November 3, 2006

Mr. James M. Levine
Executive Vice President, Generation
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. 32 RE: RISK-INFORMED INSERVICE INSPECTION PROGRAM (TAC NOS. MC9627, MC9628, AND MC9629)

Dear Mr. Levine:

By letter dated January 16, 2006, as supplemented by letters dated June 10, August 30, and September 28, 2006, Arizona Public Service Company (the licensee) submitted Relief Request No. 32, requesting approval of a risk-informed inservice inspection (RI-ISI) alternative to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), ection XI, requirements at Palo Verde Nuclear Generating Station (Palo Verde), Units 1, 2, and 3. The request for relief would authorize the use of the proposed RI-ISI program for ASME Code Class 1 and Class 2 piping, Examination Categories B-F, B-J, C-F-1, and C-F-2 piping welds.

Based on the enclosed safety evaluation, the Nuclear Regulatory Commission 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 licensee's alternative repair as stated in Relief Request No. 32, is authorized for Palo Verde, Units 1, 2, and 3 for the third period of the second 10-year inservice inspection interval.

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/

David Terao, 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

cc w/encl: See next page

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Executive Vice President, Generation
Arizona Public Service Company
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SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 - RELIEF REQUEST NO. 32 RE: RISK-INFORMED INSERVICE INSPECTION PROGRAM (TAC NOS. MC9627, MC9628, AND MC9629)

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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. 32

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 January 16, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML060310511, Reference 1), as supplemented by letters dated June 10 (ADAMS Accession No. ML061710461, Reference 2), August 30 (ADAMS Accession No. ML062490536, Reference 17), and September 28, 2006 (ADAMS Accession No. ML062790182, Reference 16), Arizona Public Service (APS or the licensee) submitted Relief Request No. 32, proposing a risk-informed inservice inspection (RI-ISI) program as an alternative to a portion of its current ISI program for the Palo Verde Nuclear Generating Station (Palo Verde), Units 1, 2, and 3. The scope of the RI-ISI program will be limited only to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Class 1 and Class 2 piping, Examination Categories B-F, B-J, C-F-1, and C-F-2 piping welds.

The licensee's RI-ISI program was developed in accordance with the methodology contained in the Electric Power Research Institute (EPRI) Topical Report (TR)-112657, Revision B-A (Reference 3) (the topical report), which was previously reviewed and approved by the Nuclear Regulatory Commission (NRC) staff. The licensee proposed the RI-ISI program as an alternative to the requirements in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(a)(3)(i). The licensee requested implementation of this alternative for the third period of the second 10-year ISI interval at Palo Verde, Units 1, 2, and 3. The second 10-year ISI intervals are set to end for Palo Verde, Units 1, 2, and 3 on July 17, 2008, March 17, 2007, and January 10, 2008, respectively.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements set forth in the ASME Code to the extent practical within the limitations of design, geometry, and materials of construction of the components. Paragraph 50.55a(g) of 10 CFR also states that 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 addenda, except where specific written relief has been granted by the NRC. The objective of the ISI program, as described in Section XI of the ASME Code and applicable addenda, is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary of these components that may impact plant safety.

The regulations also require, during the first 10-year ISI interval and during subsequent intervals, that the licensee's ISI program complies with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference into 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. Palo Verde, Units 1, 2, and 3 are in the third period of the second 10-year ISI interval. The applicable edition of Section XI of the ASME Code for Palo Verde, Units 1, 2, and 3 for this 10-year ISI interval is the 1992 Edition with the 1992 Addenda.

According to 10 CFR 50.55a(a)(3), the NRC may authorize alternatives to the requirements of 10 CFR 50.55a(g), if an applicant demonstrates that the proposed alternatives would provide an acceptable level of quality and safety, or that the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis" (Reference 6), defines the following safety principles that should be met in an acceptable RI-ISI program:

(1) The proposed change meets current regulations unless it is explicitly related to a requested exemption.

(2) The proposed change is consistent with the defense-in-depth philosophy.

(3) The proposed change maintains sufficient safety margins.

(4) When proposed changes result in an increase in risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

(5) The impact of the proposed change should be monitored using performance measurement strategies.

RG 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping" (Reference 7), describes methods acceptable to the NRC staff for integrating insights from probabilistic risk assessment (PRA) techniques with traditional engineering analyses into ISI programs for piping, and addresses risk-informed approaches that are consistent with the basic elements identified in RG 1.174.

The licensee has proposed to use an RI-ISI program for ASME Code Class 1 and Class 2 piping (Examination Categories B-F, B-J, C-F-1, and C-F-2 piping welds), as an alternative to the ASME Code, Section XI, requirements. The licensee states that this proposed program was developed using the RI-ISI methodology described in the topical report. The NRC staff's safety evaluation report (SER) of October 28, 1999, approving the methodology described in the topical report, concluded that this methodology conforms to the guidance provided in RGs 1.174 and 1.178, and that no significant risk increase should be expected from the changes to the ISI program resulting from applying the methodology. The transmittal letter for the topical report's SER, of the same date, stated that an RI-ISI program as described in the topical report utilizes a sound technical approach and will provide an acceptable level of quality and safety. It also stated that, pursuant to 10 CFR 50.55a, any RI-ISI program meeting the requirements of the topical report provides an acceptable alternative to the piping ISI requirements with regard to (1) the number of locations, (2) the locations of inspections, and (3) the methods of inspection.

