UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 123 TO FACILITY OPERATING LICENSE NO. NPF-41,

AMENDMENT NO. 123 TO FACILITY OPERATING LICENSE NO. NPF-51,

AND AMENDMENT NO. 123 TO FACILITY OPERATING LICENSE NO. NPF-74

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 December 16, 1998, and supplemented by letters dated July 16, September 29, and December 21, 1999, the Arizona Public Service Company (APS or the licensee) requested changes to the Technical Specifications (TSs) for the Palo Verde Nuclear Generating Station, Units 1, 2, and 3. APS submitted this request on behalf of itself, the Salt River Project Agricultural Improvement and Power District, Southern California Edison Company, El Paso Electric Company, Public Service Company of New Mexico, Los Angeles Department of Water and Power, and Southern California Public Power Authority. The proposed amendments would (1) change Condition G of TS 3.8.1, "AC Sources - Operating," to ensure that the appropriate actions will taken to prevent double sequencing of safety-related loads, and (2) change TS 3.3.7, "Diesel Generator (DG) - Loss of Voltage Start (LOVS)," to ensure that the setpoint allowable values for the degraded voltage relays reflect the required function of the relays.

The July 16, September 29, and December 21, 1999, letters provided additional clarifying information that was within the scope of the original application and *Federal Register* notice and did not change the staff's initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

The potential for double sequencing of safety-related loads following a postulated design-basis accident was first identified by APS in Licensee Event Report (LER) 93-011, Supplement 1, dated February 6, 1995. APS stated in this LER supplement that double sequencing would occur if the switchyard voltage is less than 99.5 percent following a plant trip with a subsequent safety injection signal. Under these conditions the degraded voltage relays would drop out while the safety loads were sequencing (automatically loading in a staggered manner) onto the offsite power source. This would result in shedding of the loads and their subsequent re-sequencing onto the DGs. To preclude the possibility of double sequencing, APS instituted interim

compensatory measures at Palo Verde to maintain adequate input voltages to the onsite electrical distribution system.

Double sequencing of safety-related loads was not postulated during the original design-basis evaluations conducted for the Palo Verde units. Double sequencing could result in delay times greater than those assumed in the accident analyses for accident mitigating equipment. In addition, the functionality of electrical equipment and system hydraulic responses has not been evaluated for this scenario.

The licensee proposes to use administrative controls as a permanent solution to protect against double sequencing of safety-related loads by modifying Condition G of TS 3.8.1. In addition, the licensee proposes to change the setpoint allowable values for the degraded voltage and loss of voltage relays in TS Surveillance Requirement (SR) 3.3.7.3. The proposed changes to the setpoint allowable values are to ensure that they reflect the required function of the relays.

3.0 EVALUATION

General Design Criterion 17 of Appendix A to 10 CFR Part 50 requires, in part, that both an onsite electric power system and an offsite electric power system be provided that have sufficient capacity and capability to provide power to assure that specific functions are accomplished or maintained upon the occurrence of certain events. To satisfy this requirement when the offsite system is powering the safety loads and is lost, circuitry in the onsite electrical system is designed to separate the offsite grid from the safety-related buses and tie the emergency DGs onto the buses. Once the DGs are tied to their respective buses, safety loads are sequentially connected by the automatic load sequencer.

Degraded voltage conditions in the transmission network to the site could adversely affect the ability of these safety loads to perform their function. The TS changes proposed by the licensee are intended to assure that degraded offsite grid conditions will not affect the ability of the onsite power system to perform its intended safety function, and thereby maintain the original design basis.

3.1 Proposed changes to TS 3.8.1

Current TS 3.8.1, Condition G

Currently, Condition G of TS 3.8.1 provides the requirements that must be taken when the Palo Verde switchyard voltage is less than limits specified in the TS Bases. The limits specified in the TS Bases are 524 kilovolts (kV) for Unit 1 and 518 kV for Units 2 and 3, when all three startup transformers are in service. When only two startup transformers are in service, the minimum voltage limit is 525 kV for all three units. The requirements that must be taken when switchyard voltage is below these limits include blocking one or two trains of fast bus transfer, or powering the safety bus from the DG in a train that is not blocked.

