APS

Palo Verde Nuclear
Generating Station

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102-05465-CDM/TNW/GAM
April 19, 2006

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
Response to NRC Request for Additional Information (RAI)
Regarding Revised Station Blackout Evaluation

By letter dated March 21, 2006, the NRC provided to Arizona Public Service Company (APS) a request for additional information (RAI) regarding the revised PVNGS station blackout evaluation that was submitted to the NRC by APS letter no. 102-05370, dated October 28, 2005. A 30-day response was requested. APS' response to the RAI is in Enclosure 1. In addition, a revised Table 5 from the October 28, 2005 submittal is provided in Enclosure 2 that corrects two typographical errors.

No 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,

David Mauldin

CDM/TNW/GAM/

Enclosures: 1. APS' Response to NRC Request for Additional Information (RAI) Regarding Revised Station Blackout Evaluation
2. Corrected Table 5 from the October 28, 2005 submittal

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

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ENCLOSURE 1

ARIZONA PUBLIC SERVICE COMPANY'S RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING REVISED STATION BLACKOUT EVALUATION

QUESTIONS RELATED TO THE ELECTRICAL AREA

NRC Question 1 (Electrical Area)

In Table 2 of the October 28, 2005, letter, main essential lighting panel load is shown as 90 kW. Table 8.3-3, page 8.3-6 of the Updated Final Safety Analysis Report indicates this load as 160 kW. Provide an explanation for this difference.

APS Response 1 (Electrical Area)

The value of 160 kW for the main essential lighting panel EQBND91 shown on FSAR Table 8.3-3, Sheet 7 of 13 (page 8.3-26), is the electrical rating of the main essential lighting panel, as noted by the column title. The value of 90 kW shown for the main essential lighting panel 1EQBND91 in Table 2, Page 1 of 3, in the October 28, 2005 SBO evaluation submittal reflects the calculated total load value, derived from the sum total of the sub-panels and rounded-off to the next higher multiple of 5 kW.

NRC Question 2 (Electrical Area)

In the October 28, 2005, letter, it is stated that the 2-way radio system has a 4-hour battery system and will be transferred to the gas turbine generator (GTG). Is the load included in Table 2 of the amendment request? If so, please identify this load.

APS Response 2 (Electrical Area)

Panel 1EQFND23, "Comm EQ UPS Power Supply Distribution Panel," serves the Unit 1 in-plant radio equipment. This load is shown in Table 2, Page 1 of 3, in the October 28, 2005 SBO evaluation submittal.

NRC Question 3 (Electrical Area)

Please confirm that the loading (3364.3 kW) shown in Table 2 of the October 28, 2005, letter represents the worst case loading for both trains of all three units.

APS Response 3 (Electrical Area)

The 3364.3 kW total load shown in Table 2, Page 3 of 3, in the October 28, 2005 SBO evaluation submittal is from the Unit 1 electrical distribution system model, and bounds the bus loading of Units 2 and 3. The load equipment is similar for all three units, but, due to slight variations such as motor brake horsepower, the Unit 1 loading is the highest, and is therefore bounding. Values are for Load Group 1, A train. B train loading is not provided since it is not the credited train for a station blackout event.

QUESTIONS RELATED TO THE HUMAN PERFORMANCE AREA
(These questions are in reference to Item 7 of the Coping Study)

NRC Question 1 (Human Performance Area)

With the exception of the operator actions in step D, are there any other new operator actions that take place after the actuation of the alternate alternating current (AAC) power source? This question also applies to the operator actions listed in Item 3, part A of Procedures. If so, what was the basis for including these particular actions as they relate to the extended coping period?