Since the issuance of the topical report's SER, several instances of primary water stress corrosion cracking (PWSCC) of alloy 82/182 dissimilar metal welds have occurred in the industry. These circumstances have prompted the NRC to send a letter (Reference 4) to the Chairman of the ASME Subcommittee on Nuclear Inservice Inspection, stating that the operating experience with leakage and flaws caused by PWSCC supports a position that current ASME Code inspection requirements are not sufficient for managing PWSCC-susceptible butt welds in the reactor coolant pressure boundary. This letter represents a departure from the NRC staff's conclusions in the topical report's SER.

3.0 TECHNICAL EVALUATION

Pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff has reviewed and evaluated the licensee's proposed RI-ISI program based on guidance and acceptance criteria provided in the following documents:

- RGs 1.174 and 1.178
- NRC NUREG-0800, Chapter 3.9.8 (Reference 8)
- EPRI TR-112657
- NRC SER for EPRI TR-112657
- NRC Letter to the Chairman of the ASME Subcommittee on Nuclear Inservice Inspection

3.1 Proposed Changes to the ISI Program

The scope of the licensee's proposed changes to the licensee's ISI program is limited to ASME Code Class 1 and Class 2 piping welds for the following Examination Categories: B-F for pressure retaining dissimilar metal welds in vessel nozzles, B-J for pressure-retaining welds in piping, C-F-1 for pressure-retaining welds in austenitic stainless steel or high-alloy piping, and C-F-2 for pressure-retaining welds in carbon or low-alloy steel piping. The RI-ISI program is proposed as an alternative to the existing ISI requirements of the ASME Code, Section XI.

The end result of the program changes is that the number and locations of nondestructive examination (NDE) inspections based on ASME Code, Section XI, requirements will be replaced by the number and locations of these inspections based on the RI-ISI guidelines. The ASME Code provides, in part, that for each successive 10-year ISI interval, 100 percent of Category B-F welds and 25 percent of Category B-J welds for the ASME Code Class 1 nonexempt piping be selected for volumetric and/or surface examination based on existing stress analyses and cumulative usage factors. The proposed RI-ISI program for Palo Verde, Unit 1, selects 61 of 596 Class 1 piping welds for NDE and 42 of 2,192 Class 2 piping welds for

NDE. The proposed RI-ISI program for Palo Verde, Unit 2, selects 61 of 573 Class 1 piping welds for NDE and 47 of 2,221 Class 2 piping welds for NDE. The proposed RI-ISI program for Palo Verde, Unit 3, selects 61 of 570 welds for NDE and 41 of 2,172 Class 2 piping welds for NDE. All piping components, regardless of risk classification, will continue to receive ASME Code-required pressure and leak testing, as part of the current ASME Code, Section XI, program. Visual examinations (VT-2) are scheduled in accordance with the Palo Verde pressure and leak test program, which remains unaffected by the proposed RI-ISI program. These results are consistent with the concept that, by focusing inspections on the most safety significant welds, the number of inspections can be reduced while at the same time maintaining protection of public health and safety.

The RI-ISI program subsumes several plant-augmented inspection programs. These include:

- Inspection program implemented in response to NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems."

- Inspection program implemented in response to NRC Bulletin 88-11, "Pressurizer Surge Line Stratification."

- Inspection program implemented in response to NRC Office of Inspection and Enforcement (IE) Bulletin 79-13, "Cracking in Feedwater System Piping."

- Inspection program implemented in response to NRC Information Notice 97-19, "Safety Injection System Weld Flaw at Sequoyah Nuclear Power Plant, Unit 2."

- Inspection program implemented in response to NRC IE Bulletin 79-17, "Pipe Cracks in Stagnant Borated Water Systems at PWR [Pressurized-Water Reactor] Plants."

Augmented inspection programs not affected by the RI-ISI program include the inspection program for high-energy line breaks (HELB) outside containment, implemented in response to Updated Final Safety Analysis Report (UFSAR), Section 6.6.8, "Augmented Inservice Inspection to Protect against Postulated Piping Failures," and the inspection program for flow-accelerated corrosion (FAC) per NRC Generic Letter 89-08.

In Reference 16, the licensee states that it will implement MRP-139, "Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline" (Reference 13), as an augmented inspection program, for the inspection and management of PWSCC-susceptible dissimilar metal welds and will supplement the RI-ISI program selection process. The RI-ISI program will not be used to eliminate any MRP-139 inspections.

Also, in Reference 17, the licensee states that it is keeping the dissimilar metal weld exam scope separate from the RI-ISI exam scope. It provides an example that if a PWSCC-susceptible weld is also selected for RI-ISI, it will receive the appropriate examination based on the topical report's requirements as well as an exam for PWSCC in accordance with Reference 13. Further evaluation of this augmented inspection program is found in Sections 3.2.1 and 3.2.4.2 of this safety evaluation (SE).

