APS

A subsidiary of Pinnacle West Capital Corporation

Palo Verde Nuclear Generating Station

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102-06290-JHH/GAM
December 03, 2010

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528, 50-529 and 50-530
Response to Draft Requests for Additional Information for the Review of the PVNGS License Renewal Application (LRA), and LRA Amendment No. 28

In an electronic mail dated November 17, 2010, the Nuclear Regulatory Commission (NRC) staff provided to Arizona Public Service Company (APS) draft requests for additional information (RAI) regarding selective leaching and metal fatigue related to the PVNGS license renewal application (LRA). Enclosure 1 contains APS's responses to the draft RAIs. Enclosure 2 contains LRA Amendment No. 28 to reflect changes described in the RAI responses.

In addition, LRA Amendment No. 28 in Enclosure 2 contains changes to the one-time inspections of small-bore piping socket welds in LRA Sections A1.19 and B2.1.19, and Commitment No. 21 in Table A4-1, to (1) specify a maximum of 25 weld examinations, and (2) specify that the inspections will be performed within the six year period prior to the period of extended operation. These changes are consistent with recent NRC discussions.

Should you need further information regarding this submittal, please contact Glenn Michael, Licensing Engineer for License Renewal, at (623) 393-5750.

A138
NRR

I declare under penalty of perjury that the foregoing is true and correct.

Executed on December 3, 2010
(date)

Sincerely,

Angela K. Krainik for John H. Hesser
by direction

JHH/RAS/GAM/gat

Enclosures:

1. Response to Draft Request for Additional Information for the Review of the PVNGS License Renewal Application

2. Palo Verde Nuclear Generating Station License Renewal Application Amendment No. 28

cc:

E. E. Collins Jr.	NRC Region IV Regional Administrator
J. R. Hall	NRC NRR Senior Project Manager
L. K. Gibson	NRC NRR Project Manager
J. H. Bashore	NRC Senior Resident Inspector (acting) for PVNGS
L. M. Regner	NRC License Renewal Project Manager
G. A. Pick	NRC Region IV (electronic)

ENCLOSURE 1

Response to Draft Requests for Additional Information for the Review of the PVNGS License Renewal Application

NRC Draft RAI 4.3.4-1

Background:

In LRA Section 4.3.4 and Amendment 16 (dated May 27, 2010), the applicant discussed the methodology to determine the locations that require environmentally assisted fatigue (EAF) analyses consistent with NUREG/CR-6260 "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components." The staff recognized that, in LRA Table 4.3-11, there are eight plant-specific components listed, based on the seven generic locations identified in NUREG/CR-6260, and one additional location (pressurizer heater penetrations). The applicant discussed in the response to RAI 4.3-7 (dated Aug 12, 2010) that the pressurizer surge line pressurizer elbow is the bounding location for the pressurizer surge line.

Issue:

The GALL Report AMP X.M1, "Metal Fatigue of Reactor Coolant Pressure Boundary" states that the impact of the reactor coolant environment on a sample of critical components should include the locations identified in NUREG/CR-6260 as a minimum, and that additional locations may be needed. During its review, the staff was unclear whether the applicant verified that the plant-specific components listed in the LRA Table 4.3-11 per NUREG/CR-6260 were bounding for the generic NUREG/CR-6260 locations. Furthermore, the staff noted that the applicant's plant-specific configuration may contain locations that should be analyzed for the effects of the reactor coolant environment other than those generic locations identified in NUREG/CR-6260. This may include locations that are limiting or bounding for a particular plant-specific configuration, or that have calculated CUF values that are greater when compared to the locations identified in NUREG/CR-6260. The staff noted that the applicant included one additional location (pressurizer heater penetrations) in Table 4.3-11 because they may be subjected to the effects of thermal stratification and insurge-outsurge transients, but the staff is unclear if this location is bounding. The discussion provided in the response to RAI 4.3-7 is needed for the other plant-specific locations and any additional limiting locations.