Blocking a train of fast bus transfer prevents one train of non-safety loads (including reactor coolant pumps) from transferring to a startup transformer from the plant's unit auxiliary transformer following a plant trip. The plant trip of concern is one that would occur as a result of

an accident. Because the startup transformers also feed plant accident loads, post-plant-trip voltages to these loads are improved by preventing non-safety load transfer to the transformers. Blocking the fast bus transfer thereby provides a method of reestablishing adequate voltages to safety loads for the potential accident event, when the switchyard voltage is below a value that would otherwise result in unacceptable voltages. This also precludes the double sequencing that would occur as a result of the inadequate voltages.

The other option available to comply with the current version of Condition G is to power the safety bus from the DG in a division that does not have the fast bus transfer blocked. This option would restore adequate voltages to safety loads by divorcing them from the inadequate offsite power source and powering them from the DG instead. This option has the advantage that, with only one train of non-safety fast bus transfer blocked, reactor coolant pumps in the other train are available to provide forced circulation in the reactor following a plant trip. The disadvantage in this option is that the plant is in a 72-hour action statement for a loss of an offsite power source, since the offsite source to that division remains incapable of supplying adequate voltages to the safety loads.

Proposed TS 3.8.1, Condition G

Subsequent to the implementation of the compensatory measures that eventually led to the current version of Condition G in TS 3.8.1, APS began a number of additional changes to address the undervoltage problem at Palo Verde. These included:

- Upgraded Unit 1 switchyard voltage meter
- Added Unit 1 control room low voltage alarm
- Replaced degraded voltage relays with more accurate relays
- Revised Class 1E transformer tap settings
- Added trip of water reclamation facility load on safety injection actuation signal and low voltage
- Replaced three Class 1E control power transformers in each unit
- Relocated control element drive mechanism (CEDM) fan sequence step

As a result of the modifications and some additional analyses, the licensee proposes an amendment to Condition G that allows more flexibility in the allowable range of voltages to be maintained in the Palo Verde switchyard. The proposed revised condition reads: "One or more required offsite circuit(s) do not meet required capability." The proposed required action reads: "G.1 Restore required capability of the offsite circuit(s), OR G.2 Transfer the ESF [engineered safety features] bus(es) from the offsite circuit(s) to the EDG(s) [emergency DG(s)]." The completion time for each required action is 1 hour. Required action G.2 is modified by a note that requires entry into the conditions for an inoperable offsite circuit or circuits. This is necessary because transferring an ESF bus to its DG does not make the affected offsite circuits operable.

The licensee states that maintaining the required capability of the offsite circuits ensures that post-trip voltage will stay above the degraded voltage relay trip setpoint and the event will not cause loss of offsite circuits. The required capability of the offsite power circuits is based upon the pre-trip switchyard voltage, the number of Palo Verde units on line and capable of regulating

switchyard voltage, post-trip startup transformer loading, and the number of 525-kV transmission lines in service. The operators will use the proposed Bases for TS 3.8.1 Condition G to assess whether the offsite circuits meet the required capability.

Revised TS Bases for Condition G

The proposed TS Bases changes contain the process the operator must use to make the determination of whether the required offsite circuits do or do not meet the required capability specified in Condition G is given in detail. No longer are just three switchyard voltage levels specified. Rather, the proposed Bases instructs the operator to review the required capability of the offsite circuits if either of the following conditions exist:

- The steady-state switchyard voltage is less than 525 kV, or
- Only one of the Palo Verde units is on line and capable of regulating switchyard voltage (generator synchronized to the grid and automatic volt-ampere reactive (VAR) control equipment in service).

If either condition is satisfied the operator is directed to a formula [$MVA_{Max} = 2 \times (kV - 490)$], where MVA_{Max} represents the maximum post-trip loading, to determine if the offsite circuits have the required capability to provide adequate post-trip voltages to the safety loads. The proposed Bases indicates that the formula for MVA_{Max} is based on calculations, 01, 02, 03-EC-MA-221, which analyze many different bus alignment conditions. Using this formula will result in a conservative load limit, according to the licensee, with sufficient margin to account for analytical uncertainties and to provide assurance that the degraded voltage relays will not actuate as a result of an accident.