3.2 Engineering Analysis

In accordance with the guidance provided in RGs 1.174 and 1.178, the licensee provides the results of an engineering analysis of the proposed changes, using a combination of traditional engineering analysis and supporting insights from the PRA. The licensee performed an evaluation to determine susceptibility of components (i.e., a piping weld) to a particular degradation mechanism that may be a precursor to leak or rupture, and then performed an independent assessment of the consequence of a failure at that location. The results of this analysis ensure that the proposed changes are consistent with the principles of defense-in-depth because the EPRI TR-112657 methodology provides that the population of welds with high consequences following failure will always have some weld locations inspected regardless of the failure potential. In the submittal, the licensee discusses a deviation from this particular provision, which will be evaluated in more detail in Section 3.2.4.2 of this SE. No changes to the evaluation of design-basis accidents in the UFSAR are being made by the RI-ISI process. Therefore, the NRC staff agrees that sufficient safety margins will be maintained.

3.2.1 Failure Potential Assessment

Piping systems within the scope of the RI-ISI program were divided into piping segments. Pipe segments are defined as lengths of pipe that are exposed to the same degradation mechanisms and whose failure (anywhere within the pipe segment) would lead to the same consequence. That is, some lengths of pipe whose failure would lead to the same consequence may be split into two or more segments when two or more regions are exposed to different degradation mechanisms. The licensee's submittal states that the failure potential assessment, summarized in Table 3.3 of the submittal, was accomplished utilizing industry failure history, plant-specific failure history, and other relevant information using the guidance provided in the topical report.

Section 3 of the licensee's submittal describes a proposed deviation from the EPRI RI-ISI methodology for assessing the potential for the thermal stratification, cycling, and striping (TASCS) degradation mechanism. The licensee indicates that the proposed methodology for assessing TASCS at Palo Verde follows the guidance provided in Reference 9 and is consistent with the guidance in Reference 14.

In the proposed deviation, the licensee provides additional considerations for determining the potential for TASCS, including piping configuration and potential turbulence, low-flow conditions, valve leakage, and heat transfer due to convection. The NRC staff finds that these considerations are appropriate for determining the potential for TASCS. The licensee further states in Reference 17 that it would incorporate applicable NRC-approved EPRI MRP final guidance on thermal fatigue management into its RI-ISI program for assessing TASCS. The NRC staff finds this regulatory commitment acceptable.

In Tables 3.3-1, 3.3-2, and 3.3-3 of the submittal, the safety injection system is not identified as susceptible to thermal transients (TT) but is susceptible to TASCS and also to intergranular stress-corrosion cracking. The chemical and volume-control system is not identified as susceptible to any sort of stress-corrosion cracking, but is susceptible to TT and TASCS. The licensee also indicates that the reactor coolant system is susceptible to PWSCC, as well as to TT and TASCS.

The NRC staff observed in Tables 5-2-1, 5-2-2, and 5-2-3 of the submittal that a number of dissimilar metal welds in the reactor coolant system did not include PWSCC as a degradation mechanism. In Reference 2, the licensee states that, per EPRI TR-112657, the threshold temperature for PWSCC to occur is 570 degrees Fahrenheit (°F), and thus the licensee did not include PWSCC as a degradation mechanism for those nickel-based alloy dissimilar metal welds that operate at temperatures below 570 °F. The NRC staff does not agree that 570 °F is a threshold, in light of recent examples such as Bottom Mounted Instrument nozzle PWSCC at South Texas Project and cold-leg PWSCC at Davis Besse. In response to NRC staff comments, the licensee states (Reference 16) that it will implement MRP-139 as an augmented inspection program, for the inspection and management of PWSCC-susceptible dissimilar metal welds and will supplement the RI-ISI program selection process. Details on the selection of affected welds are provided in Section 3.2.4.2 of this SE.

Based on its independent review, the NRC staff concludes that the licensee has met the Standard Review Plan (SRP) 3.9.8 guidelines by confirming that a systematic process was used to identify the component's (i.e., pipe segments) susceptibility to common degradation mechanisms, and by placing these degradation mechanisms into the appropriate degradation categories with respect to their potential to result in a postulated leak or rupture.

3.2.2 Consequence Evaluation

The licensee states that the consequences of pressure boundary failures were evaluated and ranked based on their impact on core damage and containment performance (i.e. isolation, bypass and large early release). Also, the licensee indicates that it considered the impact on the above measures due to both direct and indirect effects, and that the consequence evaluation includes an assessment of shutdown and external events. The licensee does not report any deviations from the approved consequence evaluation guidance provided in the topical report. Therefore, the NRC staff considers the consequence analysis performed by the licensee for this application to be acceptable.

3.2.3 Probabilistic Risk Assessment

As stated in its submittal, the licensee used Revision 13 of the Palo Verde PRA model, as documented in APS Engineering Study 13-NS-C029, "Interim PRA Change Documentation," to evaluate the consequences of pipe ruptures. In Reference 2, the licensee, in response to Combustion Engineering Owners' Group (CEOG) Fact and Observation (F&O) AS-02, indicates that the current PRA does not include internal flooding events; rather, the flooding analysis was performed as part of the RI-ISI evaluation. Both the licensee's submittal and Reference 2 (CEOG F&O AS-02) indicate that the current PRA model accounts for fire risk. In the submittal, the licensee states that the base core damage frequency (CDF) estimated from this PRA model, including the contribution from fire initiators, is 1.64E-05/year, and the base large early release frequency (LERF) estimated is 1.74E-06/year. The licensee states in the submittal that it maintains a database to track potential update issues that may impact the PRA model or its documentation, and that it has evaluated each current issue identified in the database for potential impact on the RI-ISI analysis. This evaluation concluded that only one outstanding issue, where a Steam Line Break Level 1 consequence sequence was incorrectly assigned to a Level 2 event tree, would impact the results of the proposed RI-ISI analysis. The licensee states that the resolution of this issue was incorporated into the Revision 13 model that was used for the Palo Verde RI-ISI analysis.

