October 31, 2006

Mr. James M. Levine
Executive Vice President, Generation
Arizona Public Service Company
P. O. Box 52034
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 - REVISED STATION BLACKOUT COPING DURATION (TAC NOS. MC8787, MC8788, AND MC8789)

Dear Mr. Levine:

By letter dated October 28, 2005, Arizona Public Service Company (APS) submitted an application to increase the station blackout (SBO) coping duration, to gain margin relative to nuclear safety, for the Palo Verde Nuclear Generating Station, Units 1, 2, and 3. Supplemental information was provided by APS in letters dated April 19 and June 9, 2006.

As detailed in the enclosed Safety Evaluation, the Nuclear Regulatory Commission staff finds the extension of the SBO coping duration from 4 hours to 16 hours to be in conformance with the SBO Rule contained in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.63. This letter constitutes the regulatory assessment of the proposed changes to the SBO coping duration under 10 CFR 50.63(c)(3).

Sincerely,

/RA/

David Terao, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, STN 50-529,
and STN 50-530

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO REVISED STATION BLACKOUT COPING DURATION

ARIZONA PUBLIC SERVICE COMPANY, ET AL.

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3

DOCKET NOS. STN 50-528, STN 50-529, AND STN 50-530

1.0 INTRODUCTION

By application dated October 28, 2005 (Agencywide Documents and Access Management System (ADAMS) Accession No. ML053120390), Arizona Public Service Company (APS or the licensee) submitted an application to revise the station blackout (SBO) coping duration for the Palo Verde Nuclear Generating Station (Palo Verde/PVNGS), Units 1, 2, and 3. Supplemental information was provided by the licensee in letters dated April 19 (ADAMS Accession No. ML061160289) and June 9, 2006 (ADAMS Accession No. ML061720037). The licensee proposes to increase the SBO coping duration from 4 hours to 16 hours to gain margin relative to nuclear safety.

The term "station blackout" refers to the complete loss of alternating current (AC) electric power to the essential and nonessential switchgear buses in a nuclear power plant. SBO, therefore, involves the loss of offsite power (LOOP) concurrent with turbine trip and failure of the onsite emergency AC power system, but not the loss of available AC power to buses fed by station batteries through inverters or the loss of power from any alternate AC source.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.63, “Loss of all alternating current power,” (SBO rule) requires that each light-water-cooled nuclear power plant be able to withstand an SBO and maintain adequate reactor core cooling and containment integrity for a specified duration. The SBO rule also requires licensees to submit information as defined in Section 50.63 and to provide a plan and schedule for conformance with the SBO rule. Guidance for conformance with the SBO rule is provided by Regulatory Guide (RG) 1.155, “Station Blackout,” August 1988, and Nuclear Management and Resources Council (NUMARC) 87-00, “Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,” dated November 1987.

Paragraph (a)(1) of 10 CFR 50.63 requires that each light-water-cooled nuclear power plant be able to withstand and recover from an SBO of a specific duration. Paragraph (a)(2) of 10 CFR 50.63(a) requires that the reactor core and associated coolant, control, and protection systems provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained for the specified SBO duration; and that the coping capability be determined by an appropriate coping analysis. RG 1.155 provides guidance for conformance with the SBO rule. Section C.3 of RG 1.155 describes the regulatory position regarding the ability to cope with an SBO and Sections C.3.1 and C.3.2 provide guidance for determining the plant-specific minimum SBO coping duration and the evaluation of plant-specific SBO capability, respectively.

The Nuclear Regulatory Commission (NRC) staff's human factors acceptance criteria related to plant procedures and operator training are based on guidance contained in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Chapter 18.0, "Human Factors Engineering" (Revision 1, 2004). Other specific review criteria are contained in Appendix B to Section 8.2 of NUREG-0800.

3.0 TECHNICAL EVALUATION

The NRC staff's evaluation of the licensee's proposal focused on the changes in equipment and methodology needed to increase the SBO coping duration from 4 hours to 16 hours.

