JANUARY 29, 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 2 AND 3 - REVIEW OF STEAM GENERATOR TUBE INSPECTION SUMMARY REPORTS (TAC NOS. MB6931 AND MB6930)

Dear Mr. Overbeck:

The staff has completed its review of the reports submitted by Arizona Public Service (APS) summarizing the steam generator tube inspections performed during the 2001 Palo Verde Nuclear Generating Station (PVNGS) Unit 3 refueling outage and the 2002 PVNGS Unit 2 refueling outage. These reports were provided in the APS letters dated October 31, 2001, and February 12, 2002, for PVNGS Unit 3 (reviewed under TAC No. MB6930) and April 12 and September 11, 2002, for PVNGS Unit 2 (reviewed under TAC No. MB6931).

As discussed in the enclosed safety evaluation, the staff concludes that APS has provided the information required by the plants' technical specifications. In addition, the staff did not identify any technical issues that warranted follow-up action at this time.

Sincerely,

/RA/

Mel B. Fields, Senior Project Manager, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

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

Enclosure: Safety Evaluation

cc w/encl: See next page

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Mr. Gregg R. Overbeck
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SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 2 AND 3 - REVIEW OF STEAM GENERATOR TUBE INSPECTION SUMMARY REPORTS (TAC NOS. MB6931 AND MB6930)

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As discussed in the enclosed safety evaluation, the staff concludes that APS has provided the information required by the plants technical specifications. In addition, the staff did not identify any technical issues that warranted follow-up action at this time.

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Mel B. Fields, Senior Project Manager, Section 2
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

OF STEAM GENERATOR TUBE INSPECTION REPORTS

ARIZONA PUBLIC SERVICE COMPANY, ET AL.

PALO VERDE NUCLEAR GENERATING STATION, UNITS 2 AND 3

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

1.0 INTRODUCTION

Arizona Public Service (APS), the licensee for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3 submitted reports summarizing the steam generator (SG) tube inspections performed during the 2001 PVNGS Unit 3 refueling outage (in letters dated October 31, 2001 and February 12, 2002) and the 2002 PVNGS Unit 2 refueling outage (in letters dated April 12, 2002 and September 11, 2002). A conference call with APS was held on August 7, 2003, to address the staff's request for additional information (RAIs) related to these summary reports. The conference call summary is Attachment 1 to this safety evaluation (SE). The staff's RAIs are contained in Attachment 2 to this SE.

During these refueling outages, PVNGS Units 2 and 3 each had two Combustion Engineering Model 80 SGs. New SGs were installed in Unit 2 during the 2003 refueling outage. There are 11012 mill annealed Alloy 600 tubes in each Model 80 SG. The tubes have an outside diameter of 3/4-inch, a wall thickness of 0.042-inch and are supported at various locations by ferritic stainless steel eggcrate tube supports, diagonal bars and/or vertical straps.

2.0 REGULATORY EVALUATION

PVNGS Unit 3 2001 Refueling Outage

During the 2001 inspection, the licensee performed tube inspections in both Unit 3 SGs. The scope of the inspections and results are discussed in the letters provided by the licensee. The licensee plugged 51 tubes in SG 31 and 84 tubes in SG 32. Tube degradation mechanisms affecting the Unit 3 SGs consisted of wear, circumferential and axial outside diameter stress corrosion cracking (ODSCC), circumferential and axial primary water stress corrosion cracking (PWSCC), and volumetric indications.

The staff requested additional information regarding the "non-wear" volumetric indications, the dent inspection sampling program, and a breakdown of the depths of the wear indications with through-wall depths greater than 40 percent. The licensee's response is outlined in the conference call summary (Attachment 1).

PVNGS Unit 2 2002 Refueling Outage

During the 2002 inspection, the licensee performed tube inspections in both Unit 2 SGs. The scope of the inspections and results are discussed in the material supplied by the licensee. The licensee plugged 127 tubes in SG 21 and 207 tubes in SG 22. Tube degradation mechanisms affecting the Unit 2 SGs consisted of wear, circumferential and axial ODSCC, circumferential and axial PWSCC, and volumetric indications. The Unit 2 SGs were replaced during the Fall 2003 Unit 2 Outage.

The licensee identified one indication of axial PWSCC at a dent in the 22 SG. The flaw was located at the 02H hot leg tube support. No indication of PWSCC at dents had been identified in either Unit 1 or Unit 3 to date. Additional information regarding this PWSCC flaw is contained in the conference call summary.