3.2.3.1 NRC Staff/Industry Review of the PRA

The original Palo Verde Individual Plant Examination (IPE) was submitted to the NRC in April 1992. The IPE estimated a CDF of 9.0E-05/year. The NRC staff evaluation report of the IPE (Reference 15) concluded that the licensee met the intent of Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities." The NRC staff evaluation report did not identify any significant weaknesses with, or areas for improvement for, the IPE. The NRC staff evaluation report also noted that a plant modification was in progress that would further reduce CDF to 6.3E-05/year.

The licensee notes that the Palo Verde PRA has undergone numerous independent reviews by industry representatives, and that all found the Palo Verde PRA model to be acceptable. A brief summary is provided below:

Independent Reviewer	Scope
CEOG Peer Assessment - November 1999.	Original Industry Peer Assessment of the Internal Events at Palo Verde PRA model.
ERIN Engineering and Research - December 2000.	A review of the resolution of the issues identified in the CEOG Peer Assessment.
RELCON AB (Suppliers of the Risk Spectrum PRA Software) - August 2001.	A review of the application of the Risk Spectrum PRA software to the Palo Verde PRA model.

The licensee indicates in the submittal that potential weaknesses identified during these reviews are not considered significant and were either incorporated into the model or into the tracking databases and were considered for this application, as discussed above. In Reference 2, the licensee provides all of the A and B level F&O sheets from the CEOG Peer Assessment (35 in total) as well as an additional four F&O sheets from the ERIN Engineering and Research review. (The licensee also states in Reference 2 that the RELCON AB review resulted in no F&Os.) In addition, the licensee notes that its response to each of the above F&Os reflects the status of resolution at the time of the performance of the RI-ISI analysis, and that subsequent to this analysis, there was another PRA update (identified in Reference 17 as Revision 14 to the PRA model), focusing primarily on failure rates/probabilities, common cause methodology and data. Certain outstanding F&Os at the time of the RI-ISI analysis, such as DA-02, DA-04, DA-06, and DA-08, were resolved by this Revision 14 to the PRA model. The licensee considers that these outstanding F&Os did not substantially affect the results of the analysis. In Reference 17, the licensee provides additional information to justify this conclusion, indicating that work to support the RI-ISI program update for the next (third) 10-year interval has been started, and that Revision 14 of the PRA model was used to calculate the new segment consequence values. The licensee indicates that a comparison of the new segment consequence values to the current segment consequence values resulted in one segment changing from a Low to Medium consequence value. However, this did not cause any of the elements therein to change overall risk ranking (i.e., Low to Medium, or Medium to High), supporting the licensee's contention that these outstanding F&Os at the time of the original RI-ISI analysis did not substantially affect the results of this analysis.

Based on its independent review, the NRC staff concludes that the licensee has adequately demonstrated that significant comments from the industry peer reviews (there were no significant comments from the NRC staff's review of the IPE) of the Palo Verde, Units 1, 2, and 3 PRA will not measurably affect this RI-ISI application. The NRC staff did not directly review the current PRA model (Revision 13) to assess the accuracy of the quantitative estimates. However, the NRC staff recognizes that the quantitative results of the PRA model are used as order of magnitude estimates to support the assignment of segments into three broad-consequence categories. Inaccuracies in the models or in assumptions large enough to invalidate the broad categorizations developed to support the RI-ISI should have been identified during the NRC staff's review of the IPE, and by the licensee's model update control program, which included the peer review/certification of the PRA model. The NRC staff notes that minor errors or inappropriate assumptions will affect only the consequence categorization of a few segments and will not invalidate the general results or conclusions.

3.2.3.2 Change in Risk

Pursuant to Section 3.7 of the topical report, the licensee evaluated the change in risk expected from replacing the current ISI program with the RI-ISI program. The calculations estimated the change in risk associated with removing locations and adding locations to the inspection program.

The licensee quantitatively evaluated the expected change in risk using the "Simplified Risk Quantification Method" described in Section 3.7 of the topical report. For high-consequence category segments, the licensee used the conditional core damage probability (CCDP) and conditional large early release probability (CLERP) based on the highest estimated CCDP and CLERP. For medium-consequence category segments, bounding estimates of CCDP and CLERP were used. The licensee estimated the change in risk using bounding pipe failure rates from the EPRI methodology.

The licensee performed its bounding analysis both with and without taking credit for an increased probability of detection (POD). The aggregate change in risk estimates are provided in the following table.

Unit	**Change in CDF**		**Change in LERF**	
	With Increased POD	**Without Increased POD**	**With Increased POD**	**Without Increased POD**
1	-4.90E-08	-9.17E-09	-4.90E-09	-9.17E-10
2	-4.64E-08	-4.91E-09	-4.64E-09	-4.91E-10
3	-4.64E-08	-7.70E-09	-4.64E-09	-7.70E-10

The change-of-risk evaluation results also indicate that the change in CDF and LERF per system is less than the system-level guidelines of 1.0E-07/year and 1.0E-08/year, respectively, and therefore, the decision criteria of Figure 3-6 (also specified on page 3-85) of the topical report was satisfied.

