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SUBJECT: Forwards update of degraded voltage & double sequencing
 issue identified at PVNGS.

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MAY

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August 2, 1996

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Reference: Letter No. 102-03735, dated July 17, 1996, "Degraded
Voltage," from J. A. Bailey, APS, to USNRC

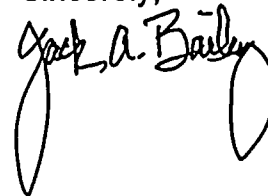
Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Degraded Voltage and Double Sequencing

On July 11, 1996, Arizona Public Service Company (APS) met with NRC management to provide an update of the degraded voltage and double sequencing issue identified at PVNGS. In that meeting and in the referenced letter, APS committed to formally provide the information discussed during the meeting. As an enclosure to this letter, please find that information which satisfies APS' commitment.

Should you have any questions, please contact Scott A. Bauer at (602) 393-5978.

Sincerely,



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JAB/AKK/DRL/rv

cc: L. J. Callan
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ENCLOSURE

Arizona Public Service Company's

Response

to

Degraded Voltage

and

Double Sequencing

On July 11, 1996, APS met with members of NRC management to discuss a weakness identified in an assumption used in the justification for the submittal of Technical Specification (TS) Actions 3.8.1.1.f and 3.8.1.1.g. At that meeting APS committed to provide the information discussed during the meeting to the NRC in a formal letter. The information below provides a discussion of the history of degraded voltage and double sequencing at PVNGS, a discussion of the safety significance to the TS, and planned actions in response to the identified weaknesses.

History of Degraded Voltage and Double Sequencing at PVNGS

The identification, understanding, evaluation, and response to degraded voltage and double sequencing has been a complex evolution. The initial identification of degraded voltage arose from the electrical design basis reconstitution efforts that began at PVNGS following the Electrical Distribution System Functional Inspection (EDSFI) in 1990. During the EDSFI, deficiencies were noted by the NRC's inspection team related to calculations supporting the adequacy of the electrical distribution system. As a result of this identification, a Voltage Regulation Improvement Project (VRIP) was begun to perform a calculation reverification and design basis reconstitution of the electrical distribution system.

The VRIP team performed an aggressive and comprehensive review of the electrical distribution system design and identification of discrepancies. On December 23, 1992, a PVNGS corrective action report was written to document an inadequacy in the electrical distribution system voltages. Specifically, under design basis minimum switchyard voltage of 95% per unit (p.u.) and the startup transformer secondary windings loaded to near capacity of 70 MVA, startup transformer output voltages would be less than 90% of 13.8 kV. Downstream cable and transformer impedances would reduce this value further, resulting in tripping of the Class 1E 4.16 kV undervoltage relays, load shedding, and operation of the ESF system from the Emergency Diesel Generators (EDG). Voltages would be substandard throughout the AC distribution system prior to stripping of the Class 1E 4.16 kV bus and loading onto the EDG.

This condition was determined to be not reportable, but industry and NRC awareness of this potentially generic issue was determined to be warranted. Therefore, on December 25, 1993, Licensee Event Report (LER) 93-011-00 was issued to document the above condition. This voluntary LER was subsequently closed in NRC Inspection Report 50-528/94-01 on January 28, 1994.

On April 8, 1994, a PVNGS corrective action report was written to document the potential for double sequencing. Double sequencing first involves sequencing ESF equipment on the Class 1E 4.16 kV bus while the bus is provided power from the offsite power circuits. Then, due to the Class 1E degraded voltage relays (DVR) sensing inadequate Class 1E 4.16 kV voltage for greater than their

time delay setting, the DVRs would drop out and not reset. This would generate a Loss of Offsite Power (LOP) signal and cause the ESF equipment to be stripped from the Class 1E 4.16 kV bus and then resequenced onto the Class 1E 4.16 kV bus. However, the Class 1E 4.16 kv bus would be powered from the emergency diesel generators (EDG). The impact of double sequencing includes inappropriate shedding of offsite power (i.e., a probability exists that the degraded voltage relay could remove the unit from preferred offsite power even when adequate voltage levels are present in the distribution system), and incomplete protection of safety related equipment (i.e., the possibility exists that given a switchyard voltage less than the anticipated range the equipment could be confronted with substandard voltages during the 35 seconds of sequencing on offsite power before going to the diesel generator).

