Palo Verde Nuclear Generating Station

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102-05335-GRO/TNW/GAM
August 30, 2005

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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
Responses to Request for Additional Information Related to Potential Operator Actions for Containment Sump Debris Blockage (NRC Bulletin 2003-01)

In letter no. 102-05236, dated March 25, 2005, Arizona Public Service Company (APS) provided to the NRC a supplemental response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized Water Reactors." The March 25, 2005 submittal provided the conclusions from APS' reviews of the candidate operator actions (COAs) in WCAP-16204, Revision 1, "Evaluation of Potential ERG and EPG Changes to Address NRC Bulletin 2003-01 Recommendations (PA-SEE-0085)," along with a schedule for implementation of the COAs to be pursued.

In e-mails dated June 22, 2005 and August 3, 2005, the NRC provided to APS a request for additional information (RAI) regarding the COA conclusions and implementation described in APS' March 25, 2005 submittal. Enclosed are the NRC RAI questions and APS' responses.

A103

No new commitments are being made to the NRC by this letter. If you have any questions, please contact Thomas N. Weber at (623) 393-5764.

Sincerely,

Gregg R. Overbeck

GRO/TNW/GAM

Enclosure: APS' Responses to NRC Request for Additional Information Related to March 25, 2005 Supplemental Response to Bulletin 2003-01

cc:	B. S. Mallett	NRC Region IV Regional Administrator
	M. B. Fields	NRC NRR Project Manager
	G. G. Warnick	NRC Senior Resident Inspector for PVNGS

ENCLOSURE

Arizona Public Service Company's Responses to NRC Request for Additional Information Related to March 25, 2005 Supplemental Response to Bulletin 2003-01

NRC Request, COA 3

COA 3, "Terminate One Train of HPSI/High-head Injection After Recirculation Alignment," you concluded that, given that the risk of sump blockage at PVNGS is low (see discussions of debris loading, Fiberfax, analytical conservatisms, debris source loadings, sump screen dimensions and debris transport results above), this measure would result in a net increase in plant risk.

The staff would like to know what increased the risk.

APS Response, COA 3

The current risk associated with sump screen blockage at PVNGS is considered to be very low. This position is supported, in part, by parametric analyses completed by Los Alamos National Laboratories, on behalf of NRC Research documented in NUREG/CR-6762. As documented therein, the probability of screen blockage for PVNGS Units 1, 2, and 3 is considered "Unlikely" for both small and medium sized breaks. The parametric assessment also concludes that the probability of blockage for the large break LOCA case is "Likely." Note, however, that the assessment was based on input data which was not representative of the actual conditions during a LBLOCA at Palo Verde. Specifically, flow rates assumed in the assessment following switchover from the refueling water tank to the containment sump were consistent with injection flow rates, not recirculation mode flow rates. At switchover, the low pressure safety injection pumps are automatically secured resulting in an approximate 40% reduction in flow from that assumed in the parametric assessment.

In addition, the assessment calculated the probability of blockage (and consequential loss of suction head) using the available head margin in the PVNGS NPSH analyses. These margins, however, reflect the available head margin after the calculated head loss is deducted for the current blockage assessment based on the methodology and correlations developed earlier in NUREG-0897. Correction for the available margin assuming a clean screen increases the allowable head loss by 200%.

As previously acknowledged by the NRC, the parametric assessment contained in NUREG/CR-6762 does not account for plant specific geometry and or features which may affect the quantities of debris that are generated and subsequently transported to the sump screen. Consideration of the particular distribution of the very limited quantities of fiber in containment, the relative open flow areas with corresponding low transport flow rates, the specific sump screen geometry (available surface area), and in consideration of the margins described above, results in the conclusion that the present configuration has a low probability of blockage for all accident conditions which require its operation.

(Note: A separate response to Generic Letter 2004-02 is being submitted by APS by September 1, 2005, describing the conclusions of a recently completed containment sump analysis that will result in future changes to the plant design and licensing bases. Corrective actions for compliance with the new sump analysis, including plant modifications, will be implemented by December 31, 2007, as permitted by the NRC in GL 2004-02 and described in APS' GL response.)