The NRC staff finds the licensee's process to evaluate and bound the potential change in risk reasonable because it (1) accounts for the change in the number and location of elements inspected, (2) recognizes the differences in degradation mechanisms related to failure likelihood, and (3) considers the synergistic effects of multiple degradation mechanisms within the same piping segment. System-level and aggregate estimates of the changes in CDF and LERF are less than the corresponding guideline values in the topical report. The NRC staff finds that redistributing the welds to be inspected, with consideration of the safety significance of the segments, provides assurance that segments whose failure would have a significant impact on plant risk will receive an acceptable and often improved level of inspection. Therefore, the NRC staff concludes that the implementation of the RI-ISI program, as described in the licensee's submittal, will have a small impact on risk, consistent with the guidelines of RG 1.174.

3.2.4 Integrated Decisionmaking

The licensee used an integrated approach in defining the proposed RI-ISI program by considering in concert the traditional engineering analysis, the risk evaluation, the implementation of the RI-ISI program, and performance monitoring of piping degradation. This approach is consistent with the guidance in RG 1.178 and is, therefore, acceptable.

3.2.4.1 Risk Characterization

The licensee states in its submittal that pipe segments (and ultimately the elements within, which are defined as all having the same degradation susceptibility) are ranked in accordance with definitions given in the topical report; therefore, this ranking approach is acceptable.

3.2.4.2 Selection of Element Population for Inspection

The licensee's process for selecting pipe elements to be inspected is described in Section 3.5 of the licensee's submittal. It states that the selection of elements to be examined was determined using the guidance provided in the topical report, specifically taking note of Section 3.6.4.2, "ASME Code Case N-578."

The licensee provides detailed information on the results of the evaluation in the following tables in the submittal:

- Tables 3.1-1, 3.1-2, and 3.1-3 provide the number of segments and elements associated with each system in the ASME Code Class 1 and Class 2 scope, for Units 1, 2, and 3, respectively.

- Tables 3.4-1, 3.4-2, and 3.4-3 identify, on a per-system basis, the number of segments, by risk category, from both perspectives of including and excluding FAC as an RI-ISI degradation mechanism, for Units 1, 2, and 3, respectively.

- Tables 3.5-1, 3.5-2, and 3.5-3 provide, from the perspective of excluding FAC as an RI-ISI degradation mechanism, a listing of the number of elements, by system, in each risk category, as well as the number of elements selected for NDE, for Units 1, 2, and 3, respectively.

- ables 3.6-1, 3.6-2, and 3.6-3 provide the risk impact analysis results for each element grouping by system, consequence rank, and combination of damage mechanisms, for Units 1, 2, and 3, respectively.

- Tables 5-1-1, 5-1-2, and 5-1-3 provide summaries comparing the number of inspections required under the 1992 ASME Code, Section XI, ISI program with the alternative RI-ISI program, by ASME Code, Section XI, weld groupings, for Units 1, 2, and 3, respectively.

- Tables 5-2-1, 5-2-2, and 5-2-3 provide summaries comparing the number of inspections required under the 1992 ASME Code, Section XI, ISI program with the alternative RI-ISI program, by RI-ISI weld groupings, for Units 1, 2, and 3, respectively.

The licensee reports a deviation from the topical report's element selection criteria in the charging system. The deviation describes one section of piping being split into two segments: the first is classified per the topical report as Risk Category 2, which is susceptible to thermal fatigue, and the second is classified per the topical report as Risk Category 4, which is not subject to any degradation mechanisms. In this instance, the licensee increased the number of inspections in the Risk Category 2 segment, while not selecting any elements for inspection in the Risk Category 4 segment. The Risk Category 4 segment is located just beyond the affected region of the charging line that is potentially subjected to thermal transients when flow is restored after a loss of charging event. The normal plant operating conditions are identical for the two segments; the materials are the same. Any inadvertently overlooked degradation mechanism will affect both segments equally without preference to location. Should a flaw be identified during examination, the licensee will perform a root cause evaluation. Scope expansion will be necessary to encompass other like locations subject to the same root cause conditions. In addition, the licensee has provided a regulatory commitment (Reference 17) to review and incorporate applicable NRC-approved final EPRI/MRP guidance on thermal-fatigue management into the Palo Verde RI-ISI program for assessing TASCS.

The NRC staff finds the approach to increase the number of exams in the Risk Category 2 segment, while not examining any locations in the Risk Category 4 segment, to be an acceptable alternative to the approach of the topical report. This finding is based on the fact that the two pipe segments are adjacent, constructed of the same materials, and subject to the same operating conditions, and because root cause evaluations will be completed when flaws are identified and will be used to determine expansion examination requirements.

In reviewing the above tables, the NRC staff concludes that, with exception of the deviation identified in the charging system discussed above, the topical report's guidance—that at least 25 percent of the locations in each high-risk category, and at least 10 percent of the locations in each medium-risk category, must be selected for NDE—has been met.