The 4-hour coping strategy included using an alternate AC power source, one of two gas turbine generators (GTGs), available within 1 hour of an SBO event. The original study assumed that the SBO unit would achieve and maintain hot standby using steam generator (SG) atmospheric dump valves (ADVs) for heat removal and that a charging pump would be used for reactor coolant system (RCS) inventory control.

The proposed 16-hour coping strategy also assumes that the alternate AC is started and loading during the first hour. At the end of 4 hours, the operator would start a unit cooldown to shutdown entry conditions. The ADVs would be used for heat removal, the pressurizer vent would be used for RCS pressure control, and RCS inventory would be controlled using a high-pressure safety injection (HPSI) pump.

Each of the differences between the original 4-hour coping duration and the proposed 16-hour coping duration are discussed in detail below.

3.1 Alternate AC Power Source

The licensee stated that two GTGs designated as alternate AC power sources are available at 1 hour of the onset of the SBO event. Each GTG has sufficient capacity and capability to operate those systems necessary for coping with an SBO for the required duration of 16 hours to bring the plant to and maintain the plant in a safe shutdown condition. The licensee provided a summary of loads required to cope with a 16-hour SBO. The continuous load to cope with a 16-hour SBO is 3,364.3 kilowatts (kW). Each GTG is rated at 3,400 kW. The licensee indicated that each GTG was factory tested and demonstrated a 5.8 percent capacity margin above 3,400 kW. The GTGs are maintained and tested to ensure their capacity to supply the load required to cope with an SBO for 16 hours.

The fuel tanks associated with the GTGs are maintained with sufficient fuel to support operation of the two GTGs for 16 hours. The licensee stated that procedure changes for operation and loading the GTGs will be implemented to support the 16-hour coping strategy.

During initial review of the SBO submittal, the staff had reviewed and accepted the GTGs as alternate AC power sources for the Palo Verde units. On the basis of its review of the loads listed in Table 2 of the licensee's October 28, 2005, application, the staff noted that the main essential lighting panel load is 90 kW instead of 160 kW as shown in the Updated Final Safety Analysis Report (UFSAR), Table 8.3-3, page 8.3-6. In response to staff questions, the licensee’s letter dated April 19, 2006, stated that the value of 160 kW for the main essential lighting panel shown in UFSAR, Table 8.3-3 is the electrical rating of the main essential lighting panel. The value of 90 kW used in SBO evaluation is the calculated total load value.

The staff also noted that the two-way radio system has a 4-hour battery system and will be transferred to the GTG. In its April 19, 2006, letter, the licensee stated that panel 1EQFND23, Comm EQ UPS Power Supply Distribution Panel, serves the Unit 1 in-plant radio equipment. This load is shown in Table 2 of the October 28, 2005, application.

Finally, the staff questioned whether the loading (3,364.3 kW) shown in Table 2 of the October 28, 2005, application represents the worst-case loading for both trains of each of the three units. In its April 19, 2006, letter, the licensee stated that the 3,364.3 kW total load shown in Table 2 of the 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, therefore, bounding. Values are for Load Group 1, A train; B train loading is not provided since it is not the credited train for an SBO event.

As a result of the SBO coping duration change from 4 hours to 16 hours, the loading requirement is changed to 3,364.3 kW, which is within the rated capacity of 3,400 kW. Since each GTG has sufficient capacity and capability to operate those systems necessary for coping with an SBO for the required duration of 16 hours to bring the plant to and maintain the plant in a safe shutdown condition, and since the licensee adequately addressed the staff concerns discussed above, the staff concludes that there is an adequate alternate AC power source for coping with an SBO of 16 hours duration.

3.2 Class 1E Battery Capacity

The licensee stated that there is no effect on the Class 1E batteries as a result of the increased coping period. In addition, the licensee confirmed that no plant or procedure changes are required to implement a 16-hour coping strategy for use of the Class 1E batteries.

