November 19, 2004

Mr. Gregg R. Overbeck
Senior Vice President, Nuclear
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 NO. 30 RE: AMERICAN SOCIETY OF MECHANICAL ENGINEERS SECTION III BOILER & PRESSURE VESSEL CODE CASE 1361-2 PARAMETER (TAC NOS. MC5080, MC5081, AND MC5082)

Dear Mr. Overbeck:

By letter dated November 11, 2004, Arizona Public Service Company submitted Relief Request No. 30, requesting NRC approval of an alternative to an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Case requirement for the Palo Verde Nuclear Generating Station (Palo Verde), Units 1, 2, and 3. The request for relief is from Code Case 1361-2, "Socket Welds, Section III," to allow a slightly larger diametral clearance between the replacement pressurizer heater sleeves and the heater sheaths. This request is associated with the pressurizer half-sleeve mid-wall weld repairs at all three units. These repairs were completed for Unit 2 during its fall 2003 refueling outage, are ongoing during the fall 2004 refueling outage for Unit 3, and are scheduled for the fall 2005 refueling outage for Unit 1. The relief is requested for the remainder of plant life at the three units.

Based on the enclosed Safety Evaluation, the NRC staff concludes that the proposed alternative provides an acceptable level of quality and safety. Therefore, pursuant to 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations*, the NRC staff authorizes the proposed alternative at Palo Verde, Units 1, 2 and 3, for the remainder of each plant's life. 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.

Sincerely,

**/RA/**

Robert A. Gramm, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

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

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM RELIEF REQUEST NO. 30

ARIZONA PUBLIC SERVICE COMPANY, ET AL.

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

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

## 1.0 INTRODUCTION

By letter dated November 11, 2004, Arizona Public Service Company (APS or the licensee) submitted Relief Request No. 30, requesting NRC approval of an alternative to an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Case requirement for the Palo Verde Nuclear Generating Station (Palo Verde), Units 1, 2, and 3. The request for relief is from Code Case 1361-2, "Socket Welds, Section III," to allow a slightly larger diametral clearance between the replacement pressurizer heater sleeves and the heater sheaths. This request is associated with the pressurizer half-sleeve mid-wall weld repairs at all three units. These repairs were completed for Unit 2 during its fall 2003 refueling outage, are ongoing during the fall 2004 refueling outage for Unit 3, and are scheduled for the fall 2005 refueling outage for Unit 1. The relief is requested for the remainder of plant life at the three units.

## 2.0 BACKGROUND

The pressurizer lower head, to which the heater sleeves are attached, is manufactured from SA-533, Grade B, Class 1 low alloy steel. The pressurizer in each unit has 36 heater sleeves. Each sleeve is a tube having nominal 1.66 inch outside diameter and 0.192 inch wall thickness, and is attached to the lower pressurizer head by a partial penetration weld (J-groove weld) made at the pressurizer inside surface. The original sleeves are made from Alloy 600 material, a nickel-based alloy, which has been found to be susceptible to primary water stress corrosion cracking (PWSCC). The attachment weld is made with Alloy 82/182 material which is a nickel-based alloy and is susceptible to PWSCC also. There is an overlay on the inside surface of the pressurizer at the intersection of the sleeve and penetration to reinforce the pressurizer wall. The heater is inserted into the sleeve and is welded (fillet weld) to the sleeve.

Replacement of these sleeves by excavating the original attachment weld and then re-welding new full-length sleeves is not practical due to inaccessibility of the pressurizer vessel internal surface and high radiation field associated with the pressurizer. Therefore, APS proposes the half-sleeve replacement method. The lower half of the original sleeve is removed in two independent steps. First, the original sleeve is cut approximately 1 inch below the bottom surface of the pressurizer using a grinder. Second, the sleeve is severed within the penetration, approximately mid-wall, using a circular cutting disk, and is then removed. APS will clean and perform a liquid penetrant test (PT) on the penetration bore surface. The half-length replacement Alloy 690 sleeve is then inserted into the penetration by slip fit. The new

weld is made at the top of the replacement half-sleeve. The top half of the original sleeve and associated attachment weld will remain in service. There will be a gap between the original half-sleeve and the new half-sleeve in the penetration.