The licensee states that the percentage of ASME Code Class 1 piping welds selected strictly for RI-ISI purposes exceeds 10 percent for each unit. This approach meets the guidelines from

Section 3.6.4.2 of the topical report, which states that if the percentage of Class 1 piping locations selected for examination falls substantially below 10 percent, then the basis for selection needs to be investigated. The licensee has met this expectation of the topical report report, and no investigation is necessary.

As discussed in Section 3.2.1 of this SE, the licensee will inspect all alloy 82/182 dissimilar metal welds in accordance with the guidance of Reference 13. The licensee identified a total of 20 alloy 82/182 dissimilar metal welds in each of the units. The NRC staff finds inspection of the alloy 82/182 dissimilar metal welds in accordance with the guidance of Reference 13 to be acceptable, as this inspection schedule will result in as many or more examinations than required by an RI-ISI program or by the ASME Code, Section XI.

Although there is no NRC-approved augmented inspection program for PWSCC described in the topical report, the NRC staff considers the adoption of Reference 13 to manage the PWSCC degradation mechanism for alloy 82/182 dissimilar metal welds to be similar to having another augmented inspection program. Because the topical report (1) lists those NRC-approved augmented inspection programs that may be subsumed into the RI-ISI program, (2) lists a couple of NRC-approved augmented inspection programs that may not be subsumed into the RI-ISI program, and (3) excludes mention of other known NRC-approved augmented inspection programs that have customarily not been subsumed into the RI-ISI program (such as the licensee's inspection program for HELB outside containment, implemented in response to UFSAR Section 6.6.8, "Augmented Inservice Inspection to Protect against Postulated Piping Failures"), the NRC staff does not view the licensee's decision to select dissimilar metal welds for inspection per Reference 13 guidance as a deviation from the topical report. Because the licensee's decision to implement Reference 13 post-dates its performance of the RI-ISI analysis, no credit for an augmented inspection program management of the PWSCC degradation mechanism was taken during the risk-characterization of the affected segments. Hence, those segments are currently conservatively risk-characterized, which the NRC staff finds acceptable.

For elements containing the FAC degradation mechanism, the licensee indicates in the submittal that no FAC examinations (per NRC Generic Letter 89-08) will be credited to satisfy RI-ISI selection criteria. In addition, in Reference 17, the licensee indicates that no examinations conducted in support of the Reference 13 augmented inspection program, for PWSCC, will be credited to satisfy RI-ISI selection criteria. Rather, inspection locations selected for RI-ISI purposes that are in the FAC and Reference 13 programs will be subject to an examination, which will also satisfy RI-ISI program criteria.

As noted previously, ASME Code Class 1 and Class 2 elements within the scope of NRC Bulletins 79-13, 79-17, 88-08, and 88-11, as well as NRC Information Notice 97-19 augmented inspection programs, have been subsumed into the RI-ISI program and are subject to selection for NDE much like all other elements in the RI-ISI scope.

Based on the NRC staff's review of the above tables (containing the results of element selection), and based upon the additional locations that will be inspected as discussed above, the NRC staff concludes that the element selection results are consistent (with the exception of that identified for the charging system) with the topical report's guidelines and with the appropriate incorporation of recent operating experience (e.g., inclusion of alloy 82/182-related butt welds in accordance with Reference 13 under an augmented inspection program). Hence, the NRC staff finds the licensee's selection of element locations to be acceptable.

3.2.4.3 Examination Methods

As noted in Section 2 of this SE, the objective of ISI is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary that may impact plant safety. To meet this objective, the risk-informed location selection process, per the topical report, employs an "inspection for cause" approach. To address this approach, Section 4 of the topical report provides guidelines for the areas and/or volumes to be inspected, as well as the examination method, acceptance standard, and evaluation standard for each degradation mechanism. Based on its review and acceptance of the topical report, the NRC staff concluded that these examination methods are appropriate since they are selected based on specific degradation mechanisms, pipe sizes, and materials of concern. The licensee states that the methodology of the topical report was applied in the development of the Palo Verde RI-ISI program plan. The licensee's use of this methodology includes the use of Section 4 of the topical report as guidance in determining the examination methods and requirements for these locations.

Based on these considerations, the NRC staff concludes that the licensee's determination of examination methods is acceptable.

3.2.4.4 Relief Requests for Examination Locations and Methods

Pursuant to Section 6.4 of the topical report, the licensee has completed an evaluation of existing relief requests to determine if any should be withdrawn or modified due to changes that could occur from implementing the RI-ISI program. The licensee concludes that none of its existing relief requests should be withdrawn as a result of the RI-ISI application.

The licensee states that it has attempted to select RI-ISI locations for examination such that a minimum of greater than 90 percent coverage (i.e., Code Case N-460 criteria) is attainable. The licensee states that for any examination location where greater than 90 percent volumetric coverage cannot be obtained, the licensee will follow the process outlined in the topical report. The NRC staff finds the licensee's proposed treatment of existing relief requests to be acceptable.

3.2.5 Implementation and Monitoring

Implementation and performance monitoring strategies necessitate careful consideration by the licensee and are addressed in Element 3 of RG 1.178 and SRP 3.9.8. The objective of Element 3 is to assess performance of the affected piping systems under the proposed RI-ISI program by utilizing monitoring strategies that confirm the assumptions and analyses used in the development of the RI-ISI program. Pursuant to 10 CFR 50.55a(a)(3)(i), a proposed alternative—in this case the implementation of the RI-ISI program, including inspection scope, examination methods, and methods of evaluation of examination results—must provide an acceptable level of quality and safety.