As in the original study, the Class 1E battery capacity without the charger support would be adequate for the first hour of the SBO event and the battery chargers are loaded onto the GTGs within 1 hour. The staff finds that loading requirements of 68.0 kW and 49.3 kW for Class 1E battery chargers A and C, respectively, are reasonable. These loads are included in the GTG loading calculation. As discussed above, each GTG has sufficient capacity and capability to operate battery chargers and other necessary systems for coping with an SBO for the required duration of 16 hours. The staff concludes that adequate DC power will be available for the 16-hour SBO coping duration.

3.3 Condensate Inventory for Decay Heat Removal and Reactor Coolant Inventory

The operators rely on the ADVs and the steam-turbine-driven auxiliary feed water (AFW) pump for adequate core cooling and decay heat removal and an HSSI pump to maintain RCS inventory. Since the AFW pump takes suction from the condensate storage tank (CST) and the HPSI pump takes suction from the refueling water storage tank (RWST), the SBO coping strategy must also ensure that the RWST and the CST have sufficient inventories to maintain sufficient RCS inventory and provide core cooling and decay heat removal during the 16-hour SBO duration.

The 16-hour coping strategy requires minimal operator action in the first hour of the event. The turbine-driven AFW pump will initiate upon a low-SG level. However, after the actuation of the alternate AC power source at 1 hour into the event, operator actions are necessary to (1) open the ADVs for decay heat removal; (2) adjust the AFW system to match the ADV flow to maintain SG level; and (3) load the 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 4 hours, operator actions are required to start a cooldown to shutdown cooling (SDC) entry condition during the remaining 12 hours of the coping period. This is done by (1) adjusting ADVs hourly to sustain an approximately 30 degrees Fahrenheit per hour cooldown rate; and (2) opening the pressurizer vent valve to maintain the RCS pressure and inventory.

The licensee used the CENTS code to analyze the plant response to an SBO event. The CENTS code, described in Westinghouse topical report WCAP-15996-P (Reference 1), is a computer code for simulation of pressurized-water reactor (PWR) plant behavior for conditions ranging from normal plant operation to operational and licensing transients. CENTS provides an interactive capability for simulating the standard nuclear steam supply system components, and may be used to determine the transient thermal-hydraulic conditions in the primary and secondary systems and the transient core power. It includes the primary and secondary control systems and the balance-of-plant fluid systems. CENTS has been reviewed and approved by the NRC (Reference 2) for referencing in a licensing application for the calculation of transient behavior in the PWRs designed by Combustion Engineering and Westinghouse Electric Company. Though the CENTS code was not used for licensing analyses of the design-basis loss-of-coolant accidents (LOCAs) and severe accidents because of insufficient benchmarking, the staff safety evaluation stated that the CENTS code is acceptable for use in modeling small breaks in the primary system that can be classified as LOCAs for the purpose of demonstrating compliance with non-LOCA regulatory acceptance criteria. The licensee also provided the basis for using the CENTS code for the SBO coping analysis in its letter dated April 19, 2006. The benchmark testing of CENTS included the SG tube rupture (SGTR) event which introduces the two major phenomena that are also applicable to SBO events: natural circulation and loss of reactor coolant. In addition, 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 than the leak rate used in the SBO case. The staff also reviewed a benchmark of the CENTS calculation of a small-break LOCA (SBLOCA), a 0.12 foot squared, cold-leg break, described in Section 8.4 of the original CENTS topical report CENPD-282-P-A (Reference 3) that illustrated the CENTS thermal-hydraulic model's ability. This SBLOCA transient involves the two-phase fluid conditions in the core, and emergency core cooling system injection that validate the thermal-hydraulic models in the code. The CENTS analysis results were compared to those from the CEFLASH-4AS code, which is an NRC-approved code for design-basis

SBLOCA analysis. The results showed good agreement between the two codes regarding the primary pressure and reactor vessel mixture level. Since leakage from the reactor coolant pumps resulting from an SBO is equivalent to a cold-leg SBLOCA, the NRC staff concludes that the SBLOCA benchmark demonstrates the adequacy of the CENTS code for the SBO coping study for the RCS inventory and decay heat removal.