The initial evaluation of this problem concluded that there was no indication that PVNGS systems would fail in a manner similar to NRC Information Notice 93-17, Revision 1, "Safety Systems Response to Loss of Coolant and Loss of Offsite Power," however, additional action was assigned to determine the time at which the existing LOCA analyses takes credit for SI pump flow (i.e., an attempt was being made to determine if existing analyses could be credited to show that double sequencing was analyzed). At this time, it was not yet known that the existing design and licensing basis included the automatic blocking of fast bus transfer. This design feature was discovered and under review in December 1994.

On January 6, 1995, a revised evaluation was issued which concluded that double sequencing was outside the design and licensing basis; i.e., an unreviewed safety question, in that, through the loss of power from the main generator, preferred offsite power would be lost to the Class 1E buses, thereby violating 10CFR 50, Appendix A, General Design Criterion (GDC) 17, "Electric Power Systems," paragraph 4. Concurrent with the issuance of the revised evaluation, a report was made under 10CFR50.72. The Plant Review Board was appraised of the existence of an unreviewed safety question on January 11, 1995 and on February 6, 1995, LER 93-011-01 was issued. This LER was subsequently closed in NRC Inspection Report 50-528/95-21 on January 10, 1996.

The plant took additional, interim corrective actions, which included blocking one train of fast bus transfer within one hour and starting, loading, and separating the EDG of the second train from offsite power within two hours, to address this issue while a Technical Specification was being developed which provided similar guidance. At a management meeting held on April 14, 1995, the compensatory actions were revised to instruct taking action as soon as practicable in order to minimize potential core damage.

Since a solution to this issue was determined to be a long term project, APS proposed temporary changes to the TS in order to provide a clear response to the double sequencing and degraded voltage scenarios. On July 3, 1995, a proposed change to TS 3/4.8.1.1 was submitted to the NRC to add new Actions 3.8.1.1.f and 3.8.1.1.g. These Actions required the blocking of one train of fast bus transfer (FBT) within the first hour of sustained degraded voltage, and 1) starting, loading, and separating the opposite train's EDG from the grid within the second hour, or 2) blocking the second train of FBT within the second hour.

The time limits for the proposed Actions were based on existing Actions in the TS. Under degraded voltage conditions, the Actions existing in TS 3.8.1.1 for A.C. sources would not be applicable since they are derived from Regulatory Guide 1.93, "Availability of Electric Power Systems," dated December 1974 which assumes GDC-17 conformance. Therefore, TS 3.0.3 must be entered. The aforementioned TS Action statements were developed to address specific action to take in the event of degraded voltage rather than entering TS 3.0.3.

Although it was reported in LER 93-011-01 that the original licensing basis was an automatic blocking of fast bus transfer on both trains if undervoltage was detected, APS desired to balance the probability of double sequencing due to degraded voltage coincident with an accident, which is unlikely ($4.9E-5/\text{yr.}$), against the probability of natural circulation due to a unit trip coincident with degraded voltage, which is also unlikely but more probable ($4.0E-3/\text{yr.}$). These probabilities were derived from Palo Verde switchyard voltage statistics for the time period immediately preceding the institution of compensatory actions. These probabilities have since decreased greatly to less than approximately $2.3E-7/\text{yr.}$ and $1.9E-5/\text{yr.}$, respectively based on 1995 and 1996 Palo Verde switchyard voltage statistics. The proposed TS provided offsite power to half of the non-Class 1E loads for forced circulation to respond to a normal plant trip as well as EDG power and offsite power from the other train to the ESF equipment to respond to any accident. The proposed changes were approved by the NRC on November 28, 1995.

In October of 1995, APS documented its position on the balancing of forced circulation and natural circulation. This position considered risk, regulatory, and operational perspectives. In this memo, one of the conclusions stated, "Some of the factors are not completely understood at this time that could impact the decision outlined in this paper. These include....[a] complete understanding of the effect of double sequencing on installed equipment. It is currently assumed that all equipment that experiences double sequencing would be unable to perform its function, but would not adversely impact the equipment on the opposite train. At the present time no evaluation of this assumption is planned."

