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U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

References:

1. SECY-12-0093 – *Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance*, dated July 9, 2012 [Agencywide Documents Access and Management System (ADAMS) Accession number ML121310648]
2. Staff Requirements Memorandum (SRM) for SECY-12-0093 – *Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance*, dated December 14, 2012 (ADAMS Accession number ML12249A378)
3. NRC letter from the Director, Division of Safety Systems, Office of Nuclear Reactor Regulation to the Nuclear Energy Institute (NEI), *Nuclear Regulatory Commission Review of Generic Safety Issue-191 Nuclear Energy Institute Revised Schedule for Licensee Submittal of Resolution Path*, dated November 21, 2012

Dear Sirs:

**Subject: Palo Verde Nuclear Generating Station (PVNGS)**  
**Units 1, 2, and 3**  
**Docket Nos. STN 50-528, 50-529, and 50-530**  
**Closure Options for Generic Safety Issue (GSI) - 191,**  
***Assessment of Debris Accumulation on Pressurized-Water***  
***Reactor Sump Performance***

Consistent with References 1, 2 and 3, Arizona Public Service Company (APS) is submitting the selected option and schedule for resolution of GSI-191 for PVNGS.

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Closure Options for Generic Safety Issue (GSI) - 191, *Assessment of Debris  
Accumulation on Pressurized-Water Reactor Sump Performance*  
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Enclosure 1 to this letter documents that APS has selected Option 2A (deterministic), *Mitigative Measures and Alternative Methods Approach*, from SECY-12-0093 and provides a description of the existing mitigation measures that support the expected time frame for resolution of GSI-191. In addition, the enclosure provides the schedule for submittals to support resolution of GSI-191.

This letter contains commitments listed in Enclosure 2.

Should you need further information regarding this submittal, please contact Robert K. Roehler, Licensing Section Leader, at (623) 393-5241.

Sincerely,



FOR D.C. HIMS

DCM/RKR/CJS

Enclosure 1 – PVNGS Closure Options for Generic Safety Issue (GSI) – 191  
Enclosure 2 – APS Commitments

cc:	A.T. Howell III	NRC Region IV Regional Administrator
	J. K. Rankin	NRC NRR Project Manager for PVNGS (electronic)
	M. A. Brown	NRC Senior Resident Inspector for PVNGS

## **Enclosure 1**

**PVNGS Closure Options for Generic Safety Issue (GSI) - 191**

## **Introduction**

Arizona Public Service Company (APS) has selected Option 2A (deterministic), *Mitigative Measures and Alternative Methods Approach*, from SECY-12-0093 and intends to pursue refinements to evaluation methods and acceptance criteria for in-vessel effects. To support use of this path, and continued operation for the period required to complete the necessary analysis and testing, APS has evaluated the existing design and procedural capabilities to identify and mitigate sump strainer and in-vessel blockage. A description of these detection and mitigation measures is provided later in this document. Additionally, a summary of the margins and conservatisms that exist for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2 and 3 are also included in this document.

## **Characterization of Current Containment Fiber Status**

From the debris generation and debris transport analysis, APS has determined that 53.8 lbs of fibrous debris could be transported to the strainers, as documented in Calculation 2005-09080 (Reference 1). Based on previously performed strainer bypass testing, the total quantity of fiber calculated to bypass the strainer and be transported to the reactor fuel is 6.6 lbs. This equates to an approximate value of 12.5 g/Fuel Assembly (FA).

The fibrous debris sources considered in these analyses include: Nukon fiber and latent fiber.

## **Characterization of Strainer Head Loss Status**

APS previously provided the results of strainer head loss testing, including the impact of chemical effects, in APS letter, dated March 13, 2009 (Reference 2). The outcome of this testing demonstrates acceptable results with regard to allowable head loss. As described in the *Licensing Basis Commitments* section of this enclosure, strainer head loss will be updated in the revised Supplemental Response to Generic Letter (GL) 2004-02. Also, the existing head loss margins are described in the *Summary of Margins and Conservatism for Completed Actions for GL 2004-02* section of this enclosure.

## **Characterization of In-Vessel Effects**

APS evaluations for the quantity of fiber that is transported to the core establishes values that fall below the maximum limit (i.e., 15 g/FA) defined within WCAP-16793, Revision 2 (Reference 4), and as conditionally approved by the associated NRC safety evaluation (Reference 5). However, limited margin would be available to address potential future operability concerns or to accommodate future design changes that may necessitate an increase in the containment fiber quantity.