For the 16-hour SBO coping analysis, the SBO event is assumed to occur at the hot full-power condition of 3,990 megawatt thermal (MWt) with the maximum allowed RCS leakage rate of 11 gallons per minute (gpm) (identified and unidentified leakage) specified in Technical Specification (TS) Limiting Condition for Operation (LCO) 3.4.14. The onset of SBO results in the trips of the reactor coolant pumps (RCPs), turbine, and reactor. In addition, the failure of the RCP seals is assumed to result in a seal leakage of 25 gpm per RCP, based on the guidelines of NUMARC 87-00.

Therefore, the CENTS SBO coping analysis assumed a total RCS leakage rate of 111 gpm, consisting of (1) the RCS operational leakage limit of 11 gpm, and (2) the loss from four reactor coolant pumps with a conservatively assumed large pump seal leakage of 25 gpm per pump). The decay heat is calculated using the American National Standards Institute/American Nuclear Society (ANSI/ANS)-5.1-1979 decay heat curve, plus a 2 sigma uncertainty, and is based on the following assumptions: fuel enrichment of 5 percent, power level of 3,990 MWt, fuel burnup of 70,000 megawatt day/metric ton of uranium (MWD/MTU), and three operating cycles of 505 days per cycle plus a 25-day outage. These assumptions comply with regulatory position C.3.2.1 of RG 1.155.

The results of the CENTS analysis are shown in Figures 3 through 15 in the October 28, 2005, application. The initiation of SBO resulted in the trip of the RCPs, as well as the turbine trip and reactor trip. The turbine trip results in the increase of SG pressure, and the main steam safety valves (MSSVs) open at 10 seconds, resulting in the decrease of the SG level that results in the initiation of the AFW at 800 seconds due to low SG level. Figure 11 shows that, except for the early part of the transient before the AFW initiation, the SG downcomer level is maintained between 21 and 24 feet through the 16-hour period. Figure 8 shows the AFW is initiated at 800 seconds as a result of low SG level and delivers 93 pounds per second (lbs/sec) flow rate, and at 1 hour the operator adjusted the AFW flow to between 30 and 40 lbs/sec maintain the SG level/match the ADV flow during the 16-hour duration. Figure 9 shows the total integrated AFW flow of 240,000 gallons (2,000,000 pounds (lbs)) at 16 hours. Figure 14 shows that, at the end of first hour, the HPSI is activated with a flow of approximately 17.5 lbs/sec (126 gpm). Figure 10 shows that the pressurizer vent valve opens at 4 hours into the transient to reduce the RCS pressure. Figure 3 shows that the pressurizer pressure drops initially to about 1,500 pounds per square inch absolute (psia) and recovers somewhat upon the HPSI injection after 1 hour. After the vent valve opens at 4 hours, the pressurizer pressure decreases again. Figure 4 shows that the pressurizer level decreases initially, but the level starts to recover upon the initiation of HPSI flow at 1 hour, and maintained between 10 and 15 feet after 4 hours. Figure 7 shows the hot-leg temperature decreases during the 16-hour duration. Figures 5 and 6, respectively, show that subcooling is maintained in the hot leg and upper head. The coping analysis, as illustrated by these figures, demonstrates that the RCS inventory is maintained such that the core is covered throughout the 16-hour duration. The decay heat removal and core cooling are achieved through the combined operations of the ADV, AFW and HPSI. The analysis also provides the following conclusions:

1. The CST has sufficient condensate inventory for decay heat removal:

   As shown in Figure 9 of the licensee's submittal, the total integrated AFW flow for 16 hours is 240,000 gallons (2,000,000 lbs). Since PVNGS TS LCO 3.7.6 requires the CST to maintain at least a level of 29.5 feet (ft), which would have an inventory of greater than 300,000 gallons, the staff concludes that there is sufficient condensate in the CST to cope with the 16-hour SBO duration.

2. The RWST has sufficient inventory to provide the RCS inventory with the core coverage:

   The total HPSI flow for the 16-hour duration, as shown in Figure 14, is less than 945,000 lbs, or approximately 113,400 gallons. The HPSI pumps take suction from the RWST, which has more than enough inventory (at least 577,000 gallons, as required by TS LCO 3.5.5 and SR 3.5.5.2) to provide for this function. Therefore, there is sufficient RWST water to maintain the core covered.