The operator uses the formula to determine the MVA_{Max} that could be tolerated on a startup transformer secondary winding and still result in adequate post-trip voltages to the safety loads fed from that winding, given an estimated post-trip switchyard voltage. If the anticipated post-trip loading exceeds the maximum post-trip loading calculated by the operator, the offsite circuit does not meet the required capability and the plant is placed in Condition G. The two critical parameters used in this determination, post-trip switchyard voltage and post-trip loading, cannot be measured prior to a unit trip. The operator therefore derives them based on information provided in the proposed Bases.

Post Trip Switchyard Voltage

The proposed Bases state that with one or both of the other Palo Verde units on line and available to regulate the switchyard voltage, the switchyard voltage will not change significantly following an accident in the unit under consideration. The same is also true when the unit under consideration is not capable of regulating switchyard voltage. The proposed Bases instructs the operator under these conditions to assume a post-trip switchyard voltage equal to the measured steady-state pre-trip level in his evaluation of offsite power capability. The basis for the above statements is that, because the generators of all three Palo Verde units are connected to the same switchyard that supplies offsite power to safety loads, the remaining Palo Verde unit(s) will be able to maintain the voltage level in the switchyard if one of the units trips. Also, with only one unit on line, if it is not supporting switchyard voltage, its loss will not affect that voltage.

Multiple Units Available to Regulate Switchyard Voltage

A generator regulates voltage in a switchyard by supplying VARs to the grid system via the switchyard. The amount of VARs a generator can supply is limited, however, just as the amount of real power a generator can supply is limited. With regard to the case described above where multiple Palo Verde units are supporting switchyard voltage, if one unit trips, the remaining units will be able to make up the lost mega-VARs (MVARs) only if they have sufficient reserve MVAR capability to make up the deficit. The staff therefore requested the licensee to address this situation.

In the July 16, 1999, response to staff questions, APS stated that the Palo Verde units are operated well below their maximum capability of 710 MVAR (normally is less than 400 MVAR). Due to the settings of the main transformer taps, operation of the units at their MVAR limit would result in overvoltage conditions at the Palo Verde switchyard and elsewhere on the grid, even during heavy grid loading conditions. The licensee also noted that, at high MVAR levels the pre-trip switchyard voltage is also high, so even if the other unit(s) were unable to pick up all of the lost MVARs, voltage margin would exist ensuring adequate post-trip voltage. These responses satisfactorily resolve the staff concerns on this matter.

Single Unit Available to Regulate Switchyard Voltage

When only one Palo Verde unit is regulating switchyard voltage, the proposed Bases offer the operator three choices. If all five 525-kV lines are in service during this period, the operator is instructed to assume a post-trip switchyard voltage of 515.4 kV for a trip of that unit. If only four of the five 525-kV lines are in service, the operator is instructed to assume a post-trip voltage of 512 kV. If fewer than four 525-kV lines are in service, the operator is instructed that the offsite circuits do not meet their required capability.

The situation when only a single Palo Verde unit is regulating switchyard voltage was of concern to the staff because when that unit trips, the switchyard voltage level is a function of other elements in the grid that are outside the direct control of the Palo Verde station. The staff therefore questioned APS about the grid analysis it performed that resulted in the switchyard voltage levels specified in the proposed Bases for this scenario.

APS responded in its July 16, 1999, letter that the grid model developed by the Western Systems Coordinating Council was conservatively used to determine the voltage effect of a Palo Verde unit trip. APS indicated that the analyses that were used to develop the proposed Bases for TS 3.8.1 Condition G modeled the following adverse conditions:

- Heavy grid loading
- A major transmission line to the Palo Verde switchyard out of service
- Generation in the Phoenix Metro area at the minimum amount needed to ensure adequate pre-trip voltages
- A single Palo Verde unit on line
- This unit is boosting switchyard voltage to the maximum credible extent prior to its trip
- This unit trips as a result of a LOCA

The licensee stated that data from manual VAR changes conducted during day-to-day plant operation confirms the analytical result that a change of approximately 30 MVAR is required to effect a 1-kV change in switchyard voltage. The license states that although there are other secondary factors that affect this result (which are included in the model), there are no known phenomena that would cause a substantially greater voltage effect.

The above responses address the staff's concerns relative to the grid analysis that was performed and provide additional confidence that it was performed conservatively.

To better understand the likelihood of relying on outside elements to control grid stability, the staff requested the licensee to provide information relative to the length of time that only a single Palo Verde unit would be regulating switchyard voltage.