Request:

a) Confirm and justify that the plant-specific components listed in LRA Table 4.3-11 (except the pressurizer surge line pressurizer elbow) are bounding for the generic NUREG/CR-6260 locations and the additional location (pressurizer heater penetrations).

b) Confirm and justify that the LRA Table 4.3-11 locations selected for environmentally assisted fatigue analyses consists of the most limiting locations *for the plant* (beyond the generic locations identified in the NUREG/CR-6260 guidance). If these locations are not bounding, clarify the locations that require an environmentally assisted fatigue analysis and the actions that will be taken for

these additional locations. If the limiting component identified consists of nickel alloy, state whether the methodology used to perform the environmentally-assisted fatigue calculation for nickel alloy is consistent with NUREG/CR-6909. If not, justify the method chosen.

APS Response to Draft RAI 4.3.4-1

The following commitment is provided as Item No. 63 in LRA Table A4-1 as shown in LRA Amendment No. 28 in Enclosure 2:

a) No later than two years prior to the period of extended operation, APS will confirm that the plant-specific components listed in LRA Table 4.3-11 (except the pressurizer surge line pressurizer elbow) are bounding for the generic NUREG/CR-6260 locations and the additional location (pressurizer heater penetrations). If locations are found that are not bounded by the Table 4.3-11 components, APS will perform new analyses as necessary to bound such locations.

And

b) No later than two years prior to the period of extended operation, APS will confirm that the LRA Table 4.3-11 locations selected for environmentally assisted fatigue analyses consist of the most limiting cumulative usage factor (CUF) locations for the plant (beyond the generic EAF locations identified in the NUREG/CR-6260 guidance). If the Table 4.3-11 locations are not bounding, APS will perform an environmentally assisted fatigue analysis for the additional CUF locations not bounded by the Table 4.3-11 locations. If the component with the most limiting CUF is composed of nickel alloy, the methodology used to perform the environmentally-assisted fatigue calculation for nickel alloy will be consistent with NUREG/CR-6909.

NRC Draft RAI B2.1.17-1

Background:

GALL AMP XI.M33, "Selective Leaching of Materials" states in element 1, "scope of program" that the program includes a one-time visual inspection and hardness measurement of a selected set of sample components to determine whether loss of material due to selective leaching is not occurring for the period of extended operation.

LRA Section B2.1.17, Selective Leaching, states that a one-time inspection of a selected sample of components internal surfaces will be performed.

Issue:

Due to the uncertainty in determining the most susceptible locations and the potential for aging to occur in other locations, the staff noted that large (at least 20%) sample sizes may be required in order to adequately confirm an aging effect is not occurring. The applicant's Selective Leaching Program did not include specific information regarding how the selected set of components to be sampled or the sample size will be determined.

Request:

Provide specific information regarding how the selected set of components to be sampled will be determined and the size of the sample of components that will be inspected.

APS Response to Draft RAI B2.1.17-1

The sample size and inspection locations for the inspections associated with the Selective Leaching Program will be developed to ensure that a representative sample of material-environment combinations is selected with a focus on inspecting leading indicator components. This approach provides assurance that the aging of the components is being adequately managed.

The representative sample size and inspection locations will be determined based on the materials of fabrication; that is, gray cast iron and copper alloys (containing greater than 15% zinc or greater than 8% aluminum). A sample size of 20% of the site population (up to a maximum of 25 inspections) has been established for each group of components with different material and environment combinations as noted below.

The specific inspection locations will be identified considering the components most susceptible to selective leaching based on time in service, severity of operating conditions/environment, and lowest design margins. In determining the leading components, factors such as the potential for aging due to component geometry (e.g., pipe versus valve body) and environmental factors (e.g., stagnant or low flow areas) will be considered. Sampled components for each system material and environment combination will not be repeated between the three Palo Verde units (i.e., the same component will not be inspected in another unit).

LRA Sections A1.17 and B2.1.17, and Commitment No. 19 in Table A4-1, have been revised, as shown in LRA Amendment 28 in Enclosure 2, to add the sampling criteria for the Selective Leaching AMP.

Inspection samples are chosen from the site population of available material/environment combinations for each of the systems noted below.