To assess the risk of WOG compensatory measures one must determine what the options are. In the case of sump blockage the options are:

1. Protect the safety injection (SI) pumps by shutting off one train given that sump blockage might occur.

or

2. Maintain all pumps running and suffer damage due to the possible sump blockage.

Once the options have been defined then the analyst must determine what changes to risk occur in each of the options and then compare the two to determine which option is the most appropriate.

If Palo Verde is to protect against the failure of SI due to sump blockage by shutting off one train of SI (Option 1), Palo Verde has to assume that the action would be taken prior to or during RAS actuation. If the need for the train occurs because of failure of the other train after the operator has shut the train off, then Palo Verde has to consider three additional failure modes in addition to sump blockage as a failure to maintain the function of SI. These 3 failures are:

- operator fails to diagnose the need to start the non-running train;
- non-running pumps and valves mechanically fail to operate after a demand is given; and
- control circuitry fails to position circuits to start pumps or move valves.

The three failures would be applicable for all situations considered in the PRA model, not just for the blocked sumps. This is because the emergency operating procedures (EOPs) are written such as to ensure the operators have as simple of an approach as possible. This causes instructions to be written for the more conservative situations. Thus in the case of Palo Verde all sized LOCAs would use the same strategy and not just the Large Break LOCA to which sump blockage is considered the most likely to occur.

For the Option 1 model there would be three sets of additional failure sequences. They are:

- SI normally running train fails after RAS because of sump blockage and SI backup train fails after RAS due to operator error, equipment failure, or sump blockage for Large Break LOCAs;
- SI normally running train fails before RAS and SI backup train fails due to operator error and/or equipment failure for all LOCAs; or
- SI normally running train fails after RAS and SI backup train fails due to operator error and/or equipment failure for Small or Medium LOCAs.

For the Option 2 model there would only be one additional failure sequence:

- SI trains fail after RAS because of sump blockage after a Large Break LOCA.

It should be noted that the information at the beginning of this response indicates sump blockage at Palo Verde is a very small number. It is therefore concluded that the addition of the failure sequence as described in Option 2 is not significant.

Comparing these two options shows that although a benefit could be gained from the Large Break sequences, the net result would be the addition of more failure sequences. The combined risk associated with the additional failure sequences of Option 1 would be greater than the risk associated with the additional failure sequence of Option 2.

Based upon the above information, Palo Verde's PRA recommendation is Option 2 and is considered the appropriate risk decision.

NRC Request, COA 4

COA 4, "Early Termination of One LPSI/RHR Pump Prior To Recirculation Alignment," you concluded that, given that the risk of sump blockage at PVNGS is low (see discussions of debris loading, Fiberfax, analytical conservatisms, debris source loadings, sump screen dimensions and debris transport results above), this measure would result in a net increase in plant risk.

The staff would like to know what increased the risk.

APS Response, COA 4

The current risk associated with sump screen blockage at PVNGS is considered to be very low. This position is supported, in part, by parametric analyses completed by Los Alamos National Laboratories, on behalf of NRC Research documented in

NUREG/CR-6762. As documented therein, the probability of screen blockage for PVNGS Units 1, 2, and 3 is considered "Unlikely" for both small and medium sized breaks. The parametric assessment also concludes that the probability of blockage for the large break LOCA case is "Likely." Note, however, that the assessment was based on input data which was not representative of the actual conditions during a LBLOCA at Palo Verde. Specifically, flow rates assumed in the assessment following switchover from the refueling water tank to the containment sump were consistent with injection flow rates, not recirculation mode flow rates. At switchover, the low pressure safety injection pumps are automatically secured resulting in an approximate 40% reduction in flow from that assumed in the parametric assessment.

In addition, the assessment calculated the probability of blockage (and consequential loss of suction head) using the available head margin in the PVNGS NPSH analyses. These margins, however, reflect the available head margin after the calculated head loss is deducted for the current blockage assessment based on the methodology and correlations developed earlier in NUREG-0897. Correction for the available margin assuming a clean screen increases the allowable head loss by 200%.

As previously acknowledged by the NRC, the parametric assessment contained in NUREG/CR-6762 does not account for plant specific geometry and or features which may affect the quantities of debris that are generated and subsequently transported to the sump screen. Consideration of the particular distribution of the very limited quantities of fiber in containment, the relative open flow areas with corresponding low transport flow rates, the specific sump screen geometry (available surface area), and in consideration of the margins described above, results in the conclusion that the present configuration has a low probability of blockage for all accident conditions which require its operation.