APS stated that the Palo Verde, Unit 1, pressurizer sleeves have not had any repairs; however, as a preventive measure, APS will perform half-sleeve replacement on all 36 heater sleeves in Palo Verde, Unit 1, in the fall of 2005. The Palo Verde, Unit 2, pressurizer sleeves have been repaired using the half-sleeve replacement method and no additional repairs are necessary. APS will perform half-sleeve replacement on all 36 heater sleeves in Palo Verde, Unit 3, in the fall of 2004.

The Palo Verde, Unit 2, heater sleeve replacement project (fall 2003) identified challenges in sleeve alignment and subsequent installation of heaters. As a result, a significantly longer duration than originally projected was required for sleeve welding. In an attempt to resolve the heater insertion challenges, APS increased the inside diameter of the replacement sleeve from 1.273 inch to 1.300 inch. The heater insertion challenges were essentially resolved utilizing the increased sleeve diameter. Ultimately, less radiation dose was incurred since substantially less time was spent by licensee personnel on the working platform.

The Unit 3 heater sleeve replacement project (fall 2004) incorporated the same heater sleeve inside diameter (1.300 inch). All heaters were inserted into the pressurizer on the initial attempt without rework and, therefore, there was no additional dose to personnel on the working platform due to rework.

The licensee recently determined that increasing the inside diameter of the replacement sleeves adversely impacted compliance with an ASME Section III Code Case.

## 3.0 REGULATORY REQUIREMENTS

The inservice inspection (ISI) of the ASME Code Class 1, 2, and 3 components in nuclear plants is to be performed in accordance with the ASME Code Section XI and applicable edition and addenda as required by 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). The regulation at 10 CFR 50.55a(a)(3) states: "Proposed alternatives to the requirements of paragraphs (c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that: (i) The proposed alternatives would provide an acceptable level of quality and safety, or (ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety." The second 10-year ISI interval code for Palo Verde, Units 1, 2, and 3, is the ASME Code, Section XI, 1992 Edition, 1992 Addenda.

The 1992 Edition, 1992 Addenda, of the ASME Code, Section XI, IWA-4120(a) states that: "Repairs shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later Editions and Addenda of the Construction Code or of Section III, either in their entirety or portions thereof, and Code Cases may be used." The construction code for the Palo Verde units is ASME Section III, 1971 Edition, and 1973 Winter Addenda, and the installation code is ASME Section III, 1974 Edition, and 1975 Winter Addenda.

Code Cases provide alternatives developed and approved by ASME or explain the intent of existing Code requirements. Regulatory Guide 1.84, "Design and Fabrication and Materials Code Case Acceptability, ASME Section III," identifies the Code Cases that have been determined by the NRC to be acceptable alternatives to applicable parts of Section III. Code Cases approved by the NRC provide an acceptable voluntary alternative to the mandatory ASME Code provisions. Therefore, 10 CFR 50.55a has been amended to incorporate this guide by reference and it states the requirements governing the use of Code Cases.

## 4.0 LICENSEE'S BASIS FOR PROPOSED ALTERNATIVE

The joint design used to attach the heater sleeve to heater sheath connection is not explicitly authorized by Section III of the ASME Code. During the construction of the Palo Verde units, Code Case 1361-2 was used for the original pressurizer assembly (heater sleeve to heater sheath fillet weld). At the time of plant construction, Regulatory Guide 1.84 listed Code Case 1361-2 as acceptable to the NRC for application in the design and construction of components and their supports in nuclear power plants. Code Case 1361-2 has been replaced by Code Case N-405-1, "Socket Welds Section III, Division 1," which is also endorsed by the current version of Regulatory Guide 1.84.

Code Case 1361-2 lists several requirements associated with this type of joint design, and the design parameter relevant to this relief request is the diametral clearance between connecting parts (cMAX) noted on Figure 1 of this Code Case. Figure 1 of Code Case 1361-2 specifies cMAX to be 0.045 inches. It should be noted that Code Case N-405-1, which is very similar to Code Case 1361-2, has essentially the same figure and also specifies that cMAX be 0.045 inches.