Brass (Copper Alloy > 15% zinc) / Closed-Cycle Cooling Water:
Essential Chilled Water System: 6 components: Sample Size - 1 component
Component Total: 6 components
Sample Component Total: 1 component

Brass (Copper Alloy > 15% zinc) / Demineralized Water:
Essential Chilled Water System: 6 components: Sample Size - 1 component
Component Total: 6 components
Sample Component Total: 1 component

Brass (Copper Alloy > 15% zinc) / Secondary Water:
Auxiliary Steam System: 9 components: Sample Size - 2 component
Component Total: 9 components
Sample Component Total: 2 components

Brass (Copper Alloy > 15% zinc) / Raw Water:
Fire Protection System: 649 components: Sample Size: 25 components
Component Total: 649 components
Sample Component Total: 25 components

Brass (Copper Alloy > 15% zinc) / wetted gas:
Fire Protection System: 85 components: Sample Size - 17 components
Diesel Generator System: 48 components: Sample Size - 10 components
Component Total: 133 components
Sample Component Total: 27 components

Bronze (Copper Alloy > 8% aluminum) / Raw Water:
Essential Spray Ponds: 12 components: Sample Size - 2 components
Component Total: 12 components
Sample Component Total: 2 components

Gray Cast Iron / Raw Water:
Fire Protection System: 848 components: Sample Size - 25 components
Component Total: 848 components
Sample Component Total: 25 components

Gray Cast Iron / Secondary Water:
Auxiliary Steam System: 30 components: Sample Size - 6 components
Chemical and Volume Control System: 6 components: Sample Size - 1 component
Component Total: 36 components
Sample Component Total: 7 components

ENCLOSURE 2

Palo Verde Nuclear Generating Station
License Renewal Application
Amendment No. 28

LRA Section	Page No.
A1.17	A-10
A1.19	A1-11
Table A4-1, Item 19	A-42
B2.1.17	B-51, 52
B2.1.19	B-55, 56

A1.17 SELECTIVE LEACHING OF MATERIALS

The Selective Leaching of Materials program manages the loss of material due to selective leaching for brass (copper alloy >15% zinc), aluminum-bronze (copper alloy >8% aluminum), and gray cast iron components exposed to closed-cycle cooling water demineralized water, secondary water, raw water and wetted gas within the scope of license renewal. The Selective Leaching of Materials program is in addition to the Open-Cycle Cooling Water program (A1.9) and the Closed-Cycle Cooling Water program (A1.10) in these cases.

The program includes a one-time inspection (visual and/or mechanical methods) of a selected sample of components internal surfaces to determine whether loss of material due to selective leaching is occurring. A sample size of 20% of the population, up to a maximum of 25 component inspections, will be established for each of the system material and environment combinations at the Palo Verde site. If indications of selective leaching are confirmed, follow up examinations or evaluations are performed.

A1.19 One-Time Inspection of ASME Code Class 1 Small-Bore Piping

The One-Time Inspection of ASME Code Class 1 Small-Bore Piping program manages cracking of stainless steel ASME Code Class 1 piping less than or equal to 4 inches.

For ASME Code Class 1 small-bore piping, volumetric examinations on selected butt weld locations will be performed to detect cracking. Butt weld volumetric examinations will be conducted in accordance with ASME Section XI with acceptance criteria from Paragraph IWB-3000 and IWB-2430. Weld locations subject to volumetric examination will be selected based on the guidelines provided in EPRI TR-112657. Socket welds that fall within the weld examination sample will be examined following ASME Section XI Code requirements. At least 10% of the socket welds in ASME Code Class 1 piping that is less than four inches nominal pipe size and greater than or equal to one inch nominal pipe size will be selected per unit for ultrasonic testing examination, up to a maximum of 25 weld examinations. The sample will be selected based on risk insights and those welds with the potential for aging degradation.

Socket welds that fall within the weld examination sample will be examined following ASME Section XI Code requirements. If a qualified volumetric examination procedure for socket welds endorsed by the industry and the NRC is available and incorporated into the ASME Section XI Code at the time of PVNGS small-bore socket weld inspections then this will be used for the volumetric examinations. If no volumetric examination procedure for ASME Code Class 1 small bore socket welds has been endorsed by the industry and the NRC and incorporated into ASME Section XI at the time PVNGS performs inspections of small-bore piping, a plant procedure for volumetric examination of ASME Code Class 1 small-bore piping with socket welds will be used.