(Note: A separate response to Generic Letter 2004-02 is being submitted by APS by September 1, 2005, describing the conclusions of a recently completed containment sump analysis that will result in future changes to the plant design and licensing bases. Corrective actions for compliance with the new sump analysis, including plant modifications, will be implemented by December 31, 2007, as permitted by the NRC in GL 2004-02 and described in APS' GL response.)

To assess the risk of WOG compensatory measures one must determine what the options are. In the case of sump blockage the options are:

1. Protect the safety injection (SI) pumps by shutting off one train given that sump blockage might occur.

or

2. Maintain all pumps running and suffer damage due to the possible sump blockage.

Once the options have been defined then the analyst must determine what changes to risk occur in each of the options and then compare the two to determine which option is the most appropriate.

If Palo Verde is to protect against the failure of SI due to sump blockage by shutting off one train of SI (Option 1), Palo Verde has to assume that the action would be taken prior to or during RAS actuation. If the need for the train occurs because of failure of the other train after the operator has shut the train off, then Palo Verde has to consider three additional failure modes in addition to sump blockage as a failure to maintain the function of SI. These 3 failures are:

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- non-running pumps and valves mechanically fail to operate after a demand is given; and
- control circuitry fails to position circuits to start pumps or move valves.

The three failures would be applicable for all situations considered in the PRA model, not just for the blocked sumps. This is because the emergency operating procedures (EOPs) are written such as to ensure the operators have as simple of an approach as possible. This causes instructions to be written for the more conservative situations. Thus in the case of Palo Verde all sized LOCAs would use the same strategy and not just the Large Break LOCA to which sump blockage is considered the most likely to occur.

For the Option 1 model there would be three sets of additional failure sequences. They are:

- SI normally running train fails after RAS because of sump blockage and SI backup train fails after RAS due to operator error, equipment failure, or sump blockage for Large Break LOCAs;
- SI normally running train fails before RAS and SI backup train fails due to operator error and/or equipment failure for all LOCAs; or
- SI normally running train fails after RAS and SI backup train fails due to operator error and/or equipment failure for Small or Medium LOCAs.

For the Option 2 model there would only be one additional failure sequence:

- SI trains fail after RAS because of sump blockage after a Large Break LOCA.

It should be noted that the information at the beginning of this response indicates sump blockage at Palo Verde is a very small number. It is therefore concluded that the addition of the failure sequence as described in Option 2 is not significant.

Comparing these two options shows that although a benefit could be gained from the Large Break sequences, the net result would be the addition of more failure sequences. The combined risk associated with the additional failure sequences of Option 1 would be greater than the risk associated with the additional failure sequence of Option 2.

Based upon the above information, Palo Verde's PRA recommendation is Option 2 and is considered the appropriate risk decision.

NRC Request, COA 5

> COA 5, "Refill of Refueling Water Storage Tank," you concluded that PVNGS would implement this COA for its RWTs (since this measure requires "considerable change to the current event mitigation strategy," and therefore extensive training will be needed, the scheduled completion date is February 24, 2006) - ICM category #3.
>
> The staff would like to know whether the filling begins after switchover or after loss of sump recirculation. Also the staff would like to know the basis for waiting until February 24, 2006 for completing this item.

APS Response, COA 5

Because of plant configuration, refill of the RWT will begin after switchover. Palo Verde is not able to refill the tank while the ECCS pumps are using the RWT as source of water. Once the suction path is swapped to the RAS sump, actions can be taken to begin refill of the RWT.

The basis for the February 24, 2006 implementation date is the support of needed operator training. This EOP revision is complex enough to warrant considerable review, discussion, and practice prior to implementation. A review of the training schedule for the Operations personnel determined that implementation of the changes prior to requalification examinations typically conducted during the summer months would not be prudent and would unnecessarily place operator licenses at risk. Sufficient time prior to the examinations was not available to properly train the operators on the differences in philosophy of ECCS equipment operation during LOCA conditions that require suction transfer from the RWT to the RAS sump. A single training cycle is scheduled following the examination period. This training cycle will be conducted during a steam generator replacement outage. The training provided during that time period will focus on the review and discussion of the EOP changes (what is changing and why it needs to change). Additionally, the information provided during this training cycle will focus on the differences between equipment performance issues and indications of blocked RAS sumps. The next training cycle will anchor this training with specific focus on simulator scenarios to allow the operators to practice the new actions and better understand the overall change.