Accordingly, APS intends to follow the resolution strategy proposed by the Pressurized Water Reactor Owners Group (PWROG) for establishing in-vessel debris limits for the Westinghouse design that exists at PVNGS Units 1, 2 and 3. APS

acknowledges that the calculation of in-vessel fiber quantity is predicated on sump screen bypass testing performed by the strainer vendor. The method used to assess the bypass fraction is considered reasonable and appropriate, but the method has not yet been reviewed by the NRC. Further bypass testing may be necessary, pending completion of the PWROG program to assess revised in-vessel fiber limits.

### **Licensing Basis Commitments**

APS does not currently have open commitments to provide additional updates or information to the NRC regarding Generic Letter (GL) 2004-02, *Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors* (ADAMS Accession number ML042360586). However, APS currently plans to provide a revised Supplemental Response to NRC Generic Letter 2004-02 to the NRC staff by August 30, 2013, that updates the response to address operating experience in the intervening period, including validation efforts related to containment coatings.

### **Resolution Schedule**

APS is participating in the PWROG program for establishing revised in-vessel debris limits. It is expected that a topical report (e.g., WCAP) will be submitted for NRC review and approval after testing is completed. APS expects to resolve GSI-191 and GL 2004-02 for PVNGS after NRC issuance of the final safety evaluation for the topical report. APS will develop a plan for demonstrating compliance with the revised PWROG program limits and communicate that plan to the NRC within 60 days of the final NRC safety evaluation for the topical report. APS has not identified a need for additional modifications to address GSI-191.

As required by 10 CFR 50.71(e), APS will incorporate the additional margin into our current licensing basis (UFSAR, etc.) following NRC review of the updated supplemental response for PVNGS Units 1, 2 and 3 and issuance of the related safety evaluation that resolves the issue for PVNGS.

### **Summary of Actions Completed To Address GL 2004-02**

To support closure of GSI-191 and to address GL 2004-02, APS has completed the following actions for PVNGS Units 1, 2 and 3, as reported in Reference 2:

- APS has replaced both trains of the Emergency Safety Features (ESF) sump strainer structures in all three units to significantly increase the available surface area. The original design provided a simple geometry with nominal 0.09 inch square openings and a total filtering surface area of 210 ft<sup>2</sup> per train. The replacement design incorporates cartridge cassettes that provide for opposing grids of deep pocket strainers having a filtering surface area of 3,142 ft<sup>2</sup> and nominal 0.083 inch circular openings per train.
- APS removed Fiberfrax insulation from containment. Nukon insulation has been removed from around the letdown delay coils. The original reactor vessel heads that contained Min-K insulation (Unit 3) and Microtherm insulation (Units 1 and

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2) were replaced. No additional quantities of these materials remain within the potential zones of influence (ZOI) in the three units.

- APS has completed latent debris sampling and characterization, including other debris sources, and performed required plant walkdowns.
- APS has completed debris generation and debris transport analyses.
- APS is currently completing ex-vessel downstream effects analysis and net positive suction head (NPSH) analysis. This analysis incorporates the discovery of additional unqualified concrete sealer, additional inorganic zinc coatings for the required 10-diameter ZOI, and refinements in the modeling techniques requested by the NRC staff in a conference call on August 31, 2010.
- Consistent with the APS response to GL 2004-02, requested information item 2(f), programmatic and procedural changes have been established to maintain an acceptable configuration and improve control of transportable debris. This reduces potential blockage and protects the design and licensing basis.

Specifically, PVNGS procedure 81DP-0AP05, *Containment Coatings Condition Assessment*, controls the monitoring program for the containment coatings. The coatings assessment walkdowns are performed in accordance with this procedure and it provides the qualification requirements of the personnel performing the assessments. The frequency of inspections is every operating cycle.

APS is also performing inspections for latent debris prior to entering Mode 4 during refueling outages at PVNGS. This process divides the containment building into areas for inspection. The visually accessible areas are monitored. The assigned personnel that conduct the monitoring are briefed on GL 2004-02, transient combustibles procedure 14DP-0FP33, *Control of Transient Combustibles*, housekeeping expectations of procedure 30DP-0WM12, *Housekeeping*, and related operating experience.

