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

February 22, 2010

Mr. Randall K. Edington
Executive Vice President Nuclear/
Chief Nuclear Officer
Mail Station 7602
Arizona Public Service Company
P. O. Box 52034
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 - RELIEF REQUEST NO. RR-40, REACTOR VESSEL WELD EXAMINATION INTERVAL EXTENSION (TAC NOS. ME1634, ME1635, AND ME1636)

Dear Mr. Edington:

By letter dated July 1, 2009, as supplemented by letter dated December 21, 2009, Arizona Public Service Company (the licensee), requested Nuclear Regulatory Commission (NRC) approval of Relief Request No. 40 (RR-40), to use an alternative to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Subarticle IWA-2432 and IWB-2412, Inspection Program B, for certain reactor pressure vessel (RPV) pressure-retaining and full-penetration welds at Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, and 3. Specifically, pursuant to paragraph 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* (10 CFR), the licensee requested approval to extend the current inservice inspection (ISI) interval for examination of certain RPV pressure-retaining and full-penetration welds from 10 to 20 years.

The NRC staff has completed its review of the information provided by the licensee for RR-40. The staff concludes that the information provided supports the granting of the proposed alternative of RR-40 pursuant to 10 CFR 50.55a(a)(3)(i), because the alternative provides an acceptable level of quality and safety. The licensee's proposed alternative is approved for the current (third) ISI interval only, for the extended inspection interval dates of 2016, 2027, and 2028 for the specified welds for PVNGS, Units 1, 2, and 3, respectively.

A copy of the Safety Evaluation is enclosed. All other ASME Code, Section 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, 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

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UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM RELIEF REQUEST NO. 40

REACTOR VESSEL WELD EXAMINATION INTERVAL EXTENSION

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

ARIZONA PUBLIC SERVICE COMPANY

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

1.0 INTRODUCTION

By letter dated July 1, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML091870432), as supplemented by letter dated December 21, 2009 (ADAMS Accession No. ML100040067)), Arizona Public Service Company (APS) requested Nuclear Regulatory Commission (NRC) approval of Relief Request No. 40 (RR-40), to use an alternative to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Table IWB-2500-1 for certain reactor pressure vessel (RPV) pressure-retaining and full penetration welds at Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, and 3. Specifically, pursuant to paragraph 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* (10 CFR), the licensee requested approval to increase the interval for performing the volumetric examinations on certain RPV pressure-retaining and full-penetration welds from 10 to 20 years for the current third inservice inspection (ISI) intervals.

2.0 REGULATORY EVALUATION

In accordance with 10 CFR 50.55a(g)(4), the licensee is required to perform ISI of ASME Code Class 1, 2, and 3 components and system pressure tests during the first 10-year interval and subsequent 10-year intervals that 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), subject to the limitations and modifications listed therein.

For the current third ISI interval at PVNGS, Units 1, 2, and 3, the code of record for the inspection of ASME Code Class 1, 2, and 3 components is the 2001 Edition through 2003 Addenda of the ASME Code, Section XI. The regulation in 10 CFR 50.55a(a)(3) states, in part, that the Director of the Office of Nuclear Reactor Regulation (NRR) may authorize an alternative to the requirements of 10 CFR 50.55a(g). For an alternative to be authorized, as per 10 CFR 50.55a(a)(3)(i), the licensee must demonstrate that the proposed alternative would provide an acceptable level of quality and safety.

Enclosure

2.1 Background

The ISI of Category B-A and B-D components consists of visual and ultrasonic examinations intended to discover any new flaws that have initiated or any pre-existing flaws that may have been missed in prior examinations, and whether any pre-existing flaws have extended. These examinations are required to be performed at regular intervals, as defined in Section XI of the ASME Code.

2.2 Summary of WCAP-16168-NP

In 2006, the Pressurized-Water Reactor Owners Group (PWROG) submitted a topical report, WCAP-16168-NP, Revision 1[1] (referred to as the WCAP in the rest of this document), to the NRC in support of making a risk-informed assessment of extensions to the ISI intervals for Category B-A and B-D components. In the report, the PWROG took data associated with three different pressurized-water reactor (PWR) plants (referred to as the pilot plants), one designed by each of the main nuclear power plant vendors in the U.S. (Westinghouse, Combustion Engineering, and Babcock and Wilcox (B&W)), and performed the studies on each of the pilot plants necessary to justify the proposed extension for the ISI interval for Category B-A and B-D components from 10 to 20 years.