NRC Request, COA 6

COA 6, "Inject More Than One RWST Volume From a Refilled RWST or By Bypassing the RWST," you concluded that this action is for a beyond design basis situation and would therefore be coordinated by the Technical Support Center (TSC) in accordance with the Severe Accident Management Guidelines (SAMGs).

The staff would like to know more about the lineups for this item. We need a short summary of the various proven paths readily available to the operator (what are the sources?).

APS Response

The SAMG procedures would provide direction to use the additional volume provided by the refill of the RWT. The transfer of greater than one RWT volume to containment is outside the design bases of the plant and may exceed the containment flooding limit with the potential for submergence of equipment and instrumentation inside containment that may be required for the recovery. The SAMG procedures are designed to manage and maintain fission product barriers following events conditions that are beyond the design basis accidents. Palo Verde will use the guidance provided to inject the volume that is necessary to maintain the core covered. The volume from the refilled RWT could be injected into the RCS by:

- Any available charging pump via the normal or alternate charging line
- A HPSI or LPSI pump via the hot/cold leg injection lines

This volume transfer would be repeated as required to maintain the core covered.

The need to bypass the RWT would be identified early in a sump blockage event according to the guidance provided in response to COA 8 (Guidance on Symptoms and Identification of Containment Sump Blockage) and COA 9 (Contingency Actions). The injection methods will depend on alignment of alternate sources of water to any available safety injection or charging pump through the normal injection alignments. The alternate sources of water available to provide the needed suction volume for continued operation of these pumps could include the spent fuel pool, reactor makeup water tank (RMWT), recycle monitor tanks (RMT), volume control tank (VCT), holdup tank (HUT), total dissolved solids (TDS) tanks, condensate storage tank (CST), and demineralized water storage tank (DWST). Additionally, the ability to batch additional volume would be included as an alternate source of water.

NRC Request, COA 7

COA 7, "Provide More Aggressive Cooldown and Depressurization Following a Small Break LOCA," you concluded that APS would make the procedure changes and complete the associated operator training by February 24, 2006 - ICM category #2.

The staff would like more specific information on the procedure changes. Also the staff would like to know the basis for waiting until February 24, 2006 for completing this item.

Palo Verde is the only plant to do rapid cooldown only after LOCA isolation. It is not understood why that is a consideration. If you cooldown and depressurize for a small or medium break LOCA, it is moot whether the break has been isolated, and you have avoided recirculation. The licensee should reconsider this restriction.

Also, for COA 7 it would be best if the licensee stated where the rapid cooldown direction to the operators is in the procedures (e.g., EP ##, EOP ##, etc.).

APS Response, COA 7

Palo Verde intends to incorporate the proposed clarification in definition of controlled and rapid cooldowns. The LOCA strategy currently refers to using a controlled cooldown and depressurization after the break is isolated. The introduction for the LOCA strategy directs that a rapid cooldown and depressurization be performed if the break can not be isolated. The distinction between controlled and rapid is not explained in the basis of the guideline. For consistency, the term controlled cooldown was adopted by the PWG in the past to be used throughout the EPGs. The case of LOCA, ESDE, and SGTR are mentioned briefly in the bases as an exception when the cooldown should be more aggressive to limit inventory losses. The EPG definition for a controlled cooldown implies that the operator is in control of the cooldown, i.e., the cooldown is within the designed reset capabilities of MSIS and SIAS, or the operator has the ability to stop or maintain a given pressure and temperature band.

A rapid cooldown is now defined as a controlled cooldown performed at or as close to the Tech Spec limit as can be achieved for the current plant conditions (maximum allowed cooldown rate).

Controlled cooldown rate would be used if the LOCA was isolated. Rapid cooldown would be used if the LOCA is not isolated.