The licensee states that upon approval of the RI-ISI program, it will prepare procedures that comply with the guidelines described in EPRI TR-112657 to implement and monitor the RI-ISI program. The licensee states in its submittal that the applicable aspects of the ASME Code not affected by the proposed RI-ISI program would be retained.

The licensee indicates in Section 4 of the submittal that the RI-ISI program is a living program and its implementation will require feedback of new relevant information to ensure the appropriate identification of safety significant piping locations. The licensee also states that, as a minimum, risk-ranking of piping segments will be reviewed and adjusted on an ASME Code period basis and that significant changes may necessitate more frequent adjustment as directed by NRC Bulletin or Generic Letter criteria, or by industry and plant-specific feedback. This periodic review and adjustment of the risk-ranking of segments ensures that changes to the PRA that the licensee will make to incorporate the peer review results will also be incorporated into the RI-ISI program as necessary.

The licensee addresses additional examinations in Section 3.5.1 of the submittal, which states that examinations performed that reveal flaws or relevant conditions exceeding the applicable acceptance standards shall be extended to include additional examinations. These additional examinations shall include piping structural elements with the same postulated failure mode and the same or higher failure potential. Additional examinations will be performed on these elements up to a number equivalent to the number of elements with the same postulated failure mode originally scheduled for that fuel cycle. If the additional examinations reveal flaws or relevant conditions exceeding the acceptance standards, the examinations will be further extended to include all elements subject to the same failure mechanism, throughout the scope of the program, during the same outage.

The NRC staff finds the licensee’s approach acceptable since the additional examinations, if necessary, will be performed during the same outage that the indications or relevant conditions are identified.

Palo Verde has commenced the third period of the second 10-year ISI interval for all three units, and the licensee states that it plans to implement the RI-ISI program during this period. The licensee will take credit for ASME Code, Section XI, ISIs performed during the first two periods of the second interval. The licensee indicates that during these periods, 63 percent, 61 percent, and 58 percent of the ASME Code, Section XI, examinations have been completed for Units 1, 2, and 3, respectively. The licensee indicates that it will examine 37 percent, 39 percent, and 42 percent of the locations selected for RI-ISI during the third period, for Units 1, 2, and 3, respectively. The NRC staff finds this examination approach acceptable because it is consistent with the guidance provided in the Reference 5. The NRC staff’s guidance in the referenced SER stated, in part, that the implementation of the RI-ISI program at any time within an inspection interval is acceptable as long as the examination schedules are consistent with the interval criteria contained in Article IWB-2000 of ASME Code, Section XI, as applied to Inspection Program B.

The NRC staff finds that the proposed process for RI-ISI program implementation, monitoring, feedback, and update meets the guidelines of RG 1.174, which states that risk-informed applications should include performance monitoring and feedback provisions. Hence, the NRC staff considers the licensee's proposed process for program implementation, monitoring, feedback, and update to be acceptable.

4.0 CONCLUSIONS

Pursuant to 10 CFR 50.55a(a)(3)(i), alternatives to the requirements of 10 CFR 50.55a(g) may be used, when authorized by the NRC, if the licensee demonstrates that the proposed alternatives will provide an acceptable level of quality and safety. In this case, the licensee has proposed an alternative to use the risk-informed process described in NRC-approved EPRI TR-112657.

RG 1.174 establishes criteria for risk-informed decisions involving a change to a plant's licensing basis. RG 1.178 establishes criteria for risk-informed decisions involving alternatives to the requirements of 10 CFR 50.55a(g) (ISI program requirements), and its directive to follow the criteria of the ASME Code, Section XI. These two RGs, taken together, define the elements of an integrated decisionmaking process that assesses the level of quality and safety embodied in a proposed change to the ISI program. EPRI TR-112567 RI-ISI methodology contains the necessary details for implementing this process. This methodology provides for a systematic identification of safety-significant pipe segments, for a determination of where inspections should occur within these segments (i.e., identification of locations), and for a determination how these locations will be inspected. Such segments/locations are characterized as having active degradation mechanisms, and/or whose failure would be expected to result in a significant challenge to safety (either immediately by initiating an event or in response to a future unrelated event).

EPRI TR-112657 methodology also provides for implementation and performance monitoring strategies, in order to ensure a proper transition from the current ISI program and to ensure that changes in plant performance, and new information from the industry and/or from the NRC, is incorporated into the licensee's ISI program as needed.

The licensee proposes two deviations from this methodology. The first is that it will assess susceptibility of piping segments and elements at Palo Verde to TASCS in accordance with the guidance in Reference 9. The methodology therein is consistent with the guidance in Reference 14. For the reasons stated above, the NRC staff finds that the considerations in these references are appropriate for determining the potential for TASCS. The NRC staff also finds the licensee's commitment to incorporate the applicable NRC-approved final MRP guidance for determining the potential for TASCS into its RI-ISI application acceptable. The second deviation relates to the licensee's selection of inspection locations in the charging system, where there are two contiguous segments in full communication with each other, but one is susceptible to thermal fatigue and the other is not subject to any degradation mechanisms. In this instance, the licensee increased the number of inspections in the higher failure potential segment, while not selecting any elements for inspection in the segment not subject to a degradation mechanism. For the reasons stated above, the NRC staff finds the licensee's rationale for this deviation acceptable.