With the implementation of an appropriate 16-hour SBO response procedure for the control room operators (discussed in the next section of this Safety Evaluation), the staff concludes that the CST has sufficient condensate inventory to provide core cooling and decay heat removal, and that the RWST and the RCS have sufficient inventories to maintain the core covered during an 16-hour SBO coping duration.

3.4 Procedure Changes and Operator Actions

The licensee identified that the procedure for operating the two GTGs that provide the alternate AC power source in SBO events would be revised to support a 16-hour coping period. The revised procedure will continue directing the operator to line up the GTGs to the shutdown bus that will provide alternate AC power to the systems and components needed for reactor shutdown during an SBO. These systems and components include the HPSI, SDC, spent fuel pool cooling, AFW, pressurizer vent valves, MSSVs, and ADVs. The current procedure for GTG operation requires the operator to manually actuate the GTGs for alternate AC power within 1 hour of an SBO event. The NRC staff finds acceptable that the revised procedure for the alternate AC power source does not propose any new or revised operator actions, other than the GTGs will be operated for a 16-hour period rather than a 4-hour period.

The licensee will revise the current SBO procedure to reflect the 16-hour coping period as well as the use of the HPSI pump in place of the charging pump for maintaining RCS inventory. The SBO procedure provides general steps with requirements for operators to perform actions in accordance with other procedures. These actions include the manual actuation and 16-hour operation of the GTGs, plant shutdown, cooldown and depressurization for up to 16 hours, and the operation of the new supplemental control air system as required during an SBO. The licensee's original and revised coping period analyses show that the first hour of the SBO does not require any additional operator actions to address reactor coolant inventory loss. The operator is expected to manually actuate the GTGs, in both the 4-hour and 16-hour coping analyses, to energize the shutdown bus that will be used to bring the affected unit to shutdown conditions. Once the alternate AC power source is available after the first hour of an SBO, the operator is expected to take the following actions throughout the remaining 15 hours of an SBO to bring the unit to cold shutdown:

- Open the SG ADVs, close the MSSVs, and lower RCS temperature to 570 degrees Fahrenheit cold-leg temperature (1 hour into the SBO)
- Adjust AFW to maintain SG level (1 hour into the SBO)
- Load the HPSI pump onto the GTG-energized bus and control flow (not to exceed 126 gpm) for RCS inventory, subcooling and natural circulation (1 hour into the SBO)
- Open the SG ADVs to initiate a 30 degrees Fahrenheit per hour cooldown, adjusting hourly to sustain cooldown (4 hours into the SBO)
- Open the pressurizer vent valves to limit increase in subcooling (4 hours into the SBO)
- Place spent fuel pool cooling in service and direct maintenance personnel to connect the supplemental control air system as necessary (at about 8 hours into the SBO)
- Adjust the SG ADVs to terminate the RCS cooldown (at about 13 hours into the SBO)
- Control the HPSI pump ($\leq$ 105 gpm) to limit pressurizer level increases (at around 13.3 hours into the SBO)
- Place the SDC system in service (at about 16 hours into the SBO)

The operator actions for the first 4 hours are similar to the operator actions in the licensee's original 4-hour SBO coping period analysis, with the exception that the HPSI pump will be used instead of the charging pump. The unavailability of the charging pump will also lead to the unavailability of the auxiliary sprays for RCS depressurization, so the revised SBO procedure will direct the operators to use an existing procedure to depressurize the RCS using the pressurizer vent valves. The controls for the pressurizer vent valves are operated by opening three remotely operated valves in the control room and the RCS pressure is vented to containment as directed by procedure. The pressurizer vent valves will be used to depressurize the RCS until RCS pressure is within range to operate the SDC system, which will occur at about 16 hours after an SBO. The revised SBO procedure will direct the operators to use the above steps to maintain subcooling and cool down the plant in accordance with other procedures (such as SG ADV and AFW operation). The operator actions occur from hot standby conditions within 4 hours in the original SBO procedure to cold shutdown conditions within 16 hours in the revised SBO procedure.