The basis for the February 24, 2006 implementation date is the support of needed operator training. This EOP revision is complex enough to warrant considerable review, discussion, and practice prior to implementation. A review of the training schedule for the Operations personnel determined that implementation of the changes prior to requalification examinations typically conducted during the summer months would not be prudent and would unnecessarily place operator licenses at risk. Sufficient time prior to the examinations was not available to properly train the operators on the differences in philosophy of ECCS equipment operation during LOCA conditions that require suction transfer from the RWT to the RAS sump. A single training cycle is scheduled following the examination period. This training cycle will be conducted during a steam generator replacement outage. The training provided during that time period will focus on the review and discussion of the EOP changes (what is changing and why it needs to change). Additionally, the information provided during this training cycle will focus on the differences between equipment performance issues and indications of blocked RAS sumps. The next training cycle will anchor this training with specific focus on simulator scenarios to allow the operators to practice the new actions and better understand the overall change.

The information regarding cooldown after a LOCA is isolated is provided in the current revisions of the LOCA and Functional Recovery EOPs, 40EP-9EO03 and 40EP-9EO09, with no distinction between the considerations of a rapid versus controlled cooldown approach. Implementation of the changes needed to support incorporation of COA 7 will introduce this distinction. That change will delineate the need for a rapid cooldown if the LOCA is not isolated. A controlled cooldown approach would be employed if the break is isolated. The current direction in the LOCA Optimal Recovery procedure adequately addresses the cooldown requirements following isolation of a break. Currently, the WCAP guidance directs a transition from the LOCA Optimal Recovery procedure to the Functional Recovery procedure if a rapid cooldown is needed. This approach will be used during the revision of the Palo Verde EOPs.

NRC Request, COA 8

> COA 8, "Provide Guidance on Symptoms and Identification of Containment Sump Blockage," you concluded that APS would implement procedure changes and associated operator training by February 24, 2006 - ICM category #1.
>
> The staff would like more specific information - implementing what changes to operator monitoring of what indications? Also the staff would like to know the basis for waiting until February 24, 2006 for completing this item.

APS Response, COA 8

The current operator training includes the monitoring of operating emergency core cooling system (ECCS) and containment spray system (CSS) pumps for indications of pump distress or loss of net positive suction head (NPSH), such as erratic current, flow or discharge pressure. Utilizing all available instrumentation to identify symptoms of containment sump blockage or degraded ECCS pump performance may enhance the current training. General symptoms of pump distress (erratic current, flow or discharge pressure) could be used in combination with sump level to determine sump blockage.

Trending and alarms to alert operators to deviations from nominal performance should be established. Alarm setpoints should be determined on a plant specific basis. The intent is to provide notification of off-normal ECCS performance. Typical indications of loss of suction include:

- Reduced/erratic flow
- Reduced/erratic discharge pressure
- Reduced/erratic motor current

The following specific parameters that operators could monitor as indications of sump blockage:

- Containment recirculation sump level
- ECCS pump flow
- ECCS pump vibration
- ECCS pump current
- ECCS pump discharge pressure
- Charging pump discharge pressure
- Charging pump flow
- Charging pump current

Once in service, a baseline 'normal' trend for each pump should be established. Assuming no changes in system configuration, expect all parameters to be similarly affected by changes in containment pressure and sump water temperature. Containment water level should remain relatively constant after the refueling water storage tank (RSWT) is transferred to containment. Unexpected increase in sump level may indicate in-leakage from component cooling water or essential service water systems. Lowering sump level may indicate an ECCS leakage outside containment, or pooling inside containment due to blocked chokepoints along the return path to the containment sump.

Individual pump mechanical degradation would be indicated by unexpected reduction or erratic behavior in pump flowrate, discharge pressure and motor current. Concurrently, other pumps operating on the same suction source would continue to trend as expected.

The containment sump screens are designed to filter out debris and provide adequate suction flow to the ECCS pumps. Debris buildup on sump screens will impair suction flow return to the ECCS pumps. Excessive debris blockage will adversely affect ECCS pump performance and may result in loss of net positive suction head (NPSH), severe cavitation, and potential pump failure. A minor Head loss would have minimal affect on pump performance. Moderate Head loss may be accompanied by noticeable reductions in flow and discharge pressure. A large Head loss would result in significant flow reduction, unstable pump operation and eventually cavitation will occur.

If sump blockage were to occur, as evident by the inability to satisfy the Safety Function Status Checks, the operators would transition from the LOCA Optimal Recovery Guideline to the Functional Recovery Guideline (FRG) and continue to monitor/restore the Safety Functions. In parallel, management (i.e., the Technical Support Center (TSC) could be called on to provide additional guidance and recommendations. Additionally, transition to the Severe Accident Management Guidelines (SAMGs) may occur in the attempt to restore core cooling and RCS inventory control.