In late November, 1995, an engineer from the original VRIP team questioned APS' position based, in part, on information printed in a November issue on an

internal 10CFR50.59 newsletter which discussed enforcement action at another licensee's plant due to 50.59 deficiencies and raised the issue to Nuclear Regulatory Affairs and the Vice President of Engineering. A January 12, 1996 memo from Nuclear Regulatory Affairs to the Vice President of Engineering concluded that should the assumption documented in the October, 1995 memo prove not to be valid, then APS would need to contact the NRC and discuss the issue. Therefore, a multi-discipline team of system experts was formed to determine if this assumption relied upon in the new TS Actions was valid. The team performed a table top review and concluded in late February that limited train interaction was possible for at least one scenario, and that blocking only one train of fast bus transfer would not assure that the unblocked train would not impact the blocked train.

A Plant Review Board (PRB) meeting was convened on March 1, 1996, and administrative controls were enacted which required blocking both trains of fast bus transfer as soon as possible, but no later than the end of the first hour, and then, if desired to return forced circulation capability on a plant trip, an EDG could be started, loaded, and separated from the grid and that train's FBT could be unblocked. In addition, an ENS notification was made. This notification was later retracted since it was concluded that the report was bounded by previous descriptions of degraded voltage and double sequencing on LERs 93-011-00 and 93-011-01. Subsequently, on June 17, 1996, LER 93-011-02 was issued to include a description of the new scenario and to update the actions that had occurred since the previous revision of the LER. The PRB concluded, in the March 1, 1996 meeting, that revisions to TS Actions 3.8.1.1.f and 3.8.1.1.g need to be requested to conform with the approved compensatory actions. A tentative date was provided to the PRB of July or August 1996. APS now plans to submit a proposed TS amendment in August 1996.

On June 21, 1996, the PVNGS Offsite Safety Review Committee (OSRC) was briefed by Nuclear Regulatory Affairs on the new scenario and the potential appearance of inaccurate information being used to obtain the TS amendment for Actions 3.8.1.1.f and 3.8.1.1.g. The OSRC's recommendation to APS' management was to brief the NRC on the issue. Therefore, APS met with members of NRC management on July 11, 1996.

Safety Significance

As part of the preparation for the July 11, 1996 meeting, the Probabilistic Risk Assessment used in the submittal for TS Actions 3.8.1.1.f and 3.8.1.1.g was revised to include the new scenario. This revision showed a slight increase in Core Melt Probability (CMP) for the Action statements ($1.93\text{E-}6$ as submitted vs. $1.96\text{E-}6$ as reanalyzed). This is approximately a 1.6% increase and is still under the CMP for a forced shutdown ($2.4\text{E-}6$); i.e., the requirement of TS 3.0.3 which

would have to be followed if degraded voltage lasted longer than one hour and the new TS Actions did not exist.

There were three occurrences of degraded switchyard voltage in 1995 totaling less than six minutes, and one occurrence in 1996 of approximately ten seconds. In all cases, the minimum voltage experienced was higher than the required voltage that the Voltage Regulation Improvement Project expects as the final required grid voltage. However, these voltages were below the compensatory actions and/or TS Actions, and the actions were followed as required.

APS also has performed a review of the submittal for TS Actions 3.8.1.1.f. and 3.8.1.1.g against the criteria in 10 CFR 50.73(a)(2)(v), 10 CFR 50.73(a)(2)(vi), and 10 CFR 50.9. LER 93-011-02 reported the new information pursuant to 10 CFR 50.73(a)(2)(v) and 10 CFR 50.73(a)(2)(vi). However, the new information did not meet the requirements of 10 CFR 50.9 in that the information submitted with the proposed TS amendment was believed to be accurate at the time of submittal. Also, the new information does not have a significant implication for public health and safety in that the total CMP is increased only approximately 1.6%.

Planned Actions

Handling this design and licensing basis discrepancy has caused APS to reflect on lessons learned gained during this evolution. APS believes that plant safety was demonstrated to be paramount as administrative controls were instituted when the issues and safety significance were understood, followed as appropriate, by Technical Specification changes. The use of management, PRB an OSRC caused actions to be taken, however APS intends to review these actions to ensure that we maintained, and will continue to maintain, a focus on safety, design basis, licensing basis, and timeliness. In addition, Nuclear Regulatory Affairs will assume an advocacy role in assisting employees in raising complex safety concerns affecting plant safety.