In addition, a containment cleanliness inspection is performed as a prerequisite prior to entering Mode 4 during each refueling outage. The requirements for the inspections are documented in procedure 40ST-9ZZ09, *Containment Cleanliness Inspection*, which implements Technical Requirements Manual (TRM) Section 3.5.202, *ECCS-Operating*, surveillance requirement 3.5.202.1.

### **Summary of Margins and Conservatisms for Completed Actions for GL 2004-02**

The following provides a summary description of the margins and conservatisms associated with the actions taken to date. These margins and conservatisms provide support for the expected time frame for resolution of GSI-191 and GL 2004-02 for PVNGS Units 1, 2 and 3.

- **Debris Generation:** A conservative approach was taken to maximize the generated debris. Each Steam Generator cavity, or D-ring, was evaluated for insulation debris and the larger value of the North D-ring was applied to the South D-ring. The South D-ring was evaluated as it is closer to the recirculation sumps than the North D-ring. As a result, the total fibrous material quantities estimated to be available for transport have been conservatively determined. This also demonstrates that the calculated sump screen head loss and fuel assembly fiber load are conservatively high.
- **Debris Transport:** A conservative approach was taken to maximize the generated debris that reaches the strainers. For example, the loss of coolant accident (LOCA) generated debris is conservatively modeled as falling to the floor in the post-accident environment. Also, since there is no data on the properties of Thermo-Lag (size distribution) the affected Thermo-Lag was considered to reach the strainers. Conservative modeling of the PVNGS compartmentalized containment was used for the purposes of debris transport to maximize the amount of debris that will reach the strainers.
- **Strainer Head Loss:** The PVNGS design includes 400 ft<sup>2</sup> of sacrificial area for margin. The pre-replacement sump screen NPSH calculations for the emergency core cooling system (ECCS) and containment spray system (CS) pumps had a screen head loss value of 6.06 ft. The conclusions of the pre-GL 2004-02 NPSH calculations showed an NPSH margin of at least 3.8 ft for all pumps. The current NPSH margin is the pre-GL 2004-02 margin (3.8 ft) plus the difference between the pre-GL 2004-02 screen head loss (6.06 ft) and the current strainer head loss (4.33 ft – derived from testing) which equals  $(3.8 + 6.06 - 4.33 = 5.53)$  5.53 ft. This is the minimum margin that occurs at a sump water temperature of 193.8 degrees F. Greater margin exists at other sump water temperatures.
- **Chemical Effects:** The maximum available containment pool volume was used in the chemical effects analysis. This conservatively maximizes the production of chemical precipitates.
- **ECCS Flow:** The ECCS design automatically trips the low pressure safety injection (LPSI) pump upon a recirculation actuation signal (RAS). The performance testing conservatively assumed a need for operator action to stop a LPSI pump after one hour of recirculation. The analysis used an initial flow rate of 11,600 gpm for the first hour of recirculation and 6,600 gpm for the remainder of the performance test. The initial flow rate of 11,600 gpm is based on one LPSI pump, one high pressure safety injection (HPSI) pump and one CS pump at maximum flow rate. The 6,600 gpm is based on the CS and HPSI pumps running at maximum flow rate for the duration of the test. These flow rates and durations are considered conservative.
- **In-Vessel:** PVNGS Units 1, 2 and 3 are conservatively calculated to have less than the accepted 15 g/FA, documented in the safety evaluation for WCAP-16793 (Reference 5), bypassing the containment sump strainers (i.e., 12.5 g/FA). The calculated 12.5 g/FA is based upon the assumption that all fiber that bypasses the sump screens reaches the fuel. This is conservative, as a large fraction of the sump

flow is directed to the CS pump suction, and this debris would be expected to circulate through the CS system and not to the reactor core.

- **Containment Spray:** The CS system is assumed to remain in operation for the entire 30-day mission time following the event. This is a conservative assumption as it maximizes dissolution of non-submerged materials.

### **Summary of Defense-In-Depth (DID) Measures**

The following describes the plant specific design features and procedural capabilities that exist for detecting and mitigating a strainer blockage or fuel blockage condition.

#### **Strainer Blockage**

PVNGS Units 1, 2 and 3 have, within their Emergency Operating Procedure (EOP) framework, specific steps for monitoring for indications of containment sump strainer blockage and actions to be taken if this condition occurs. These actions are described in an APS letter, *Supplement to Response to Bulletin 2003-01*, dated March 25, 2005 (Reference 3). The actions taken in response to the Bulletin are still in effect at PVNGS Units 1, 2 and 3.