APS responded in its July 16, 1999, letter that in the 5-year period from July 1, 1994, to July 1, 1999, the Palo Verde site has operated with only one unit on line for a total of 23.8 days, the last such occurrence on August 11, 1996. APS stated that simultaneous outages are not planned at the Palo Verde site, and based on the shorter duration of refueling outages, the elimination of mid-cycle outages, and the record of the past 3 years, it is expected that such conditions would be rare in the future. The site history of 23.8 days over a 5-year period approximates to 1.3 percent of the time that only a single Palo Verde unit was regulating switchyard voltage. This is a relatively small period of time that regulation of switchyard voltages would not be under the direct control of Palo Verde (via other operating Palo Verde generators) following a plant trip.

Post Trip Loading

The post-trip loading is the second parameter the operators are instructed to evaluate in the proposed Bases section. Post-trip loading is the loading in MVA (mega-volt amperes) that would be supplied by the associated startup transformer secondary winding immediately after the completion of the automatic load sequencing resulting from a loss-of-coolant accident (LOCA) or other design-basis accident. The magnitude of the post-trip loading is affected by several switching conditions. The loads for each of the load blocks that would be powered from the startup transformer secondary winding immediately after sequencing are summed to determine post-trip loading.

There are six potential load blocks identified in the proposed Bases. The largest of these (43 MVA) are the house loads (including reactor cooling pumps) associated with the fast bus transfer. The remaining five load blocks, which include other non-safety as well as safety loads, range from 3 to 10 MVA. The operator determines which of the load blocks are applicable to the offsite circuit (i.e., startup transformer secondary winding) under review. These are then summed and compared to the maximum post-trip loading calculated by the MVA_{Max} formula, to determine if the offsite circuit has the required capability (adequate post-trip voltage to safety loads) required by proposed Condition G.

In the current required action for Condition G the operator is instructed to block trains of fast bus transfer to reduce the loading on the startup transformer. In the proposed Condition G, that requirement is replaced by the more general requirement to restore the required capability of the offsite circuits. This together with the instructions in the proposed Bases allows the operator to

reduce loading by other means besides just blocking fast bus transfer. The instructions to reduce loading on the startup transfer by other means achieve the same objective as blocking fast transfer of loads, which is to assure adequate post-trip voltage to safety loads. In addition, these other means, which include increasing switchyard voltage or removing a non-safety related load, will not affect the ability of any safety system to perform its intended safety function. Therefore, this additional flexibility will not adversely impact safe plant operation and is acceptable to the staff.

The staff concludes that the proposed changes to TS 3.8.1, and the supporting analytical results, provide reasonable assurance that double sequencing of safety-related loads following a postulated design- basis accident will not occur. Therefore, the staff concludes that the requirements of General Design Criterion 17 are met, and the licensee's proposed changes to TS 3.8.1 are acceptable.

3.2 Proposed changes to TS 3.3.7

APS is also proposing to change the setpoint allowable values for the degraded voltage relays and the loss of voltage relays specified in SR 3.3.7.3 of TS 3.3.7. These relays sense the safety bus voltage and initiate the transfer of the bus from the offsite power source to the DGs when the safety bus voltage is inadequate to power the safety loads. APS states that these changes are editorial in nature and do not affect any design- or licensing-basis criteria.

Degraded Voltage Function Time Delay

SR 3.3.7.3.a currently specifies the time delay allowable value for the degraded voltage function as $\leq$ 35 seconds at 3744 volts. APS proposes to delete this voltage level from this specification. The licensee states that the dropout voltage allowable values ($\geq$3697 volts and $\leq$3786 volts) are already specified in SR 3.3.7.3.a, and the timer has a discrete setting that is not affected by the voltage level. The staff agrees that a separate voltage level is not needed in the time delay portion of this specification.

The staff did, however, question why there was no lower limit specified for the time delay of the degraded voltage protection. Without a lower limit the degraded voltage protection could unnecessarily separate the offsite power system due to a very short-term negative voltage transient. APS responded by adding a lower limit ($\geq$ 28.6 seconds) to the time delay allowable value specified for the degraded voltage function in its revised submittal dated September 29, 1999. This change resolves the staff's concerns on this matter.

