A subsidiary of Pinnacle West Capital Corporation

Palo Verde Nuclear Generating Station

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102-06247-JHH/GAM
September 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
Supplemental Responses to Request for Additional Information Regarding Small Bore Piping Socket Welds and Cavitation Erosion Related to the PVNGS License Renewal Application

By letter letter no. 102-06233, dated July 30, 2010, Arizona Public Service Company (APS) submitted responses to requests for additional information (RAIs) regarding small bore piping socket welds and cavitation erosion related to the PVNGS License Renewal Application. Enclosed are supplemental responses to those RAIs.

APS makes no new commitments in this letter. Should you need further information regarding this submittal, please contact Russell A. Stroud, Licensing Section Leader, at (623) 393-5111.

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

Executed on September 3, 2010
(date)

Sincerely,

Angela Krainik
for John H. Hesser per telecon

JHH/RAS/GAM

Enclosure: Supplemental Responses to Request for Additional Information Regarding Small Bore Piping Socket Welds and Cavitation Erosion Related to the PVNGS License Renewal Application

A138
NRR

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

Supplemental Responses to Request for Additional Information Regarding Small Bore Piping Socket Welds and Cavitation Erosion Related to the PVNGS License Renewal Application

Small Bore Piping Socket Welds Follow-up RAI B2.1.19-3
Cavitation Erosion (LRA B2.1.6)

Enclosure
Supplemental Responses to Request for Additional Information Regarding Small Bore Piping Socket Welds and Cavitation Erosion

NRC Follow-up RAI B2.1.19-3

The NRC Staff has requested additional information to verify that examining a 10% sample of small-bore piping socket welds in the one-time inspection program will provide assurance that the ASME Code Class 1 small-bore piping socket welds are not experiencing aging degradation.

APS Supplemental Response to Follow-up RAI B2.1.19-3

(This response supplements the response to follow-up RAI B2.1.19-3 provided in APS letter no. 102-06233, dated July 30, 2010)

As described in revised LRA Sections A1.19 and B2.1.19, and Table A4-1, Commitment 21, in LRA Amendment No. 21 (APS letter no. 102-06233, July 30, 2010), 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 prior to the period of extended operation. The sample will be selected based on risk insights and those welds with the potential for aging degradation. The purpose of this examination is to provide assurance that the ASME Code Class 1 small-bore piping socket welds are not experiencing aging degradation.

Based on a Palo Verde Unit 1 population of approximately 320 socket welds in piping that is less than four inches nominal pipe size and greater than or equal to one inch nominal pipe size, 32 examinations would be performed. This approximate Unit 1 population was determined from a review of plant drawings, and it is expected that Units 2 and 3 will have a similar number of socket welds.

The 10% inspection sample for ASME Code Class 1 small-bore piping socket welds in each Palo Verde Unit is greater than a sample selected using a 90/90 selection criteria (90% confidence that 90% of the population will not experience aging). A 90/90 selection criteria is consistent with the GALL One-Time Inspection AMP (XI.M32). Based on a 300 component population, a 90/90 selection criteria would yield an inspection population of 22.6 welds, and a 400 component population would yield an inspection population of 23 welds.

NRC RAI: Cavitation Erosion (B2.1.6)

Background:

In its discussion of aging effects for cavitation erosion for treated water, EPRI 1010639, "Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools," Appendix A, Section 4.1, "Assumptions," states, in part, that it is assumed cavitation erosion problems are a design deficiency, which will be detected and corrected during current operation, except when the cavitation occurs in infrequently operated systems.

In these cases, it states that plant specific consideration may need to be addressed in the aging management review. In addition, the GALL Report, Table IX.E, Aging Effects notes that "loss of material" may be due to several causes and erosion is specifically included. Also, the GALL Report, Table IX.F, "Significant Aging Mechanisms," defines both cavitation, and erosion.

Issue:

During a review of operating experience at PVNGS, the NRC identified CRDR 2932507, which documents a through-wall leak in piping immediately downstream of a valve in the HPSI RWT recirculation line "due to erosion by damaging cavitation." The apparent cause evaluation for this issue indicated that the Flow-Accelerated Corrosion (FAC) Program was to ultrasonically inspect these potentially susceptible components, and that the FAC program was to be revised to examine portions of all three units' HPSI train "B" recirculation piping every 18 months in order to assess cavitation erosion. Subsequent information, made available to the NRC, indicated that the affected sections of the HPSI system are to be replaced on a conservative interval of every 7.5 years. While this will preclude further need of aging management for those specific locations, the extent of condition performed in the above apparent cause evaluation indicated that components and locations in other safety-related systems were potentially susceptible to the same degradation mechanism.

Based on PVNGS' operating experience, the exception noted above in EPRI 1010639, regarding infrequently operated systems, appears to apply, and plant-specific consideration needs to be addressed in the aging management review.

In addition, the extent of condition section in PVNGS' Apparent Cause Evaluation for CRDR 2932507 indicates that it only addressed stainless piping and components in systems associated with heat removal and implied that the FAC Program would address the cavitation erosion issue in carbon steel piping systems. The staff notes that although the FAC program monitors carbon steel piping, the implementing computer program, CHECWORKS, specifically excludes cavitation considerations, and that the scope of the FAC program only includes a limited number of systems (condensate, feedwater, etc.) that are operated within specific parameters (temperatures, pressures, oxygen content, etc.) associated with FAC.

Request:

1) For all in-scope piping and components that have been identified, either directly or as a result of the extent of condition evaluation, as being susceptible to cavitation erosion:

   a) provide the currently established time-based replacement frequency and the basis for this frequency, or

b) if a time-based replacement frequency will not be established, prior to the period of extended operation, provide the proposed aging management program for these segments or components until such time as a time-based replacement frequency is established, or

c) provide the proposed aging management program that will be used to manage this age related degradation during the period of extended operation.