The NRC staff recognizes that the licensee has already incorporated existing RCS cooldown and depressurization steps and the operation of the GTGs into the existing SBO procedure and that these changes, along with the general steps for the operation of the new supplemental control air system, will be included in the revised SBO procedure. The SBO revision will also reflect the operators using the pressurizer vent valves instead of the auxiliary sprays to depressurize the RCS and extend the usage of the SG ADVs and AFW system in performing the cooldown of the RCS for up to 16 hours. The licensee will train the operators on the SBO procedure changes prior to the implementation of the revised SBO procedure, with emphasis on the times in which each of the above actions are to be performed for successful cooldown and depressurization of the RCS. The NRC staff has determined that the proposed SBO procedure changes, combined with the operator training, are reasonable for the operators to bring the plant down to cold shutdown conditions within 16 hours.

Finally, the licensee recognizes that a new procedure is needed for instructing the operators to supply and operate the new supplemental control air system for the SG ADVs throughout the

16-hour SBO coping period. The revised SBO procedure will direct the operators to connect the supplemental control air system at about 8 hours after an SBO occurs in reference to this new procedure. The procedure will provide the steps necessary for the operators to connect the supplemental control air system, as needed, to back up the nitrogen accumulators for extended operation of the SG ADVs for up to 16 hours during an SBO. The procedure will also address plant storage of the gas supplies, maintenance, testing, and operation of the new supplemental control air system. The licensee will perform design validation testing on the new supplemental control air system to confirm that the device can be operated as needed. Operators will be trained on the new procedure in conjunction with the revised SBO procedure to connect and operate the supplemental control air system appropriately during an SBO. The NRC staff has determined that the new procedure for the supplemental control air system, with operator training, will be adequate to address the 16-hour coping period.

In summary, 10 CFR 50.63 requires that licensees provide a description of procedures to be used by the operators to support a designated SBO coping period. The licensee plans to revise the SBO procedure to bring the plant into cold shutdown conditions within 16 hours of an SBO. The licensee also plans to revise the existing procedure for operating the GTGs as the alternate AC power source and add a new procedure for the usage of the new supplemental control air system that will back up the nitrogen accumulators for the SG ADVs to support the 16-hour coping period. The licensee will continue to train the operators on the new and revised procedures related to the 16-hour SBO coping period. The staff has reviewed the human factors aspects of the licensee's proposed changes and has determined that the licensee will continue to meet 10 CFR 50.63 contingent upon the procedure's changes, corresponding plant modifications, and operator training being made by the licensee in support of a cold shutdown of the plant for up to 16 hours after an SBO.

3.5 Effects of Loss of Ventilation

SBO results in a slow heat-up of containment due to a loss of active containment cooling, the latent heat from RCP and RCS leakage and the RCS discharge from the pressurizer vent valve, and the sensible heat from component hot surfaces. The licensee has performed calculations that show that temperatures during a 16-hour SBO are bounded by thermal profiles considered for the design-basis accident (DBA) LOCA event. The analysis to determine the 16-hour SBO temperature and pressure response of the containment atmosphere use the computer program COPATTA. The COPATTA computer code is used to perform Palo Verde's LOCA and main steam line break (MSLB) containment temperature and pressure analysis. The staff has previously approved these calculations in NUREG-0857, "Safety Evaluation Report," dated November 1981.

Using the design basis COPATTA model for SBO, the licensee calculated the containment temperature and pressure response to a 16-hour SBO considering both the sensible and latent heat addition to the containment. The heat transfer coefficient between the containment atmosphere and containment walls and internal structures is based on leakage from RCP seals to the containment environment that will produce a saturated atmosphere. Since the dominant means of heat transfer will be by condensation, the licensee used the Uchida condensing heat transfer correlation. The licensee did not consider the turbulence induced by the RCS discharge into the containment, which would result in conservatively low-heat transfer rates to the containment surfaces, resulting in higher predicted temperatures.