In addition, the licensee clarified that it will inspect all alloy 82/182 dissimilar metal welds in accordance with the guidance of Reference 13, due to potential susceptibility to PWSCC, under an augmented inspection program. Based on the topical report's positions with respect to other, previously-recognized augmented inspection programs, the NRC staff does not view this treatment as a deviation from the topical report.

Other aspects of the licensee's ISI program, such as system pressure tests and visual examination of piping structural elements, will continue to be performed on all Class 1, 2, and 3 systems in accordance with ASME Code, Section XI. This provides a measure of continued monitoring of areas that are being eliminated from the NDE portion of the ISI program. Pursuant to the EPRI TR-112657 methodology, the existing ASME Code performance measurement strategies will remain in place. In addition, the EPRI TR-112657 methodology provides for increased inspection volumes for those locations that are included in the NDE portion of the program.

For the foregoing reasons, the NRC staff concludes that the licensee's proposed program, which is consistent with the methodology as described in EPRI TR-112657, with two acceptable deviations and the adoption of a new augmented inspection program, will provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a(a)(3)(i) for the proposed alternative to the piping ISI requirements with regard to (1) the number of locations, (2) the locations of inspections, and (3) the methods of inspection.

The NRC staff concludes that the licensee's proposed RI-ISI program is an acceptable alternative to the current ISI program for Class 1 and Class 2 piping welds at Palo Verde, Units 1, 2, and 3. Therefore, the proposed RI-ISI program is authorized for the third period of the second 10-year ISI interval pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that this alternative will provide an acceptable level of quality and safety.

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.

5.0 REFERENCES

1. Letter from David Mauldin, Arizona Public Service, to U.S. Nuclear Regulatory Commission, "Docket Nos. 50-528, 50-529, and 50-530, Palo Verde Units 1, 2, and 3 - Proposed Alternative to PVNGS' ASME Section XI Inservice Inspection Program for ASME Code Category B-f, B-J, C-F-1, and C-F-2 Piping (Relief Request 32)," dated January 16, 2006.

2. Letter from James M. Levine, Arizona Public Service, to U.S. Nuclear Regulatory Commission, "Palo Verde, Units 1, 2, and 3, Response to the NRC Request for Additional Information Regarding Risk-Informed Inservice Inspection Program Request," dated June 10, 2006.

3. EPRI TR-112657, Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure", Final Report, December 1999.

4. Letter from J. E. Dyer, Director of Nuclear Reactor Regulations, to Gary C. Park, Chairman, ASME Subcommittee on Nuclear Inservice Inspection, “Gary C. Park Letter Re: Primary Water Stress Corrosion Cracking in Reactor Coolant System Nickel-based Alloy Butt Welds,” dated December 20, 2005 (ADAMS Accession No. ML053480359).

5. NRC Staff Safety Evaluation Report on EPRI TR-112657, Revision B-A, dated October 28, 1999.

6. NRC Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” Revision 1, November 2002.

7. NRC Regulatory Guide 1.178, “An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping,” Revision 1, September 2003.

8. NRC NUREG-0800, Chapter 3.9.8, “Standard Review Plan for the Review of Risk-Informed Inservice Inspection of Piping,” Revision 1, September 2003.

9. Letters dated February 28, 2001, and March 28, 2001, from P.J. O'Regan (EPRI) to Dr. B. Sheron (USNRC), "Extension of Risk-Informed Inservice Inspection Methodology."

10. EPRI TR-111880, "Piping System Failure Rates and Rupture Frequencies for Use In Risk-Informed In-Service Inspection Applications," Final Report, September 1999.

11. ANO-2 Code Case N-578 Application Submittals, Letter #2CAN099706 dated September 30, 1997, and Letter #2CAN039808, dated March 31, 1998.

12. Vermont Yankee Code Case N-S 60 Application Submittals Letter # BVY97-99, dated August 6, 1997, and Letter #BVY97-105, dated August 15, 1997.

13. EPRI MRP-139, “Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139),” Final Report, July 14, 2005.

14. EPRI TR-1000701, “Interim Thermal Fatigue Management Guideline (MRP-24),” Final Report, dated January 2001.

15. Letter from Brian E. Holian, Senior Project Manager, Office of Nuclear Reactor Regulation, to Mr. William L. Stewart, Executive Vice President, Arizona Public Service Company, “Staff Evaluation of the Palo Verde Nuclear Generating Station Individual Plant Examination (IPE) for Internal Events - Unit Nos. 1, 2, and 3.”

16. Letter from David Mauldin, Arizona Public Service, to U.S. Nuclear Regulatory Commission, “Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, and 3. Docket Nos. 50-528, 50-529, and 50-530, Information in Response to the NRC Phone Call on July 21, 2006,” dated September 28, 2006.

7. Letter from David Mauldin, Arizona Public Service, to U.S. Nuclear Regulatory Commission, Docket Nos. 50-528/529/530, Palo Verde Units 1, 2, and 3 - Response to the NRC Request for Additional Information Regarding Risk-Informed Inservice Inspection Program Request," dated August 30, 2006.

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