The staff requested additional information (Attachment 2) regarding the "non-wear" volumetric indications, the PWSCC flaw, the inspection scope "expansion" due to the confirmation rate of distorted support indications (DSI) confirmed with a rotating coil probe, and a breakdown of the depths of the wear indications with through-wall depths greater than 40 percent. The licensee's response is outlined in the conference call summary. The staff made an observation during the conference call related to the dent inspection scope expansion plans. This observation is summarized below in the conclusion section.

Conclusions

The staff made one observation during the course of the phone call related to the dent inspection sample criteria initiated at Unit 2 and carried forward to Units 1 and 3. The licensee's dent inspection scope expansion was primarily based on dent location and temperature (i.e., the expansion increased the inspection scope of dents between the top-of-the-tubesheet on the hot leg to the 3rd or 5th hot leg support) rather than on dent size (i.e., voltage). The staff suggested that during future inspections, the licensee consider incorporating the dent size into the dent inspection scope expansion in addition to dent location (i.e., temperature). The staff suggestion was based upon industry experience indicating that dent size can play an equally important role in the initiation of PWSCC as that of temperature. Therefore, screening dents only in the warmest section of the SG tube may preclude early identification of PWSCC initiating from large dents in other regions of the SG tube.

Based upon the information contained in the SG Tube Inspection Summary Reports and the information provided during the conference call, the staff concluded the licensee adequately responded to the request for additional information and submitted the information required by their technical specifications. The staff does not require additional follow-up at this time.

Principal Contributor: Martin Murphy

Date: January 29, 2004

CONFERENCE CALL SUMMARY

BETWEEN ARIZONA PUBLIC SERVICE AND THE NRC STAFF

ON AUGUST 7, 2003

A conference call was held on August 7, 2003 with Arizona Public Service (APS), the licensee for Palo Verde Nuclear Generating Station (PVNGS), Units 2 and 3 to discuss the requests for additional information (RAI) resulting from the staff's review of the 2001 Unit 3 Steam Generator Tube Inspection Summary Report and the 2002 Unit 2 Steam Generator Tube Inspection Summary Report. A draft of this summary was shared with the licensee to ensure its accuracy. The staff's five RAI questions are contained in Attachment 2.

Response to RAI #1

The staff requested that APS provide information regarding the source and basis for dispositioning volumetric indications identified in PVNGS Units 2 and 3. The licensee indicated that they initially use the single volumetric indication/multiple volumetric indication (SVI/MVI) flaw designations to identify many indications which are subsequently examined with a rotating probe. For example, the SVI/MVI flaw designations may be used for indications which are later determined to be volumetric corrosion (e.g., intergranular attack [IGA]), wear at support plates, wear due to loose parts tube-to-tube wear (TTW), pit-like indications (not corrosion related), manufacturing burnish marks (MBM), and volumetric indications initiated from the inside diameter of the tube (manufacturing related). Approximately 70 percent of the SVI calls result from TTW which occurs in the upper tube bundle region. The licensee indicated that these indications are generally small, below the plugging limit and are left in service if less than the plugging limit. The licensee has detected a number of small pit-like indications which are typically traceable back to the steam generator (SG) baseline inspections. The licensee believes that these indications are the result of the tube manufacturing process. The licensee inspects these indications every outage and identifies these indications as "non-wear" volumetric indications. If the inspection results indicate a change in the indication signal, it is plugged. Lastly, the licensee has identified volumetric indications that initiate from the inside diameter of the tube and are believed to be related to manufacturing. These are monitored for change.

The licensee provided the following breakdown of volumetric indications requiring plugging and the apparent cause:

Tubes Plugged for Volumetric Indications			
Unit 2		Unit 3	
SG 21	SG 22	SG 31	SG 32
None	(1) SVI due to a change from the baseline	(1) SVI due to a change from the baseline	(5) for TTW
	(2) for TTW	(1) for IGA	(2) SVI due to a change from the baseline
	(2) for possible IGA in the ARC region	(1) VID (volumetric inner diameter) potential to mask degradation	
	(1) MBM - due to its potential to mask degradation	(2) for TTW	