The licensee-identified conservatisms that have been included in the methodology for predicting containment environment are: (1) the RCP leakage rate and enthalpy have been assumed constant for a duration of 16 hours; this is conservative because both would decrease as the RCS pressure decreases; (2) sensible heat from the RCS and secondary system has been selected to reflect conditions resulting from 100 percent power operation, and it is assumed constant for the duration of the event; (3) containment heat sinks are minimized during the event; the licensee conservatively reduced all heat sink areas to account for the possibility that not all the containment heat sinks would directly be exposed to the full effects of the RCP seal discharge and the sensible heat load. Specifically, the heat sink area outside the SG compartment D-rings below the operating deck may not be as effective as other heat sinks, and therefore was not used in the licensee's containment analysis. The licensee stated that based on drawings, this area accounts for about one third of the containment total; (4) to bound all conditions, initial event conditions were selected to be at the TS limits of 120 degrees Fahrenheit for the initial containment temperature and 2.5 pounds per square inch gauge (psig), for the initial containment pressure. The NRC staff finds acceptable the use of these assumptions, since they will result in conservative predictions of containment temperature and pressure following a postulated SBO.

According to the UFSAR, the peak pressure and peak temperature was determined to be 60 psig and 300 degrees Fahrenheit, respectively, for the LOCA DBA. Figure 1 of the licensee's October 28, 2005, submittal shows that the pressure remains below 45 psig for the duration of the event and Figure 2 shows that the temperature remains below 250 degrees Fahrenheit for the duration of the event. Therefore, the peak containment temperature and pressure remain well below the LOCA and MSLB peak pressures and temperatures for the duration of the SBO event.

For the case of loss of ventilation outside containment, the NRC staff concludes that the change in SBO duration to 16 hours has no impact on the conclusion reached by the NRC staff in support of the original 4-hour SBO review. The extended coping duration does not add any new dominant areas of concern for consideration, since for all rooms with essential equipment, the essential air handling unit will be available after an alternate AC is available (at 1 hour).

3.6 Containment Isolation

The licensee reviewed plant containment isolation valves to ensure that containment integrity is maintained during the SBO event. NUMARC 87-00, Section 7.2.5, defines "containment integrity" as the capability for valve position indication and closure of containment isolation valves independent of the preferred class 1E power supplies. The containment isolation valves requiring this capability are valves that may be in the open position at the onset of an SBO.

The staff reviewed and compared Table 4, of the licensee's October 28, 2005, submittal, "Containment Isolation Valves," to the UFSAR list of containment isolation valves, in order to verify that all appropriate valves were identified. The staff reviewed a sample of these valves for appropriate indication of valve position closure capability in accordance with the guidance of NUMARC 87-00, Section 7.2.5. Based on the staff's review, the staff determined that for a postulated SBO, containment integrity is expected to be accomplished.

3.7 Compressed Air

The SG ADVs are the primary means of heat removal during an SBO. The ADVs are air-operated valves with a backup nitrogen accumulator. For the 16-hour coping duration, the backup accumulators would be marginal, requiring a supplementary compressed air system. Therefore, the licensee has committed to supplement the control air system to support ADV operation for a 16-hour SBO. The gas source will be purchased, stored, and maintained per the requirements of RG 1.155.

Since the licensee is taking the necessary steps to assure that sufficient compressed air will be available for the entire 16-hour SBO coping duration, the NRC staff concludes that the regulatory requirements are being met.

3.8 Emergency Lighting

The licensee stated that the emergency lighting system, with 8-hour battery-backed power supplies, provides illuminating requirements where local manual operation is required within the power block. This lighting illuminates automatically upon a loss of AC power. After 1 hour, the essential lighting is powered by the GTGs. The licensee stated that no plant or procedure changes are required to implement a 16-hour coping strategy.

On the basis of its review, the staff finds that AC power will be available to the emergency lighting system from alternate AC power source within 1 hour. As discussed above, each GTG has sufficient capacity and capability to supply emergency lighting and other necessary systems for coping with an SBO for the required duration of 16 hours. The staff concludes that adequate lighting will be available during the 16-hour SBO event. The staff agrees that no plant or procedure changes regarding emergency lighting are required to implement a 16-hour coping strategy since an alternate AC power source will be available within 1 hour of an SBO event.