The licensee is requesting relief from Code Case 1361-2 because this Code Case is identified in the Updated Final Safety Analysis Report as the regulatory basis for the original pressurizer assembly (heater sleeve to heater sheath fillet weld). The proposed relief request applies to all 36 heater sleeves in each of the three units' pressurizer and is requested for the remainder of plant life at the three units.

The licensee proposes to use a maximum 0.062 inches (0.055 inches nominal) diametral clearance (cMAX) between the pressurizer heater sleeve and pressurizer heater sheath as an alternative to the Code Case requirement of 0.045 inches. The licensee states that this proposed alternative will provide an acceptable level of quality and safety and thus will meet the requirements of 10 CFR 50.55a(a)(3)(i). The licensee based this conclusion on a revised analysis of the reconfigured weld joint to demonstrate compliance with ASME Code Section III, Paragraph NB-3220 allowables for primary membrane, primary membrane plus bending, primary plus secondary, and fatigue stresses.

The original Palo Verde pressurizer stress reports evaluated the integrity of the heater sleeve-to-heater sheath fillet weld applying internal pressure and the effects of steady state temperature. The original construction for the heater sleeve was Alloy 600. The original construction for the heater sheath was either Alloy 600 or SA 213, Type 316. The materials of construction for the sleeve and heater sheath utilized in the Palo Verde pressurizers for the new design now fall into two category types as follows:

1. A replacement sleeve made out of Alloy 690 material is used in combination with Alloy 600 for the heater sheath material.

2. A replacement sleeve made out of Alloy 690 material is used in combination with SA 213, Type 316 stainless steel for the heater sheath material.

The original fillet weld connected a sleeve with an inner diameter (ID) of 1.273 inch and an outer diameter (OD) of 1.66 inch, and a heater sheath with an OD of 1.245 inch. The resulting fillet weld had a leg of 0.1875 inch with a nominal diametral clearance between the parts of 0.028 inch.

The new design replacement heater sleeve has an ID of 1.30 inch and an OD of 1.66 inch, with the same heater sheath OD of 1.245 inch. The fillet weld size connecting these parts is the same as the original construction, namely a 0.1875 inch leg. However, the maximum diametral clearance is 0.062 inch (0.055 inch nominal). The reason for the increased diametral clearance is explained in Section 2.0 of this Safety Evaluation.

The original stress reports modeled the fillet weld with a nominal design clearance between the parts of 0.028 inches using finite element analysis (FEA) techniques. The revised analysis performed in support of this relief request evaluates the same fillet weld with a maximum diametral clearance between the parts of 0.062 inches (0.055 inch nominal). The revised analyses utilize the results from the original stress report to determine acceptability of the replacement heater sleeve/sheath weld configuration. In the revised analysis, the loads and weld cross sectional properties are modified by a ratio factor that takes into account the change in diametral clearance between the parts. The licensee states that the results of the revised analysis demonstrate compliance with the ASME Code NB-3220 allowables for primary membrane, primary membrane plus bending, primary plus secondary, and fatigue stresses.

The licensee conducted a liquid penetrant examination of the subject welds for Palo Verde, Units 2 and 3, in accordance with ASME Section III, Class I requirements. The results of these non-destructive examinations were acceptable.

Code Case 1361-2 was approved in March of 1972. At that time, the ASME Code did not prepare a basis document for their Code Case assumptions as is being done currently. Thus, the basis for the diametral clearance requirement of 0.045 inch in Code Case 1361-2 is not specified. However, the licensee believes that, by maintaining the clearance between the parts relatively small, the amount of bending stresses that can be imparted on the fillet weld due to deflection of the parts is negligible. The manner in which the Palo Verde pressurizer heaters are held in place, fixed at one end by the fillet weld and supported at the other end by two consecutive heater support plates, satisfies this criterion (i.e., minimizes bending stresses at the fillet weld). The clearance between the heater and heater support plates is nominally 0.037 inch (1.282 inch minus 1.245 inch).

Based on the above discussion, the licensee concludes that the reconfigured weld joint is acceptable from a stress/fatigue perspective for remaining plant life.