APS Response 1 (Human Performance Area)

No additional operator actions for the 16 hour SBO coping are required. The operator actions identified in the October 28, 2005 submittal, Step d under Section B, "Coping Study," Item 7, "Reactor Coolant Inventory Loss," and Part a under Section C, "Procedures," Item 3, "SBO Response Procedures," (referred to as "step D" and "Item 3, part A of Procedures" in the NRC question) can be summarized as follows:

Time, hrs	Operator Action
1	• Operator opens ADVs on each SG to close MSSVs and approach 570° F T_{cold}. • Operator adjusts AFW to maintain SG level/match ADV flow. • HPSI pump is loaded onto the GTG-energized bus, and flow initiates (and is controlled not to exceed 126 gpm).
4	• Operator opens the ADVs on each SG to initiate a ~ 30° F/hr cooldown, and is adjusted hourly to sustain cooldown. • Operator opens the pressurizer vent valve to limit the increase in subcooling.
~ 8	• Place spent fuel pool cooling in service. • Direct maintenance personnel to connect the supplemented control air system as necessary.
13	• Operator adjusts ADVs to terminate the cooldown.
13.3	• Operator controls HPSI (≤ 105 gpm) to limit pressurizer level increases.
~ 16	• Place shutdown cooling in service.

NRC Question 2 (Human Performance Area)

> **What was the justification for using the pressurizer vent valves as opposed to the auxiliary spray to control Reactor Coolant System (RCS) pressure after 4 hours of an SBO and preceding operator actions in step D?**

APS Response 2 (Human Performance Area)

The operating procedures for SBO direct the operators to utilize available systems to control RCS pressure. For the limiting SBO 16-hour coping analysis, the pressurizer vent valve is specified to control RCS pressure in conjunction with a HPSI pump because it is assumed that a charging pump would not be available to provide auxiliary spray.

NRC Question 3 (Human Performance Area)

> **How will the simulator be modeled and validated to meet the estimated response times listed on Table 5 for the operators using the revised procedures?**

APS Response 3 (Human Performance Area)

No changes to the simulator are required for a 16 hour SBO event. The fidelity of the simulator has been validated (ANSI/ANS 3.5) by simulation of other limiting events such as steam generator tube rupture and natural circulation. An SBO event does not introduce any new challenges to operators and, therefore, specific validation would not be required. Time responses to mitigate the SBO are similar to other events that operators are trained for.

QUESTIONS RELATED TO THE REACTOR SYSTEM AREA

NRC Question 1 (Reactor System Area)

The PVNGS 16-hour SBO coping analysis was performed using the CENTS code to model the behavior of the RCS. Provide the basis for using the CENTS Code for this use.

APS Response 1 (Reactor System Area)

As documented in the December 1, 2003, NRC Safety Evaluation Report (SER) related to Westinghouse topical report WCAP-15996 (packaged in the front of each volume of the latest approved version, Revision 1, of the topical), CENTS is approved for application to small breaks in the primary system for demonstrating compliance with non-LOCA criteria.

In addition, the benchmark testing of CENTS (documented in Volume 4 of WCAP-15996) included the steam generator tube rupture (SGTR) event which introduces the two major phenomena that also drive the station blackout (SBO) event: (1) natural circulation (due to loss of AC power); and (2) loss of reactor coolant. Further, the SBO event is well bounded by the SGTR event with regard to the RCS leak rate, as the SGTR event assumes a leak rate that is more than a factor of two larger.

NRC Question 2 (Reactor System Area)

The 16-hour SBO coping strategy includes several operator actions. For example, after the actuation of the AAC power source at one hour into the event, operator actions are necessary to (1) open the steam generator (SG) atmospheric dump valves (ADVs) for decay heat removal; (2) adjust the auxiliary feedwater system to match the ADV flow to maintain SG level; and (3) load the high-pressure safety injection (HPSI) pump onto the GTG-energized bus to deliver flow as the RCS pressure drops below the HPSI pump shutoff head to maintain RCS inventory, subcooling, and natural circulation. At four hours, the following operator actions are required to start a cooldown to shutdown cooling entry condition during the remaining 12 hours of the coping period: (1) adjusting ADVs hourly to sustain an approximately 30 °F/hr cooldown; and (2) opening the pressurizer vent valve to maintain the RCS pressure and inventory.

Describe how the CENTS Code was controlled to reflect these operator actions.

APS Response 2 (Reactor System Area)

Control room operator actions were simulated by manipulating CENTS input parameters.

