, residual stress evaluations demonstrating acceptable residual stresses in weld overlays ranging from 100 to 500 square inches, and service history in which weld repairs exceeding 100 square inches were NRC approved and applied to DMW nozzles in several BWR and PWR applications. Some of the cited repairs are greater than 15 years old, and have been inspected several times with no evidence of any continued degradation. The above theoretical arguments and empirical data have been verified in practice by extensive field experience with temper bead weld overlays, with ferritic material coverage ranging from less than 10 square inches up to and including 325 square inches.

The NRC staff finds that the proposed 300-square inch weld area on the ferritic material is acceptable because the stress analysis presented in EPRI report 1011898 shows that the structural integrity of ferritic material is not adversely affected by a 300-square inch weld overlay area. Therefore, the NRC staff finds the licensee's alternative weld area to provide an acceptable level of quality and safety.

4.0 CONCLUSION

The NRC staff concludes that the licensee's proposed alternative to use GTAW ambient temperature temper bead welding for RPV head penetration nozzle J-groove weld repairs as stated in the licensee's RR 18 provides an acceptable level of quality and safety. The NRC staff also concludes that compliance with the ASME Code-required volumetric examinations of the repair weld would result in hardship without a compensating increase in the level of quality and safety, and that the licensee's proposed alternative to implement progressive penetrant exams for RPV head penetration nozzle J-groove weld repairs provides reasonable assurance of structural integrity. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i) and (ii), the staff authorizes the proposed alternative to the GTAW-machine temper bead welding requirements of IWA-4600 and IWA-4630 of ASME Section XI at PVNGS, Units 1, 2, and 3 for the third 10-year ISI interval.

The NRC staff has reviewed the licensee's submittal and determined that RR 36 for PVNGS, Units 1 and 3, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the use of RR 36, for the installation of full structural weld overlay on the dissimilar metal welds identified by Section 3.2.1 of this evaluation. The time period for which RR 36 is authorized for implementation is the third 10-year ISI interval for PVNGS, Units 1 and 3. Once an FSWOL has been installed per the requirements of RR 36, it is authorized through the design life of the mitigation as defined by this relief request. The proposed non-destructive examination requirements associated with these FSWOL are authorized for the third 10-year ISI interval only for PVNGS, Units 1 and 3.

All other requirements of the ASME Code, Sections III and XI, for which relief has not been specifically requested and approved, remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: J.W. Collins

Date: November 10, 2008

November 10, 2008

alternative for the installation of full structural weld overlay on the dissimilar metal welds for PVNGS, Units 1 and 3, for the third 10-year ISI program interval.

The licensee's submittal dated May 8, 2008, also contained RR 34, which was reviewed and approved by the NRC staff by letter dated October 2, 2008.

A copy of the Safety Evaluation is enclosed. All other ASME Code, Sections III and XI, requirements for which relief has not been specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Sincerely,

/RA/

Michael T. Markley, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, STN 50-529,
and STN 50-530

Enclosure:
Safety Evaluation

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