The basis for the February 24, 2006 implementation date is the support of needed operator training. This EOP revision is complex enough to warrant considerable review, discussion, and practice prior to implementation. A review of the training schedule for the Operations personnel determined that implementation of the changes prior to requalification examinations typically conducted during the summer months would not be prudent and would unnecessarily place operator licenses at risk. Sufficient time prior to the examinations was not available to properly train the operators on the differences in philosophy of ECCS equipment operation during LOCA conditions that require suction transfer from the RWT to the RAS sump. A single training cycle is scheduled following the examination period. This training cycle will be conducted during a steam generator replacement outage. The training provided during that time period will focus on the review and discussion of the EOP changes (what is changing and why it needs to change). Additionally, the information provided during this training cycle will focus on the differences between equipment performance issues and indications of blocked RAS sumps. The next training cycle will anchor this training with specific focus on simulator scenarios to allow the operators to practice the new actions and better understand the overall change.

NRC Request, COA 9

> COA 9, "Develop Contingency Actions in Response to: Containment Sump Blockage, Loss of Suction, and Cavitation," you concluded that APS would implement this COA as an outgrowth of its implementation of COAs 5, 7 and 8 discussed above, with completion by February 24, 2006 - ICM category #1.
>
> The staff would like more specific information - will you implement the Sump Blockage control Room Guideline from the WCAP? Also the staff would like to know the basis for waiting until February 24, 2006 for completing this item.
>
> The statement "Guidance provided by the WCAP will be used to define the needed actions within the SAMGs" is very nebulous. Are they implementing the WCAP Sump Blockage Control Room Guideline (SBCRG) or some other part of the WCAP? Most importantly, what actions are the operators prepared to take if the sump clogs (a listing of the actions would be appropriate, not a lot of detail needed, but all should be mentioned)?

APS Response, COA 9

As previously discussed, Palo Verde would transition from the EOPs to the SAMGs in the event that actions taken in the FRG were not sufficient to satisfy the Safety Function Status Checks. Guidance provided by the WCAP will be used to define the needed actions within the SAMGs.

The basis for the February 24, 2006 implementation date is the support of needed operator training. This EOP revision is complex enough to warrant considerable review, discussion, and practice prior to implementation. A review of the training schedule for the Operations personnel determined that implementation of the changes prior to requalification examinations typically conducted during the summer months would not be prudent and would unnecessarily place operator licenses at risk. Sufficient time prior to the examinations was not available to properly train the operators on the differences in philosophy of ECCS equipment operation during LOCA conditions that require suction transfer from the RWT to the RAS sump. A single training cycle is scheduled following the examination period. This training cycle will be conducted during a steam generator replacement outage. The training provided during that time period will focus on the review and discussion of the EOP changes (what is changing and why it needs to change). Additionally, the information provided during this training cycle will focus on the differences between equipment performance issues and indications of blocked RAS sumps. The next training cycle will anchor this training with specific focus on simulator scenarios to allow the operators to practice the new actions and better understand the overall change.

A review of the information provided by the WCAP determined that the reference Sump Blockage Control Room Guideline (SBCRG) is a part of the information contained in COA A9-W (Westinghouse Plants Develop Contingency Actions in Response to: Containment Sump Blockage, Loss of Sump, and Cavitation. There is no mention of a similar guidance for the Combustion Engineering plants. The information contained in the WCAP specific to the CE facilities will be the primary source of information used during the development of needed EOP changes to support implementation of COA 9. A review of the Sump Blockage Control Room Guideline (SBCRG) will be included as additional information to understand the Westinghouse approach and to determine if there are additional actions to consider.

NRC Request, COA 10

> COA 10, "Early Termination of One Train of HPSI/High Head Injection Prior to Recirculation Alignment," you concluded that, given that the risk of sump blockage at PVNGS is low (see discussions of debris loading, Fiberfax, analytical conservatisms, debris source loadings, sump screen dimensions and debris transport results above), this measure would result in a net increase in plant risk.

The staff would like to know what increased the risk.