<u>One-hour to four-hour period</u>

After actuation of the alternate AC (AAC) source at one hour, the following operator actions are assumed and modeled:

A. To maintain RCS heat removal, the operator is assumed to open the atmospheric dump valves (ADVs) to reduce cold leg temperature below 570 °F.

   Modeling: A time-dependent ADV opening area was specified as input to the CENTS simulation based on a hand-calculated estimate of the valve area required to pass the steam flow needed to remove decay heat at this time.

B. To maintain adequate steam generator (SG) level, the operator controls auxiliary feedwater (AFW) flow.

   Modeling: To approximate this operator action, input to CENTS specifies that AFW flow be set equal to the ADV flow starting at one hour.

C. To establish and maintain adequate pressurizer level, the operator is assumed to start one high pressure safety injection (HPSI) pump and maintain adequate subcooling.

   Modeling: This operator action was approximated with input to CENTS which specified both a time to initiate HPSI pump flow and specified a limit on the maximum flow rate.

<u>Four-hour to 16-hour period</u>

A. The operator initiates a cooldown to assure adequate subcooling can be maintained, for entry into shutdown cooling (SDC). To initiate and progress through the cooldown requires the operator to further open the ADVs to exceed decay heat removal and to attain a desired cooldown rate as temperature trending would indicate.

   Modeling: These actions were input to CENTS by specifying a time dependent / hourly-adjusted ADV opening area based on a hand-calculated estimate of the steam flow required to remove decay heat plus sensible heat corresponding to 30 °F/hr.

B. The operator adjusts AFW flow to maintain SGs level.

   Modeling: To model this action, input to CENTS continues to specify that AFW flow be set equal to the ADV flow.

C. *To control RCS subcooling, the operator is assumed to open the pressurizer vent valve as needed to limit the increase in subcooling.*

Modeling: This action is modeled in CENTS with a time-dependent valve area which is stepped to the full-open position at four hours.

D. Termination of cooldown. Once shutdown cooling entry conditions are reached, the operator would throttle back on ADV flow to terminate the secondary side cooldown, adjust the AFW (to maintain SG level), and regulate HPSI flow (to maintain pressurizer level).

Modeling: All these actions were modeled with CENTS input as previously described. The CENTS simulation indicates that the vent valve can remain open after termination of the cooldown as adequate subcooling is sustained to the end of the simulation at 16 hours.

Summary of Operator Actions

Although specifically timed actions are used in the CENTS simulation, the results not only demonstrate a capability to cope for 16 hours following a Station Blackout event, but also show a degree of flexibility in the timing / degree of actions taken. In particular, significant margin exists in terms of available condensate and reactor coolant makeup inventories.

ENCLOSURE 2

CORRECTED TABLE 5 FROM THE OCTOBER 28, 2005 SUBMITTAL

Table 5 SBO Design Case (111 gpm RCS and RCP leakage) Controlled with HPSI Sequence of Events		
Time, sec	Parameter	Value
0	SBO conditions arise. Total RCP seal + TS 3.4.14 max. allowed leakage assumed, gpm. Turbine / reactor trip.	- - 111 - -
10	MSSVs open.	- -
800	AFW flow is initiated as a result of ~~on~~ low SG level, lb_m/sec.	93
3600	Operator opens ADVs on each SG to close MSSVs and approach 570 °F T_{cold}. Operator adjusts AFW to maintain SG level/match ADV flow. HPSI pump is loaded onto the GTG-energized bus, and flow initiates (and is controlled not to exceed 126 gpm) as RCS pressure drops below shutoff head, psia.	- - - - 1715
14400	Operator opens the ADVs on each SG to initiate a ~ 30 °F/hr cooldown, and is adjusted hourly to sustain cooldown. Operator opens the pressurizer vent valve to limit the increase in subcooling.	- - - -
~ 40000	SDC entry pressure is achieved, psig.	435
~ 43000	SDC entry temperature achieved, °F.	<350
46800	Operator adjusts ADVs to terminate the cooldown.	- -
48000	Operator controls HPSI (≤ ~~405~~ 105 gpm) to limit pressurizer level increases.	