The One-Time Inspection of ASME Code Class 1 Small-Bore Piping program is a new program that will be implemented within the six year period ~~P~~prior to the period of extended operation. Industry and plant-specific operating experience will be evaluated in the development and implementation of this program.

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Amendment No. 28

LRA Table A4-1, License Renewal Commitment No. 19 is revised as follows (deleted text shown in strikethrough and new text underlined):

Item No.	Commitment	LRA Section	Implementation Schedule
19	The Selective Leaching of Materials program is a new program that will be implemented prior to the period of extended operation. Industry and plant-specific operating experience will be evaluated in the development and implementation of this program. The Selective Leaching of Materials program includes a one-time inspection (visual and/or mechanical methods) of a selected sample of components internal surfaces to determine whether loss of material due to selective leaching is occurring. A sample size of 20% of the population, up to a maximum of 25 component inspections, will be established for each of the system material and environment combinations at the Palo Verde site. If indications of selective leaching are confirmed, follow up examinations or evaluations are performed. (RCTSAIs 3246908 [U1]; 3247260 [U2]; 3247261 [U3] 3563030)	A1.17 B2.1.17 Selective Leaching Of Materials	Within the ten year period prior to the period of extended operation[1].

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License Renewal Application
Amendment No. 28

LRA Table A4-1, License Renewal Commitment No. 21 is revised as follows (deleted text shown in strikethrough and new text underlined):

Item No.	Commitment	LRA Section	Implementation Schedule
21	The One-Time Inspection of ASME Code Class 1 Small-Bore Piping program is a new program that will be implemented prior to the period of extended operation. Industry and plant-specific operating experience will be evaluated in the development and implementation of this program. For ASME Code Class 1 small-bore piping, volumetric examinations on selected butt weld locations will be performed to detect cracking. Butt weld volumetric examinations will be conducted in accordance with ASME Section XI with acceptance criteria from Paragraph IWB-3000 and IWB-2430. Weld locations subject to volumetric examination will be selected based on the guidelines provided in EPRI TR-112657. Socket welds that fall within the weld examination sample will be examined following ASME Section XI Code requirements. At least 10% of the socket welds in ASME Code Class 1 piping that is less than four inches nominal pipe size and greater than or equal to one inch nominal pipe size will be selected per unit for ultrasonic testing examination, up to a maximum of 25 weld examinations. The sample will be selected based on risk insights and those welds with the potential for aging degradation. (RCTSAIs 3246910 [U1]; 3247265 [U2]; 3247266 [U3])	A1.19 B2.1.19 One-Time Inspection of ASME Code Class 1 Small-Bore Piping	Within the six year period ~~P~~prior to the period of extended operation[1].

Palo Verde Nuclear Generating Station
License Renewal Application
Amendment No. 28

LRA Table A4-1, License Renewal Commitment No. 63:

Item No.	Commitment	LRA Section	Implementation Schedule
63	a) No later than two years prior to the period of extended operation, APS will confirm that the plant-specific components listed in LRA Table 4.3-11 (except the pressurizer surge line pressurizer elbow) are bounding for the generic NUREG/CR-6260 locations and the additional location (pressurizer heater penetrations). If locations are found that are not bounded by the Table 4.3-11 components, APS will perform new analyses as necessary to bound such locations. And b) No later than two years prior to the period of extended operation, APS will confirm that the LRA Table 4.3-11 locations selected for environmentally assisted fatigue analyses consist of the most limiting cumulative usage factor (CUF) locations for the plant (beyond the generic EAF locations identified in the NUREG/CR-6260 guidance). If the Table 4.3-11 locations are not bounding, APS will perform an environmentally assisted fatigue analysis for the additional CUF locations not bounded by the Table 4.3-11 locations. If the component with the most limiting CUF is composed of nickel alloy, the methodology used to perform the environmentally-assisted fatigue calculation for nickel alloy will be consistent with NUREG/CR-6909. (RCTSAI 3563689)	Response to Draft RAI 4.3.4-1 in APS letter No. 102-06290, dated December 03, 2010.	No later than two years prior to the period of extended operation.