Response to RAI #2

The staff requested additional information regarding the sample inspection of dents performed during the 2001 inspection at Unit 3. The licensee corrected the staff's RAI by indicating that the majority of the dents in Unit 3 are located in the horizontal section of the square bends in the upper tube bundle, not in the lower tube support plates (TSPs) as was stated in the staff's RAI. The licensee also indicated that the SGs are not susceptible to "evolutionary denting" (tube denting resulting from the buildup of corrosion products at the intersection of the tube and tube support plates) because the Unit 3 SGs contain a stainless steel eggcrate design. The licensee did not detect any degradation of the dents during the Fall 2001 SG inspections. During the subsequent inspection in the Spring 2003, the licensee inspected all dents from the top-of-the-tubesheet (TTS) on the hot leg side up through the 5th eggcrate on the hot leg side. The licensee indicated they use a 2 volt screening criteria in the straight vertical sections of tubing and a 4 volt screening criteria in the horizontal and square bend sections of tubing for their dent examination program. PWSCC was not detected as a result of the dent inspection in Spring 2003. The following is a list of the dents identified in Unit 3 based on the screening criteria:

Unit 3 Dents

	<2 volts	2 - 5 volts	>5 volts
SG 31	2 (2)	618 (120)	655 (164)
SG 32	0	729 (116)	845 (168)
(#) Indicates dents inspected with a rotating coil probe in 2003			

Response to RAI #3

The staff requested additional information regarding a PWSCC flaw at a dent identified in Unit 2 during the 2002 SG inspection and the resulting sample expansion. The licensee indicated that only one instance of PWSCC has been identified at a dent in Unit 2. No indications of PWSCC from dents have been identified in either Unit 1 or 3. The licensee indicated that in Unit 2, two small dents were identified at the 02H support (12.5 volts and 6.2 volts measure by bobbin probe) and were within the eggcrate/tube intersection region. The axial PWSCC indication was identified in the 12.5 volt dent. As a result of a PWSCC indication at a dent in Unit 2 the licensee indicated that they revised the scope of their dent sampling program in 2002 to include all dents greater than 2 volts located between the TTS on the hot leg to the 3rd hot leg support. Following the Unit 2 outage the licensee further evaluated this issue, updated the site degradation assessment and concluded that future SG inspections at Units 1 and 3 would include an inspection of 100 percent of all dents greater than 2 volts located between the TTS on the hot leg to the 5th hot leg support in all three SGs in each unit. No indications of PWSCC at dents has been identified in either Unit 1 or Unit 3 to date. The expanded sample inspection plan was not implemented at Unit 2 because the SGs were replaced during the Fall 2003 refueling outage.

The staff made one observation during the course of the phone call related to the dent inspection sample criteria initiated at Unit 2 and carried forward to Units 1 and 3. The licensee's dent inspection scope expansion was primarily based on dent location and temperature (i.e., the expansion increased the inspection scope of dents between the TTS on the hot leg to the 3rd or 5th hot leg support) rather than on dent size (i.e., voltage). The staff suggested that during future inspections, the licensee should consider incorporating the dent size into the dent inspection scope expansion in addition to dent location (i.e., temperature). The staff suggestion was based upon industry experience indicating that dent size can play an equally important role in the initiation of PWSCC as that of temperature. Therefore, screening dents only in the warmest section of the SG tube may preclude early identification of PWSCC initiating from large dents in other regions of the SG tube.

Response to RAI #4

The Unit 2 SG tube inspection summary report discussed an inspection scope expansion related to rotating coil probe examination of bobbin DSIs (distorted support indications) identified by either the primary or secondary analyst. The staff requested additional information regarding the details that led to this expansion.

The licensee indicated that typically, a resolution analyst would make the decision as to whether a bobbin DSI, called by either the primary or secondary analyst, would require an inspection with a rotating coil probe. During the outage prior to 2002, the subsequent rotating coil inspections did not confirm the presence of any flaw indications. During the Unit 2 2002 refueling outage, the licensee noted a rotating coil confirmation rate of bobbin DSIs of approximately 7 percent in both SGs (approximately 57 axial flaws were identified based on the rotating coil examination). Based on this atypical confirmation rate, as well as past industry experience, the licensee "expanded" the inspection plan to automatically require a rotating coil examination of any DSI called by either the primary or secondary analyst. As a result 92 additional DSI indications were examined using a rotating coil probe and 1 small axial indication

was confirmed. The licensee stated this expansion criteria philosophy would be carried over to the other two PVNGS units in subsequent outages.