APS Response, COA 10

The current risk associated with sump screen blockage at PVNGS is considered to be very low. This position is supported, in part, by parametric analyses completed by Los Alamos National Laboratories, on behalf of NRC Research documented in NUREG/CR-6762. As documented therein, the probability of screen blockage for PVNGS Units 1, 2, and 3 is considered "Unlikely" for both small and medium sized breaks. The parametric assessment also concludes that the probability of blockage for the large break LOCA case is "Likely." Note, however, that the assessment was based on input data which was not representative of the actual conditions during a LBLOCA at Palo Verde. Specifically, flow rates assumed in the assessment following switchover from the refueling water tank to the containment sump were consistent with injection flow rates, not recirculation mode flow rates. At switchover, the low pressure safety injection pumps are automatically secured resulting in an approximate 40% reduction in flow from that assumed in the parametric assessment.

In addition, the assessment calculated the probability of blockage (and consequential loss of suction head) using the available head margin in the PVNGS NPSH analyses. These margins, however, reflect the available head margin after the calculated head loss is deducted for the current blockage assessment based on the methodology and correlations developed earlier in NUREG-0897. Correction for the available margin assuming a clean screen increases the allowable head loss by 200%.

As previously acknowledged by the NRC, the parametric assessment contained in NUREG/CR-6762 does not account for plant specific geometry and or features which may affect the quantities of debris that are generated and subsequently transported to the sump screen. Consideration of the particular distribution of the very limited quantities of fiber in containment, the relative open flow areas with corresponding low transport flow rates, the specific sump screen geometry (available surface area), and in consideration of the margins described above, results in the conclusion that the present configuration has a low probability of blockage for all accident conditions which require its operation.

(Note: A separate response to Generic Letter 2004-02 is being submitted by APS by September 1, 2005, describing the conclusions of a recently completed containment sump analysis that will result in future changes to the plant design and licensing bases. Corrective actions for compliance with the new sump analysis, including plant modifications, will be implemented by December 31, 2007, as permitted by the NRC in GL 2004-02 and described in APS' GL response.)

To assess the risk of WOG compensatory measures one must determine what the options are. In the case of sump blockage the options are:

1. Protect the safety injection (SI) pumps by shutting off one train given that sump blockage might occur.

or

2. Maintain all pumps running and suffer damage due to the possible sump blockage.

Once the options have been defined then the analyst must determine what changes to risk occur in each of the options and then compare the two to determine which option is the most appropriate.

If Palo Verde is to protect against the failure of SI due to sump blockage by shutting off one train of SI (Option 1), Palo Verde has to assume that the action would be taken prior to or during RAS actuation. If the need for the train occurs because of failure of the other train after the operator has shut the train off, then Palo Verde has to consider three additional failure modes in addition to sump blockage as a failure to maintain the function of SI. These 3 failures are:

- operator fails to diagnose the need to start the non-running train;
- non-running pumps and valves mechanically fail to operate after a demand is given; and
- control circuitry fails to position circuits to start pumps or move valves.

The three failures would be applicable for all situations considered in the PRA model, not just for the blocked sumps. This is because the emergency operating procedures (EOPs) are written such as to ensure the operators have as simple of an approach as possible. This causes instructions to be written for the more conservative situations. Thus in the case of Palo Verde all sized LOCAs would use the same strategy and not just the Large Break LOCA to which sump blockage is considered the most likely to occur.

For the Option 1 model there would be three sets of additional failure sequences. They are:

- SI normally running train fails after RAS because of sump blockage and SI backup train fails after RAS due to operator error, equipment failure, or sump blockage for Large Break LOCAs;
- SI normally running train fails before RAS and SI backup train fails due to operator error and/or equipment failure for all LOCAs; or
- SI normally running train fails after RAS and SI backup train fails due to operator error and/or equipment failure for Small or Medium LOCAs.

For the Option 2 model there would only be one additional failure sequence:

- SI trains fail after RAS because of sump blockage after a Large Break LOCA.

It should be noted that the information at the beginning of this response indicates sump blockage at Palo Verde is a very small number. It is therefore concluded that the addition of the failure sequence as described in Option 2 is not significant.

Comparing these two options shows that although a benefit could be gained from the Large Break sequences, the net result would be the addition of more failure sequences. The combined risk associated with the additional failure sequences of Option 1 would be greater than the risk associated with the additional failure sequence of Option 2.

Based upon the above information, Palo Verde's PRA recommendation is Option 2 and is considered the appropriate risk decision.