Loss of Voltage Function Setpoint Allowable Value and Time Delay

APS is also proposing to modify the setpoint allowable value and time delay for the relays that provide the loss of voltage function. Unlike the components used for the degraded function discussed above, these relays have a time delay that is a function of the voltage level that is sensed by the relay. The lower the voltage that is detected by the relay the quicker the relay will trip.

The loss of voltage function in the current SR 3.3.7.3.b includes a setpoint (≥ 3250 volts) and a time delay (11.4 seconds) at a specific voltage (2929.5 volts). APS proposes to modify the setpoint allowable value and time delay for the relays that provide this loss of voltage function.

APS states in its submittal that there is no specific requirement in any analysis that the loss of voltage relays trip within a certain time for a degraded voltage condition. Their explicit function is to trip in 2.4 seconds or less for a complete loss of voltage condition. With regard to the setpoint, APS states that since the purpose of the loss of voltage relay is to detect a loss of voltage condition and actuate within a delay time, the setpoint (≥ 3250 volts) is not required. The licensee explained that, although the nominal setpoint of these relays is 3250 V, they will not necessarily trip at that level. The manufacturer only shows the time/voltage curve for these relays in the range of 0 to 2925 volts because the trip time above 2925 volts is less predictable. The hypothetical curve in the 2925 to 3250 volt range is asymptotic to 3250 volts, so the trip time may be very long at or near this voltage, or due to tolerances the relay may not trip at all until a lower voltage is reached. The licensee therefore proposed that the SR 3.3.7.3.b read, "Time delay: ≤ 2.4 seconds at 0 V [volts]."

The staff agrees that while the primary function for the loss of voltage relay is to detect a loss of voltage, there is also a secondary function provided by this relay. That function is to provide a lower limit for degraded voltage protection. A voltage that falls substantially below the setpoint of the degraded voltage protection will then be detected by the loss of voltage relay. This will trip the circuit more quickly than the degraded voltage protection otherwise would, avoiding the potentially more limiting effects of the lower voltage.

The proposed change to only test the relay at 0 volts will not verify this secondary function of the relay. However, the staff agreed with the licensee that the nominal setpoint (3250 volts) is not a predicable value at which to check the timing of the relay. The licensee therefore revised the proposed surveillance by letter dated September 29, 1999. The surveillance now reads, "Time delay: ≥10.3 seconds and ≤12.6 seconds at 2929.5 V, and ≥2.0 seconds and ≤2.4 seconds at 0 V."

This proposed version of SR 3.3.7.3.b will check the relay timing at the maximum and minimum points shown on the manufacturer's time/voltage curve for the relay and also specifies a lower as well as an upper limit for the time delay to avoid unwanted separations from the offsite power system, as discussed for the loss of voltage protection above.

The staff concludes that the proposed changes to SR 3.3.7.3.a and SR 3.3.7.3.b will continue to assure that the protection circuitry will trip in accordance with its design provisions and will not unnecessarily separate safety loads from the offsite power supply. The applicable design requirements of General Design Criterion 17 are met, and therefore, the staff finds these proposed TS changes acceptable.

3.3 Evaluation Summary

The licensee's proposed revision to TS 3.8.1, Condition G is designed to preclude a degraded voltage/double sequencing scenario from occurring at the Palo Verde site. The staff finds this approach acceptable based in part on the fact that operation with only a single Palo Verde

generator regulating switchyard voltage will only occur infrequently (approximately 1.3 percent of the time). The majority of the time additional Palo Verde generators (under the direct control of Palo Verde personnel) will also be regulating switchyard voltage, such that if one is lost during an event the remaining generators will maintain the pre-event switchyard voltage level. This in combination with the conservative approach taken by APS in their analysis used to predict the post-trip switchyard voltages during the infrequent periods of single generator voltage regulation, provides reasonable assurance that double sequencing events will be precluded and the requirements of General Design Criterion 17 will be met.

With regard to proposed Specification 3.3.7, Surveillance SR 3.3.7.3, the staff finds that the protection will trip in accordance with its design provisions and will not unnecessarily separate safety loads from the offsite power supply. The applicable design requirements of General Design Criteria 17 are therefore met and the proposed specification is acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Arizona State official was notified of the proposed issuance of the amendments. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and change surveillance requirements. The NRC staff has determined that the amendments involve no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (64 FR 14279). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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