2) For any other in-scope ~~stainless steel~~ piping and components in infrequently operated water systems, which were excluded from the extent of condition evaluation discussed above, provide the basis to show that a cavitation erosion degradation mechanism, similar to that identified in the above plant-specific operating experience, is not applicable, or provide appropriate aging management programs. *[Note: The "strike-out" has been made to reflect discussions with the NRC Staff.]*

APS Supplemental Response 1(a) and Response 2 to RAI: Cavitation Erosion (B2.1.6)

Supplemental Response 1(a)

(This response replaces Response 2 to RAI: Cavitation Erosion (B2.1.6) provided in APS letter no. 102-06233, dated July 30, 2010. This response provides the previous response along with new text that is underlined.)

As documented in CRAI 3337611, Engineering Study 13-MS-B089, "Cavitation in Safety Injection System," APS identified 26 components and associated piping in each PVNGS unit potentially susceptible to cavitation under design basis maximum flow conditions. All locations potentially subject to cavitation have been identified regardless of whether the potential for cavitation results from high flow, valve throttling, or flow area reduction.

One location in each unit, the HPSI recirculation piping downstream of throttle valve JSIBUV0667, has been confirmed to be susceptible to cavitation erosion, and a 7.5-year time-based replacement schedule described below has been established.

All of the remaining 25 locations identified as potentially susceptible to cavitation in Unit 2, 20 of the locations in Unit 1, and 15 of the locations in Unit 3 have been inspected by ultrasonic testing (UT) and demonstrated no degradation. The remaining five locations in Unit 1 are scheduled to be inspected in the Unit 1 fall 2011 refueling outage. Of the remaining ten locations in Unit 3, five will be inspected in the Unit 3 fall 2010 outage and five will be inspected in the Unit 3 spring 2012 outage. Therefore, the inspections in all three units will be completed no later than June 30, 2012. If any of the remaining components and associated piping is found to be susceptible to cavitation or a form of flow-related degradation, it will be incorporated into a replacement plan similar to that for the HPSI recirculation piping downstream of throttle valve JSIBUV0667.

The time-based replacement frequency for the HPSI recirculation piping downstream of throttle valve JSIBUV0667 is replacement every 7.5 years (five operating cycles) based on the assessment described below. As recorded/stated in the Prompt Operability Determination and Extent of Condition Review for CRDR No. 2932507, the following numbers describe the piping and the erosion damage:

(1) HPSI B Recirc pipe (SI-112-2") is nominal 2", schedule 160 pipe and pipe thickness = 0.343 inches

(Note: The pipe wall thickness near the failure area was measured to be a minimum of 0.330 inches. Therefore, the assumption of initial wall thickness and depth of erosion damage of 0.343 inches is conservative.)

(2) HPSI B Recirc pipe (SI-112-2") min-wall thickness = 0.141 inches

(3) HPSI B Recirc pipe (SI-112-2") elbow min-wall thickness = 0.141 inches

(4) HPSI B Recirc run time per average year = 30 to 35 hours (assumed normal operation)

(5) Depth of erosion damage = 0.343 inches (most conservative value to utilize, since pipe failed)

A review of the installation data for this specific piping and associated valves revealed that the piping was installed during original construction, prior to January 1986. No specific date could be determined. As such, it is assumed that at the time of the failure in October 2006, that the piping had seen approximately 20 years of service. Therefore, considering 20 years of normal operation, the erosion rate was:

Pipe (SI-112-2") erosion rate = 0.343 inches ÷ 20 years = 0.01715 inches per year

Applying this erosion rate, along with the piping's min-wall thickness, to determine an overall replacement timeframe:

Pipe (SI-112-2") replacement timeframe = (pipe thickness - min-wall thickness) ÷ erosion rate

= (0.341 inches - 0.141 inches) ÷ 0.01715 inches per year

(Note: The value of 0.341 inches shown here was an editorial error in the calculation that resulted in a more conservative result than if the actual value of 0.343 inches had been used.)

= 11.66 years

Since a normal operating cycle is 18 months or 1.5 years, then the replacement timeframe is equal to:

= 11.66 years ÷ 1.5 years/cycle

= 7.8 cycles

Therefore, applying additional conservatism, a further reduction in this calculated timeframe is needed and the HPSI B Recirc piping (and valve) should be preventatively replaced every 5th operating cycle.

Response 1(b)

No change to Response 1(b) provided in APS letter no. 102-06233, dated July 30, 2010.

Response 1(c)

No change to Response 1(c) provided in APS letter no. 102-06233, dated July 30, 2010.

Suplemental Response 2

(This response replaces Response 2 to RAI: Cavitation Erosion (B2.1.6) provided in APS letter no. 102-06233, dated July 30, 2010 [new text is underlined].)

The Palo Verde Apparent Cause Evaluation for CRDR No. 2932507 and the associated Engineering Study 13-MS-B089 evaluated the high pressure safety injection, low pressure safety injection, containment spray, and shutdown cooling systems for damaging cavitation erosion to identify the potential for damaging cavitation erosion. A review of stainless steel and carbon steel in-scope piping and components in infrequently operated systems which were not included in the extent of condition evaluation discussed above identified no piping or components in systems within the scope of license renewal with the potential for damaging cavitation erosion.

This cavitation erosion review was based on evaluation of:

- stainless steel and carbon steel water filled piping and components,
- infrequently operated systems (normally operating or frequently operating systems were excluded), and
- the potential for cavitation based on high/maximum flow, valve throttling, or flow area reduction.