The analyses in the WCAP used probabilistic fracture mechanics (PFM) tools and inputs from the work described in the NRC's pressurized thermal shock (PTS) risk re-evaluation[2,3]. The PWROG analyses incorporated the effects of fatigue crack growth and ISI. Design-basis transient data was used as input to the fatigue crack growth evaluation. The effects of ISI were modeled consistently with the previously-approved PFM codes[4]. These effects were put into evaluations performed with the Fracture Analysis of Vessels-Oak Ridge (FAVOR) code[5]. All other inputs were identical to those used in the PTS risk re-evaluation.

From the results of the studies, the PWROG concluded that the ASME Code, Section XI 10-year inspection interval for Category B-A and B-D components in PWR reactor vessels can be safely extended to 20 years. The PWROG's conclusion from the results for the pilot plants was considered to apply to any plant designed by the three vendors, as long as that plant's

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1 Westinghouse Owners Group, WCAP-16168-NP, Revision 1, "Risk-Informed Extension of the Reactor Vessel In-Service Inspection Interval," January 2006 (ADAMS Accession No. ML060330504).

2 U.S. Nuclear Regulatory Commission, "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Limit in the PTS Rule (10 CFR 10.61), Summary Report," NUREG-1806, 2006 (ADAMS Accession No. ML061580318).

3 U.S. Nuclear Regulatory Commission, "Recommended Screening Limits for Pressurized Thermal Shock," NUREG-1874, 2007 (ADAMS Accession No. ML070860156).

4 U.S. Nuclear Regulatory Commission, "Safety Evaluation of Topical Report WCAP-14572, Revision 1, Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," dated December 15, 1998 (ADAMS Accession Nos. ML012630349, ML012630327, and ML012630333).

5 Oak Ridge National Laboratory/U.S. Nuclear Regulatory Commission, "Electronic Archival of the Results of Pressurized Thermal Shock Analyses for Beaver Valley, Oconee, and Palisades Reactor Pressure Vessels Generated with the 04.1 version of FAVOR," ORNL/NRC/LTR-04/18, dated October 15, 2004 (ADAMS Accession No. ML042960391).

critical plant-specific parameters (defined in Appendix A of the WCAP) are bounded by those of the applicable pilot plant.

2.3 Summary of NRC Safety Evaluation Report of WCAP-16168-NP

The NRC staff's conclusion in its safety evaluation[6] (SE) of the WCAP indicates that the methodology presented in the WCAP, in concert with the guidance provided by Regulatory Guide (RG) 1.174[7], is acceptable for referencing in requests to implement alternatives to ASME Code inspection requirements for PWR plants in accordance with the limitations and conditions in the SE. In addition to an applicant's need to show that the subject plant is bounded by the applicable pilot plant's information from Appendix A in the WCAP, the key points of the SE are summarized below:

1. The dates identified in the request for alternative should be within plus or minus one refueling cycle of the dates identified in the implementation plan provided to the NRC. Any deviations from the implementation plan[8] should be discussed in detail in the request for an alternative ISI interval. The maximum interval for proposed ISI is 20 years.

2. The request for alternative ISI interval can use any NRC-approved method to calculate ΔT_{30} and RT_{MAX-X}. However, if the request uses the NUREG-1874 methodology to calculate ΔT_{30}, then the request should include the analysis described in paragraph (6) of subsection (f) to the voluntary PTS rule. The analysis should be done for all of the materials in the beltline area with at least three surveillance data points.

3. If the subject plant is a B&W plant:

    - Licensees must verify that the fatigue crack growth of 12 heat-up/ cool-down transients per year bound the fatigue crack growth for all of its design basis transients

    - Licensees must identify the design basis transients that contribute to significant fatigue crack growth

4. If the subject plant has RPV forgings that are susceptible to underclad cracking or if the RPV includes forgings with RT_{MAX-FO} values exceeding 240 degrees

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6 Nieh, H.K., U.S. Nuclear Regulatory Commission, to G. Bischoff, Westinghouse Electric Company, "Final Safety Evaluation for Pressurized Water Reactor Owners Group (PWROG) Topical Report (TR) WCAP-16168-NP, Revision 2, 'Risk-Informed Extension of the Reactor Vessel In-Service Inspection Interval' (TAC No. MC9768)," dated May 8, 2008 (ADAMS Accession No. ML081060053).

7 U.S. Nuclear Regulatory Commission, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Regulatory Guide 1.174, Revision 1, November 2002 (ADAMS Accession No. ML023240437).

8 Schiffley, F.P., PWR Owners Group, letter OG-06-356 to U.S. Nuclear Regulatory Commission, "Plan for Plant Specific Implementation of Extended Inservice Inspection Interval per WCAP-16168-NP, Revision 1, 'Risk-Informed Extension of the Reactor Vessel In-Service Inspection Interval,' MUHP 5097-99, Task 2059," dated October 31, 2006 (ADAMS Accession No. ML082210245).

Fahrenheit (°F), then the WCAP analyses are not applicable. The licensee must submit a plant-specific evaluation for any extension to the 10-year inspection interval for ASME Code, Section XI, Category B-A and B-D RPV welds.

3.0 TECHNICAL EVALUATION

3.1 Description of Proposed Alternatives

In RR-40, the licensee proposes to defer the ASME Code-required Category B-A and B-D ISI of certain RPV welds at PVNGS Unit 1 until 2016, Unit 2 until 2027, and Unit 3 until 2028. This schedule is generally consistent with the information in PWROG letter, OG-06-356, dated October 31, 2006, with the exception that the proposed date for Unit 3 is pushed back from 2013.

3.2 Components for Which Relief is Requested

The affected components are the PVNGS, Units 1, 2, and 3 RPVs. The following examination categories and item numbers from IWB-2500 and Table IWB-2500-1 of the ASME Code, Section XI, are addressed in this request:

Examination Category	Item Number	Description
B-A	B1.11	Circumferential Shell Weld
B-A	B1.12	Longitudinal Shell Welds
B-A	B1.22	Meridional Head Weld (Bottom Head only)
B-A	B1.30	Shell-to-Flange Weld
B-D	B3.90	Nozzle-to-Vessel Welds
B-D	B3.100	Nozzle Inner Radius Areas

3.3 Basis for Proposed Alternatives

The basis for the first alternative is found in the NRC-approved version of the WCAP[9] (referred to as the WCAP-A). Plant-specific parameters for the PVNGS are summarized in the enclosure to the licensee's letter of July 1, 2009. The format of the information is patterned after that found in Appendix A of the WCAP-A.

All of the critical parameters listed in Tables 1, 2, and 3 of the enclosure to the licensee's letter of July 1, 2009, are bounded by the WCAP-A pilot plant evaluations.

The WCAP-A notes that all reactor coolant pressure boundary failures to date have been identified as a result of leakage and were discovered by visual examinations. The Category B-N-1 visual examinations and the Category B-P pressure tests required at the end of

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[9] Buschbaum, D. E., PWR Owners Group, "Transmittal of NRC Approved Topical Report WCAP-16168-NP-A, Rev. 2, 'Risk-Informed Extension of Reactor Vessel In-Service Inspection Interval,' (TAC NO. MC9768) (MUHP 5097/5098/5099 Task 2008/2059, PA MSC-0120," dated June 13, 2008 (ADAMS Accession No. ML082820046).

each refueling outage are not affected by this alternative. The interval extension does not impact on the defense-in-depth elements associated with the overall inspection philosophy.

3.4 Duration of Proposed Alternatives

The duration of the proposed alternative is up to the end of the extended third ISI intervals for PVNGS, Units 1, 2, and 3 (2016, 2027, and 2028, respectively).

3.5 NRC Staff Evaluation

The NRC staff has reviewed RR-40, including the enclosure to the licensee's letter dated July 1, 2009, and the subsequent letter dated December 21, 2009. The dominant pressurized thermal shock transients in the NRC PTS Risk Study are applicable to PVNGS Units 1, 2, and 3. The through-wall cracking frequency (TWCF) of all three units is bounded by the pilot plant basis. The frequency and severity of design transients for PVNGS, Units 1, 2, and 3 were found to be bounded by the analyses in the WCAP-A. Also, PVNGS, Units 1, 2, and 3 RPVs are single-layer clad and so are bounded by the assumptions of the WCAP-A.

Tables 2.1-1, 2.1-2, 2.2-1, 2.2-2, 2.3-1, and 2.3-2 in the attachment of the licensee's July 1, 2009, submittal included additional information pertaining to previous RPV inspections and the schedule for future inspections. One circumferentially-oriented flaw was found in PVNGS Unit 1 within the inner 1 inch of the RPV beltline. The through-wall extent of the flaw was 0.174 in and the flaw length was 1 in. Based on the volume of the plate, the licensee determined that the flaw was acceptable per the proposed PTS Rule in SECY-07-0104[10]. Furthermore, in its letter dated December 21, 2009, the licensee stated that the flaw was acceptable under subarticle IWB-3510 via Table IWB-3510-1 of the ASME Code and so did not require a detailed flaw evaluation, and the NRC staff has confirmed the licensee's determination.

The proposed inspection dates of 2016, 2027, and 2028 for Units 1, 2, and 3, respectively, are consistent with the PWROG letter OG-06-356, dated October 31, 2006, for PVNGS Units 1 and 2, but not for Unit 3. The exact timing of inspections among the operating reactor fleet is currently under review and the change in the proposed inspection date for PVNGS, Unit 3 does not undermine the intent of OG-06-356. The NRC staff has concluded that the proposed schedule is acceptable and maintains the goal of spacing inspections throughout the extended interval.

The licensee's calculation of $TWCF_{95\text{-}TOTAL}$ was performed using data from Tables 2.1-3, 2.2-3, and 2.3-3 from the July 1, 2009 letter. The chemistry data in those Tables came from a report submitted to the NRC in 1995[11], and the chemistries listed in that report were later used in CE

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[10] U.S. Nuclear Regulatory Commission, "Proposed Rulemaking - Alternative Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events (RIN 3150-AI01)," Commission Paper SECY-07-0104, dated June 25, 2007 (ADAMS Accession No. ML070570141).

[11] Stewart, W. L., Arizona Public Service Company, "Response NRC Generic Letter 92-01, Rev. 1, Supplement 1" (LTR 102-03448), dated August 17, 1995 (ADAMS Legacy Library Accession No. 9508210112).

NPSD-1039[12] to produce best estimate values that were then cited and accepted by the NRC in 1998[13]. The later chemistry data (the best estimate values accepted by the NRC in 1998) provide a more appropriate basis for the relief request and should have been the data cited in the licensee's submittal. In this evaluation, the NRC staff has used the best-estimate chemical compositions of the PVNGS, Units 1, 2, and 3 RPV beltline material previously accepted by the staff. These values are shown in Tables 4.1 through 4.3:

Table 4.1 - PVNGS, Unit 1 CE NPSD-1039 Values

#	Region/Component Description		Cu [wt%]	Ni [wt%]
7	Axial Weld	101-124A	0.047	0.049
8	Axial Weld	101-124B	0.047	0.049
9	Axial Weld	101-124C	0.047	0.049
10	Axial Weld	101-142A	0.035	0.079
11	Axial Weld	101-142B	0.035	0.079
12	Axial Weld	101-142C	0.035	0.079
13	Circ Weld	101-171	0.031	0.096

Table 4.2 - PVNGS, Unit 2 CE NPSD-1039 Values

#	Region/Component Description		Cu [wt%]	Ni [wt%]
7	Axial Weld	101-124A	0.046	0.059
8	Axial Weld	101-124B	0.046	0.059
9	Axial Weld	101-124C	0.046	0.059
10	Axial Weld	101-142A	0.074	0.067
11	Axial Weld	101-142B	0.074	0.067
12	Axial Weld	101-142C	0.074	0.067
13	Circ Weld	101-171	0.031	0.096

Table 4.3 - PVNGS, Unit 3 CE NPSD-1039 Values

#	Region/Component Description		Cu [wt%]	Ni [wt%]
7	Axial Weld	101-124A	0.031	0.096
8	Axial Weld	101-124B	0.031	0.096
9	Axial Weld	101-124C	0.031	0.096
10	Axial Weld	101-142A	0.031	0.096
11	Axial Weld	101-142B	0.031	0.096
12	Axial Weld	101-142C	0.031	0.096
13	Circ Weld	101-171	0.031	0.096

12 Combustion Engineering Owners Group, "Best Estimate Copper and Nickel Values in CE Fabricated Reactor Vessel Welds," CE NPSD-1039, Revision 2, Final Report, June 1997 (ADAMS Legacy Library Accession No. 9707180236).

13 Levine, J.M., Arizona Public Service Company, letter to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information Regarding Reactor Pressure Vessel Integrity at Palo Verde Nuclear Generating Station" (LTR 102-04139), dated June 24, 1998 (ADAMS Legacy Library Accession No. 9806300521).

In its letter dated December 21, 2009, the licensee stated that the submittal values were correct and that they would update various databases to reflect this. The NRC staff concludes that the chemistry values cited above in Tables 4.1 through 4.3 are the most appropriate and should be used to update the plant Updated Final Safety Analysis Report (UFSAR) and any other plant listings of the chemistries. These differences did not affect the calculation of $TWCF_{95\text{-}TOTAL}$.

The licensee provided ΔT_{30} values via the methodology found in RG 1.99, Revision 2[14]. All submittal calculations were verified by NRC staff calculations and were found to be correct and within regulatory guidance. The $TWCF_{95\text{-}TOTAL}$ was found to be acceptably low, as calculated through the methodology prescribed in the WCAP-A and detailed in Tables 2.1-3, 2.2-3, and 2.3-3 of the licensee's submittal dated July 1, 2009, and verified by the staff's calculation.

The NRC staff will grant ISI interval extensions for the subject components on an interval-by-interval basis (i.e., only the current ISI interval for a facility will be extended up to a maximum interval of 20 years for the subject inspections). Licensees will have to submit subsequent requests for alternatives for NRC review and approval to extend each subsequent ISI interval from 10 years to 20 years, as needed. Based on this NRC position, the requirement in the staff's SE on WCAP-16168-NP for a license condition to address the evaluation of future ISI data is no longer necessary. Subsequent requested alternatives which seek to extend additional ISI intervals from 10 to 20 years for the subject component examinations should include the evaluation of a facility's most recent ISI data in accordance with the criteria in the final alternative PTS Rule, 10 CFR 50.61a, in order to obtain NRC staff approval.

In summary, the licensee has demonstrated in its submittals that the RPVs for PVNGS, Units 1, 2, and 3 are bounded by the assumptions and analyses in WCAP-A and the associated NRC SE. The submittals demonstrate that there is no significant additional risk associated with extending the current ISI interval for Category B-A and B-D components from 10 years to 20 years for PVNGS, Units 1, 2, and 3. Therefore, the NRC concludes that the proposed alternative provides an acceptable level of quality and safety.

4.0 CONCLUSION

The NRC staff has completed its review of the submittals for RR-40 for PVNGS, Units 1, 2, and 3. The staff concludes that extending the current third ISI interval for Category B-A and B-D components from 10 years to 20 years shows no appreciable increase in risk based on the fact that the plant-specific information provided by the licensee is bounded by the data in the WCAP-A, and the request meets all the conditions and limitations described in the WCAP-A and the associated NRC SE. Therefore, RR-40 provides an acceptable level of quality and safety and the alternative can be granted pursuant to 10 CFR 50.55a(a)(3)(i) until the end of the current extended ISI interval dates of 2016, 2027, and 2028, for the specified welds, for PVNGS, Units 1, 2, and 3, respectively.

[14] U.S. Nuclear Regulatory Commission, "Radiation Embrittlement of Reactor Vessel Materials," Regulatory Guide 1.99, Revision 2, May 1988 (ADAMS Accession No. ML003740284).

The NRC staff notes that the licensee should amend the proposed corrective action documented in its December 21, 2009, letter to use the correct chemistry values cited in Tables 4.1 through 4.3 of this SE when updating Chapter 5 of the UFSAR.

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

Principal Contributor: D. Widrevitz

Date: February 22, 2010

A copy of the Safety Evaluation is enclosed. All other ASME Code, Section 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

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