## 5.0 NRC STAFF EVALUATION

Regulatory Guide 1.84 lists the ASME Section III Code Cases found to be acceptable by the staff for the design and construction of pressure-retaining ASME Section III, Class 1, components within the reactor coolant pressure boundary (Quality Group A). The staff concludes that compliance with the requirements of these Code Cases will result in a quality level that is commensurate with the importance of the safety function of the reactor coolant pressure boundary and constitutes an acceptable basis for satisfying the requirements of General Design Criterion 1 and is, therefore, acceptable. At the time of plant licensing, Code Case 1361-2 was listed in the then current Regulatory Guide 1.84 (Revision 2) as an acceptable Code Case. The current version of Regulatory Guide 1.84, Revision 32, lists Code Case N-405-1 as an acceptable Code Case. As noted in Section 4.0 of this Safety Evaluation, Code Case N-405-1 is a replacement for Code Case 1361-2.

The staff's evaluation of the licensee's proposed relief request to slightly increase the diametral clearance between the heater sleeve to heater sheath, focused on the new stresses that would be seen by the connecting joints. Code Case 1361-2 and Code Case N-405-1 both contain the same relevant requirements:

(a) The design of the joint shall be such that stresses will not exceed the limits described in NB-3220 and tabulated in Tables I-1.1 and I-1.2.

(b) A fatigue strength reduction factor of not less than 4 shall be used in the fatigue analyses of the joints.

(c) The finished welds shall be examined by a magnetic particle or by a liquid penetrant method in accordance with Section V and the Acceptance Standards of NB-5000.

The specific value of cMAX that is contained in both Code Cases is intended to maintain the clearance between the parts relatively small, limiting the amount of bending stresses that can be imparted on the fillet weld due to deflection of the parts. However, the primary assurance of safety is demonstrated by satisfying the ASME Code stress limits and by proper examination of the finished welds. Therefore, the staff's acceptance of the proposed increase in cMAX will be based on whether the three requirements stated above are met for the new design.

ASME Section III, NB-3220, specifies loading conditions that need to be considered and specifies the stress limits that must be satisfied for these load conditions. The specific stresses to be considered for the sleeve-to-sheath weld are general primary stress, primary membrane-plus-bending stress, primary-plus-secondary stress, and primary-plus-secondary-plus-peak stress, which is used in the fatigue evaluation. The licensee accounted for the increased cMAX by reducing the weld throat area used to calculate the stresses. The staff concludes that this analysis was satisfactorily performed, and that all resultant stresses were within the acceptance criteria required by NB-3220. Therefore, the staff finds that requirement (a) has been satisfied.

The fatigue strength reduction factor used in the licensee's analysis was set at 5, in compliance with requirement (b) above. The resulting cumulative usage factor, considering a 60-year plant life, was significantly less than the allowable value of 1.0. Therefore, the staff finds that requirement (b) has been satisfied.

The licensee examined the finished welds for both Units 2 and 3 by a liquid penetrant method in accordance with ASME Section III, Class 1 requirements (which are located in Section V and the Acceptance Standards of NB-5000 of this Code), and will examine the Unit 1 finished welds after the Unit 1 repair activities are conducted in the fall 2005. Therefore, the staff finds that requirement (c) has been satisfied.

Based on the above discussion showing compliance with the three primary requirements of both Code Case 1361-2 and its replacement, Code Case N-405-1, the NRC staff finds acceptable the proposed alternative value of cMAX. Specifically, the staff accepts the licensee's proposal to use a maximum 0.062 inches (0.055 inches nominal) diametral clearance (cMAX) between the pressurizer heater sleeve and pressurizer heater sheath as an alternate to the Code Case requirement of 0.045 inches.

## 6.0 CONCLUSION

Based on the above evaluation, the staff concludes that the proposed alternative value of cMAX, as discussed in the licensee's request for relief, provides an acceptable level of quality and safety. Therefore, the proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(i) for the duration of plant life for the Palo Verde Nuclear Generating Station, Units 1, 2, and 3.

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.

Contributor: J. Fair

Date: November 19, 2004

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