B2.1.17 Selective Leaching of Materials

Program Description
The Selective Leaching of Materials program manages the loss of material due to selective leaching for copper alloy >15% zinc (brass), copper alloy >8% aluminum (aluminum bronze), and gray cast iron components exposed to closed-cycle cooling water, demineralized water, secondary water, raw water and wetted gas within the scope of license renewal. Components susceptible to selective leaching are in the auxiliary steam, chemical and volume control, diesel generator, essential chilled water, essential spray ponds, and fire protection systems.

A one-time inspection of a selected sample of components internal surfaces is performed. A sample size of 20% of the population, up to a maximum of 25 component inspections, will be established for each of the system material and environment combinations at the Palo Verde site. Sampled components for each system material and environment combination will not be repeated between the three Palo Verde units (i.e., the same component will not be inspected in another unit).

Visual and/or mechanical methods determine whether loss of material due to selective leaching is occurring. If these inspections detect dezincification, de-alloying, or graphitization, which are indications of selective leaching, then a follow-up examination/evaluation is performed. The examination/evaluation may require confirmation of selective leaching with a metallurgical evaluation which may include microstructure examination. The sample size of the system/material/environment combination may be expanded based on the results of the evaluation and testing. If indications of selective leaching are confirmed, follow up examinations/evaluations are performed.

NUREG-1801 Consistency

The Selective Leaching of Materials program is an existing program that is consistent with exception to NUREG-1801, Section XI.M33, "Selective Leaching of Materials".

Exceptions to NUREG-1801

Program Elements Affected

Scope of Program – Element 1, Preventive Actions – Element 2, Parameters Monitored or Inspected – Element 3, and Detection of Aging Effects – Element 4

NUREG-1801, Section XI.M33 recommends hardness testing of sample components in addition to visual inspections. However, a qualitative determination of selective leaching is used in lieu of Brinell hardness testing for components within the scope of the PVNGS Selective Leaching of Materials program. The exception involves the use of examinations, other than Brinell hardness testing identified in NUREG-1801 to identify the presence of selective leaching of materials. The exception is justified, because (1) hardness testing may not be feasible for most components due to form and configuration and (2) other mechanical means, e.g., scraping, or chipping, provide an equally valid means of identification.

Additionally, hardness testing only provides definitive results if baseline values are available for comparison purposes. Specific material contents for copper alloys may not be known and gray cast irons may not have published hardness numbers. Without specific numbers for

comparison, hardness testing would yield unusable results. In lieu of hardness testing, visual and mechanical inspections are performed on a sampling of components constructed of copper alloys (>15% zinc and >8% aluminum) and gray cast iron from various station system environments. Follow-up examinations or evaluations are performed on component material samples where indications of dezincification, de-alloying, or graphitization are visually detected and additional analysis as part of the engineering evaluation is required. The engineering evaluation may require confirmation with a metallurgical evaluation (which may include a microstructure examination).

Enhancements

None

Operating Experience

The accelerated de-alloying of aluminum-bronze (copper alloy >8% aluminum), caused by Microbiologically Induced Corrosion (MIC), which was the subject of Information Notice 94- 59 regarding selective leaching, is documented. The PVNGS open-cycle cooling water systems are chemically treated with biocides to prevent the growth of MIC causing bacteria and systems, not in continuous use, are recirculated periodically to ensure adequate chemical mixing is maintained.

Conclusion

The continued implementation of the Selective Leaching of Materials program provides reasonable assurance that aging effects will be managed such that the systems and components within the scope of this program will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation.

B2.1.19 One-Time Inspection of ASME Code Class 1 Small-Bore Piping

Program Description

The One-Time Inspection of ASME Code Class 1 Small-Bore Piping program manages cracking of stainless steel ASME Code Class 1 piping less than or equal to 4 inches.

For ASME Code Class 1 small-bore piping, volumetric examinations (by ultrasonic testing) will be performed on selected butt weld locations to detect cracking. Small-bore weld locations are selected for examination based on the guidelines provided in EPRI TR-112657. Volumetric examinations are conducted in accordance with ASME Section XI with acceptance criteria from Paragraph IWB-3131 and IWB-2430 for butt welds. At least 10% of the socket welds in ASME Code Class 1 piping that is less than four inches nominal pipe size and greater than or equal to one inch nominal pipe size will be selected per unit for ultrasonic testing examination, up to a maximum of 25 weld examinations. The sample will be selected based on risk insights and those welds with the potential for aging degradation.