3.9 Communication

The licensee stated that the primary modes of communication during an SBO are the telephone system, the plant 2-way radio system, and the sound-powered phone system. The licensee stated that the telephone system has at least a 2-hour battery capacity. The 2-way radio system has a 4-hour battery system and will be transferred to the GTGs. The sound-powered phone system requires no external power source to operate. The licensee stated that no plant or procedure changes are required to implement a 16-hour coping strategy.

On the basis of its review, the staff finds that AC power will be available to the communication systems from alternate AC power source within 1 hour of an SBO event. As discussed above, each GTG has sufficient capacity and capability to supply communication systems and other necessary systems for coping with an SBO for the required duration of 16 hours. The staff concludes that adequate communication systems will be available during the 16-hour SBO event. The staff agrees that no plant or procedure changes regarding communication systems are required to implement a 16-hour coping strategy since an alternate AC power source will be available within 1 hour of an SBO event.

4.0 IMPLEMENTATION

When the NRC staff issued Amendment 157 to the Operating Licenses for all three Palo Verde units on November 16, 2005, the following license condition was added to the licenses, in accordance with the licensee's letter dated October 21, 2005:

> APS will implement the changes needed to revise from a 4-hour station blackout coping duration to a 16-hour coping duration within 6 months following NRC approval of the proposed coping changes.

The licensee's October 28, 2005, application listed the following changes that are needed to support a 16-hour SBO coping duration:

1. Supplement the control-air system, to support operation of the ADVs for 16 hours. The gas source will be purchased, stored, and maintained per the requirements of RG 1.155.

2. Procedures required to be changed to support a 16-hour coping period include:

    - Blackout, 40EP-9EO08, 40DP-9AP13
    - GTG operation and loading, 40OP-9GT01, 55OP-0GT01, 55OP-0GT02
    - Operations Support Center Actions, EPIP-02.

Based on the discussions contained in Section 3 of this safety evaluation (SE), the NRC staff concludes that these are the appropriate changes to support a 16-hour SBO coping duration. Further, the NRC staff concluded, as part of the issuance of Amendment 157 to the Operating Licenses, that completing these changes within 6 months of the date of this SE is acceptable based on the following: (1) the Palo Verde grid is considered to be reliable after fixing the problem associated with the LOOP event of June 14, 2004; (2) the emergency diesel generators are reliable; (3) the alternate AC power source has sufficient capacity and capability for significantly more than 4 hours; and (4) the probability of having an SBO during this time period is very low.

5.0 CONCLUSION

As described above, the NRC staff reviewed the assumptions, inputs, and methods used by the licensee to assess the impact of increasing the SBO coping duration from 4 hours to 16 hours. The NRC staff's review also considered the proposed procedure changes and associated operator actions for the revised SBO coping period, as well as the proposed enhancements to the compressed-air system. The NRC staff also finds acceptable the licensee's commitment to implement these changes within 6 months following NRC approval.

The NRC staff concludes that the extension of the SBO coping duration from 4 hours to 16 hours to be in conformance with the SBO rule contained in 10 CFR Section 50.63. This conclusion constitutes the regulatory assessment of the proposed changes to the SBO coping duration under 10 CFR 50.63(c)(3).

6.0 REFERENCES

1. WCAP-15996-P, WCAP-15996-NP, "Technical Description Manual for the CENTS Code," December 2002.

2. Letter from H. N. Berkow, U.S. Nuclear Regulatory Commission, to G. Bischoff, Westinghouse Electric Company, "Final Safety Evaluation for Topical Report WCAP-15996-P, 'Technical Description Manual for the CENTS Code' (TAC No. MB6982)," December 1, 2003.

3. CENPD-282-P-A, "Technical Manual for the CENTS Code," ABB Combustion Engineering Nuclear Fuel, February 1991.

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Date: October 31, 2006

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