Response to RAI #5

The PVNGS Units 2 and 3 Steam Generator Tube Inspection Summary Reports contain a summary table of wear indications. The staff requested the licensee to provide a breakdown of the indications in the 40-100 percent category. The licensee provided the information in the table below and stated that all wear indications were well below the structural limit as well as the in-situ pressure test criteria.

40-100% Wear Indications

Unit 2		Unit 3	
SG 21	SG 22	SG 31	SG 32
5	22	2	4
42% Maximum depth	48% Maximum depth	41% Maximum depth	56% Maximum depth

PALO VERDE NUCLEAR GENERATING STATION, UNITS 2 AND 3

2002 AND 2001 SG TUBE INSPECTION REPORTS

REQUEST FOR CLARIFICATIONS PROVIDED TO ARIZONA PUBLIC SERVICE

Clarification is requested on the following issues:

1. Table 2 in Special Report 3-SR-2001-001-01 indicates that volumetric indications were identified in each steam generator (SG) (80 tubes in SG 31 and 50 tubes in SG 32), and only 12 of these tubes were plugged during the Fall 2001 refueling outage. Similarly, Table 2 in Special Report 2-SR-2002-001-01 indicates that volumetric indications were identified in each SG (45 tubes in SG 21 and 50 tubes in SG 22), and only 6 of these tubes were plugged during the Spring 2002 refueling outage. Special Report 2-SR-2002-001-01 also states that these indications are "non-wear volumetric indications."

   For both units, discuss the source of these indications, the inspections performed (e.g., bobbin, rotating probe, etc.), and the basis for dispositioning the indications. Include both the basis for leaving these indications in service as well as the reason a small number of the tubes with these indications were plugged.

2. The staff would like to obtain a more detailed understanding of the sample inspection of dents that was performed in the Palo Verde Nuclear Generating Station (PVNGS) Unit 3 SGs during the Fall 2001 inspection. It appears that details on this topic are not described in Supplement 1 to Special Report 3-SR-2001-001-01. The staff did participate in a conference call with the licensee during the Fall 2001 refueling outage to discuss the ongoing SG tube inspections. At that time, the licensee indicated that the dents that were inspected with a rotating probe were located in the first through third tube support plate (TSP) on the hot leg (HL) side. At PVNGS 3, the largest dents and the majority of the dents are located in the lower TSPs. Provide a summary of the number of dents present in the PVNGS 3 SGs, a summary of the range of dent sizes in terms of voltage (e.g., X dents 0 – 2 volts, Y dents 2 – 5 volts, and Z dents greater than 5 volts), and a more detailed scope of the dents that were inspected during the Fall 2001 outage (e.g., X dents, Y percent, in the 0 – 2 volt category, etc.).

3. The summary of expansions, for U2R10, in Special Report 2-SR-2002-001-01 indicates that an expansion occurred in SG 21 and 22 for rotating coil (RC) examination of dent locations from TSH through 03H. During the conference calls held with the licensee regarding this refueling outage (April 3, 2002 and December 6, 2002, [ADAMS Accession No. ML021580390]), the licensee provided details regarding an expansion resulting from an axial PWSCC flaw at a dent in tube row 69 column 124. The staff assumes that expansion #2 in the expansion summary table of Special Report 2-SR-2002-001-01 and that discussed in the conference calls are the same. Provide additional information regarding the size of the dent the primary water stress corrosion cracking flaw was identified in, the details of the expansion criteria (i.e., scope, dent size, etc.) and the basis for the expansion criteria.

4. The summary of expansions, for PVNGS Unit 2 Refueling Outage 10, in Special Report 2-SR-2002-001-01 indicates that an expansion occurred in SG 21 and 22 for RC examination of distorted support indications (DSI) identified by primary or secondary analysts. Section 4 of the report indicates that the expansion was based on the number of bobbin DSIs that confirmed with RC results and that the expansion required RC examination of all hot leg DSI indications identified by either the primary or secondary analyst. Provide additional information regarding the change which led to this expansion and additional details regarding the expansion. How has this impacted the inspection scope (analysis process) in the other two PVNGS units?

5. Table 2 of Special Report 2-SR-2002-001-01 indicates that there were 27 wear indications in SG 21 and 22 within the 40-100 percent category. Provide a breakdown of the depth of the indication within this category. Provide similar details on the wear indications in Table 2 of Special Report 3-SR-2001-001-01.