#### **Fuel (Core) Blockage**

PVNGS Units 1, 2 and 3 are low-fiber plants and conform to the NRC accepted criterion (i.e., 15 g/FA) for bypass flow to the reactor vessel (i.e., 12.5 g/FA). The containment contents (e.g., insulation materials, etc.) and sump screens are intrinsically safe by design with limited need to credit mitigation actions to ensure ample flow through the core, post-accident.

- **Detection**

Multiple methods exist for detection of a core blockage condition as manifested by an inadequate reactor coolant system (RCS) inventory or core heat removal condition. The primary detection methods include core exit thermocouples (CET) and the reactor vessel level monitoring system (RVLMS). This monitoring is initiated early in the event in the EOPs through the Safety Function Status Checks which are performed initially by the control room staff and throughout the event by personnel in the Technical Support Center (TSC). An additional method for detection of a core blockage condition includes monitoring of containment radiation levels and alarms.

- **Mitigation**

Upon identification of an inadequate RCS inventory or core heat removal condition, the EOPs direct operators to take actions to restore cooling flow to the RCS including:

- Reducing HPSI flow rate
- Refilling the Refueling Water Tank (RWT)



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- Providing core cooling by steaming through the steam generators, if available
- Filling the RCS from alternate paths
- Considering flooding containment

Although these measures are not expected to be required (due to current design margins and the low probability of beyond design basis events that may inhibit fuel cooling), they do provide additional assurance that the health and safety of the public would not be jeopardized.

### **Conclusion**

The planned APS resolution path for GSI-191, documented in this enclosure for PVNGS Units 1, 2 and 3, is consistent with NRC and industry initiatives. The execution of the actions identified in this document provides a basis for resolution of GSI-191 and closure of GL 2004-02. Given the increased surface area and design of the installed strainers, the corrective actions taken, the design margins and conservatisms inherent in the analyses performed, the defense-in-depth measures in place, and the low probability of pipe breaks, there is reasonable assurance that the health and safety of the public will be maintained.

### **References**

- 1) SDOC N001-1106-00003, Calculation 2005-09080, *Post LOCA Debris Transport for Resolution of GSI-191*, Revision 2
- 2) APS letter number 102-05973, dated March 13, 2009, *Revision 1 to Supplemental Response to NRC Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors*, (ADAMS Accession number ML090830334)
- 3) APS letter number 102-05236, dated March 25, 2005, *Supplement to Response to Bulletin 2003-01, Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized Water Reactors, Regarding Operator Actions* (ADAMS Accession number ML050950199)
- 4) Pressurized Water Reactor Owners Group (PWROG), Topical Report (TR) WCAP-16793-NP, Revision 2, *Evaluation of Long-Term Core Cooling Considering Particulate Fibrous and Chemical Debris in the Recirculating Fluid*, dated October 12, 2011
- 5) Safety Evaluation (SE) for PWROG Topical Report WCAP-16793-NP, Revision 2, *Evaluation of Long-Term Cooling Considering Particulate Fibrous and Chemical Debris in the Recirculating Fluid*, dated April 8, 2013. The SE for WCAP-16793, Revision 2 became publicly available on April 16, 2012 (ADAMS Accession number ML13084A152).

## **Enclosure 2**

### **APS Commitments**

APS makes the following commitments with regard to the resolution of Generic Safety Issue (GSI) 191 and NRC Generic Letter NRC 2004-02, *Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors*, (ADAMS Accession number ML090830334):

	<b>APS Commitments</b>	<b>Completion Date</b>
1	APS currently plans to provide a revised Supplemental Response to NRC Generic Letter 2004-02 to the NRC staff by August 30, 2013, that updates the response to address operating experience in the intervening period, including on-going validation efforts related to containment coatings.	August 30, 2013
2	APS is participating in the PWROG program for establishing revised in-vessel debris limits. It is expected that a topical report (e.g., WCAP) will be submitted for NRC review and approval after testing is completed. APS expects to resolve GSI-191 and GL 2004-02 for PVNGS after NRC issuance of the final safety evaluation for the topical report. APS will develop a plan for demonstrating compliance with the revised PWROG program limits and communicate that plan to the NRC within 60 days of the final NRC safety evaluation for the topical report.	60-days following NRC issuance of final safety evaluation for PWR Owners Group topical report