Socket welds that fall within the weld examination sample will be examined following ASME Section XI Code requirements. If a qualified volumetric examination procedure for socket welds endorsed by the industry and the NRC is available and incorporated into the ASME Section XI Code at the time of PVNGS small-bore socket weld inspections then this will be used for the volumetric examinations. If no volumetric examination procedure for ASME Code Class 1 small bore socket welds has been endorsed by the industry and the NRC and incorporated into ASME Section XI at the time PVNGS performs inspections of small-bore piping, a plant procedure for volumetric examination of ASME Code Class 1 small-bore piping with socket welds will be used.

If evidence of an aging effect is revealed by a one-time inspection, evaluation of the inspection results will identify appropriate corrective actions.

This Program will be implemented and inspections completed and evaluated within the six year period ~~P~~prior to the period of extended operation.

NUREG-1801 Consistency

The One-Time Inspection of ASME Code Class 1 Small-Bore Piping program is a new program that, when implemented, will be consistent~~,~~ with NUREG-1801, Section XI.M35, "One-Time Inspection of ASME Code Class 1 Small-Bore Piping," with an exception.

Exceptions to NUREG-1801

Program Elements Affected

Scope of Program - Element 1

Guidelines from EPRI TR-112657, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," Rev. B-A, were used for identifying susceptible piping instead of EPRI Report 1000701, "Internal Thermal Fatigue Management" Guidance (MRP-24). Guidelines for identifying piping susceptible to potential effects of thermal stratification or turbulent penetration that are provided in EPRI Report 1000701 are also provided in EPRI TR-112657. The recommended inspection volume for welds in EPRI Report 1000701 are identical to those for inspection of thermal fatigue in RI-ISI programs; thus, the PVNGS risk-informed process

examination requirements meet the requirements of NUREG-1801 and no enhancements are required.

Enhancements

None.

Operating Experience

In order to estimate the extent of the problem of cracking in Class 1 piping socket welds, NEI conducted a review of LERs available in the NRC ADAMS database. Of 141 LERs reviewed, 48 were determined to be associated with failures of Class 1 socket welds. For the 46 LERs where a cause was identified, 42 of the failures were due to either vibration-induced high cycle fatigue or improper installation and are not age-related. Of the four remaining failures, one was due to randomly applied loads during maintenance and not age-related, and three were related to aging: two due to insulation contamination on the outside surface, and one associated with IGSCC, although there were other contributing factors not associated with aging (poor weld fit up, weld repair, nearby missing support, etc.).

The NEI review indicates that there have been a relatively small number of Class 1 socket weld failures of which only three were related to aging.

PVNGS has experienced two related instances where failures have occurred in ASME Code Class 1 small-bore piping with socket welds. The failures were reported in the following LERs:

87-018 for a socket weld on the upstream side of the isolation valve for the flanged refueling water level indication;

04-001 for a cracked socket weld on a high pressure safety injection line.

Evaluations were performed to determine the cause of each of the failures. In each case, the failure cause was the same, and was determined not to be cracking due to stress corrosion or thermal and mechanical loading and was not aging related. The cause of the 1987 failure was determined to be high cycle fatigue and the piping configuration, and was mitigated with the installation of a design modification for six similar locations. The 2004 failure was due to the incorrect installation of this modification for one of the other locations. The correct support configuration was installed on the line associated with the 2004 failure and there have been no subsequent failures of the ASME Code Class 1 small-bore piping socket welds.

A review of the second 10-year ISI Interval Summary Reports for Units 1, 2 and 3 indicates there were no code repairs or code replacements required for continued service of ASME IWB Code components during the second 10-year ISI Interval.

Conclusion

The implementation of the One-Time Inspection of ASME Code Class 1 Small-Bore Piping program will provide reasonable assurance that aging effects will be managed such that the systems and components within the scope of this program will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation.