October 13, 2010

MEMORANDUM TO: Troy W. Pruett, Deputy Director
Division of Reactor Safety
Region IV

FROM: Thomas B. Blount, Deputy Director **/RA/**
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: FINAL RESPONSE TO PALO VERDE NUCLEAR GENERATING STATION TASK INTERFACE AGREEMENT 2010-005, REQUIREMENTS FOR DEGRADED VOLTAGE RELAY SETPOINTS

By letter dated March 22, 2010 (Agencywide Documents Access and Management System Accession No. ML100830682), the U.S. Nuclear Regulatory Commission Region IV Office requested the Office of Nuclear Reactor Regulation (NRR) to provide answers to the following Task Interface Agreement (TIA) questions regarding degraded voltage relay setpoints at Palo Verde Nuclear Generating Station.

1. What are the licensing basis and purpose for the Degraded Voltage Function setpoints in Palo Verde [Technical Specification] TS [Surveillance Requirement] SR 3.3.7.3?

2. What are the licensing basis and purpose for Palo Verde [Limiting Condition for Operation] LCO 3.8.1 ACTION G?

3. Does the basis for Palo Verde LCO 3.8.1 ACTION G bound that of the Degraded Voltage Function setpoints in Palo Verde TS SR 3.3.7.3?

The Electrical Engineering Branch of NRR has completed the review of the TIA. The staff assessment is enclosed.

Enclosure:
As stated

CONTACT: Eric E. Bowman, NRR/DPR
(301) 415-2963

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TASK INTERFACE AGREEMENT (TIA) 2010-005

DEGRADED VOLTAGE RELAY SETPOINTS

PALO VERDE NUCLEAR GENERATING STATION

1.0 INTRODUCTION

By letter dated March 22, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100830682), the U.S. Nuclear Regulatory Commission (NRC) Region IV Office requested the Office of Nuclear Reactor Regulation (NRR) to provide answers to the following Task Interface Agreement (TIA) questions in resolving interpretation of the function of the degraded voltage relays at the Palo Verde Nuclear Generating Station (PVNGS).

1. What are the licensing basis and purpose for the Degraded Voltage Function setpoints in Palo Verde [Technical Specification] TS [Surveillance Requirement] SR 3.3.7.3?

2. What are the licensing basis and purpose for Palo Verde [Limiting Condition for Operation] LCO 3.8.1 ACTION G?

3. Does the basis for Palo Verde LCO 3.8.1 ACTION G bound that of the Degraded Voltage Function setpoints in Palo Verde TS SR 3.3.7.3?

2.0 BACKGROUND

On July 17, 2009, the NRC Region IV team completed the onsite portion of the component design bases inspection (CDBI) at PVNGS where the team identified an unresolved item (URI) documented in NRC Inspection Report 05000528; -529; and -530/2009008, ADAMS Accession No. ML093240524. This URI questioned the calculations that demonstrate adequate voltage to safety-related loads during worst case loading conditions and the adequacy of a time delay of 35 seconds for transfer of safety buses to the onsite power supplies should an actual degraded voltage condition occur.

During the inspection, the team reviewed the relevant references and correspondence between the NRC and PVNGS regarding degraded voltage relays. The team noted that Item 32 of the NRC Qualification Review dated December 12, 1977, provided guidance for complying with NRC requirements for the capacity and capability of power sources. This letter required the installation of automatic voltage monitors to detect the presence of a sustained degraded voltage condition. Specifically, Position 1.a of item 32 stated that the selection of voltage and time setpoints shall be determined from an analysis of the voltage requirements of the safety-related loads at all onsite system distribution levels, and Position 1.C(1) stated in part

ENCLOSURE

that, “the time delay selected shall not exceed the maximum time delay that is assumed in the Preliminary Safety Analysis Report accident analysis.”

The licensee's proposals for meeting these requirements were accepted by the NRC in the Safety Evaluation Report (SER), NUREG-0857, Supplement 5, Section 8.4.7, “Adequacy of Station Electric Distribution System Voltages,” dated November 1983. The NRC staff stated that the review would be completed after the applicant provided additional information related to Part 1 (relay trip setpoints and time delay) and Part 4 (voltage levels for maximum and minimal load conditions). The SER stated that the PVNGS design had two redundant and independent emergency buses and each bus had two levels of undervoltage protection that included loss of power and degraded grid voltage.

In 1992, the NRC Electrical Distribution System Functional Inspection team identified a lack of calculations to support the degraded voltage relay setpoints. PVNGS updated the voltage calculations and identified several deficient conditions involving the degraded voltage scheme which are documented in Licensee Event Report (LER) 1993-011. Between 1993 and 1999, PVNGS and the NRC exchanged several communications, including: (1) Request for amendment to TS 3.8.1, “Alternating current (AC) Source – Operating,” and 3.3.7, “Diesel Generator (DG) - Loss of Voltage Start (LOVS),” dated December 16, 1998; (2) Issuance of amendments - changes related to Double Sequencing and Degraded Voltage Instrumentation, dated December 29, 1999; and (3) Response to NRC request for additional information (RAI) regarding proposed amendment to TS 3.8.1 and 3.3.7 dated July 16, 1999. The license amendment request dated December 16, 1998, proposed TS changes to prevent the spurious separation of safety buses during an accident. Specifically, TS 3.8.1, Condition G, added a one hour action statement for restoring the capability of an offsite power source that was determined not to be capable, or to transfer the affected safety buses to the onsite emergency diesel generators (EDG).

TS 3.3.7, DG – LOVS, established the low and high degraded voltage relay trip setpoints of $\geq$ 3697 volts alternating current (Vac) and $\leq$ 3786 Vac using engineering practices of the period rather than formal calculations. The licensee performed calculations to establish 3805 Vac as the most limiting voltage condition that would be expected to occur following a design basis accident. The NRC CDBI team noted that 3805 Vac is above the degraded voltage relay reset setpoint and that a specific analysis of voltages less than 3805 Vac had not been performed.

On November 11, 2008, and December 2, 2008, the licensee documented the lack of calculations to support the degraded voltage relay setpoints in Palo Verde Action Request (PVAR) 3253612 and Condition Report/Disposition Report (CRDR) 3256729. The licensee’s operability evaluation stated that the issue was a “paper nonconformance” that does not affect operability because it is not credible to have switchyard voltage low enough to cause a degraded voltage condition due to requirements specified in TS 3.8.1, Condition G. The licensee also stated that as part of the December 16, 1998, amendment request for the TS 3.8.1 change, the calculations demonstrated that the voltage to the switchgear would always remain above the degraded voltage setpoints. Therefore, the degraded voltage relays would never be relied upon to support a design basis event.

Because the prevention strategy value of 3805 Vac instead of the maximum degraded voltage relay reset value was included in Calculation 01-EC-MA-0221, “AC Distribution,” the CDBI team questioned the adequacy of the voltage used in the calculation. The licensee indicated specific calculations did not need to be performed at voltage levels below 3805 Vac. Nevertheless, in response to the CDBI team's questions, the licensee performed preliminary calculations to assess the voltages at the values of the degraded voltage relays. The calculations showed that there was a decrease in margin, but that the motor control center control circuits would maintain an adequate margin to operate at the voltages corresponding to the degraded voltage relay setpoints.

The licensee maintains that consistent with their request for amendment submittal dated December 16, 1998, a degraded voltage condition concurrent with a design basis accident is not credible. The NRC's request for additional information (RAI) dated June 14, 1999, and the SER (NUREG-0857) dated November 1981 did not provide a definitive response regarding the acceptability of the licensee's position regarding the functionality of the degraded voltage relays during design basis accidents. Specifically, the RAI and the SER showed no explicit indication of acceptance or denial by the NRC staff that a degraded voltage condition concurrent with an accident was not credible.

3.0 EVALUATION

The staff reviewed TIA 2010-005; NRC SER (NUREG-0857) dated November 1981; TS Sections 3.8.1, 3.3.7.3, and Table 3.3-3 and 4; PVNGS Updated Final Safety Analysis Report (UFSAR) Section 8; NRC staff safety evaluations (SEs) for license amendments Nos. 96, 84, and 67 for Units 1, 2, and 3, respectively, ADAMS Accession No. ML021710324, and amendment No. 123 for Units 1, 2, and 3, ADAMS Accession No. ML003670588; and staff positions established in the NRC Generic Letter (GL) dated June 2, 1977, GL 79-36, and NRC Qualification Review of the PVNGS Units 1, 2, and 3 letter dated December 12, 1977.

Degraded voltage events at Millstone 2 on July 5, 1976, and Arkansas Nuclear One on September 16, 1978, revealed that the operability of the Engineered Safety Feature equipment could not be assured. As a result, the NRC required all licensees to implement degraded voltage protection under Generic Action (Multiplant Action B-23) to ensure automatic protection of safety buses and loads. Since degradation of the offsite power system can lead to or cause the failure of redundant Class 1E safety-related electrical equipment, the NRC required licensees to install degraded voltage protection schemes as described in NRC letter dated June 2, 1977. In GL 79-36, the NRC required all licensees to review the electric power systems at each of their nuclear power plants to determine analytically if, assuming all onsite sources of AC power are not available, the offsite power system and the onsite distribution system is of sufficient capacity and capability to automatically start as well as operate all required safety loads. GL 79-36, Enclosure 2, provided guidance on evaluating the performance of electric power systems with regard to voltage drop calculations.

On December 25, 1993, as supplemented on February 6, 1995 and June 17, 1996, in LER 93-011-02, the licensee reported potential for double sequencing following a unit trip and a safety injection actuation signal, with the switchyard voltage less than 99.5 percent (i.e., no loss

of offsite power) and the startup transformer secondary windings fully loaded, with a successful fast bus transfer (for the reactor coolant pumps). The licensee stated that the undervoltage relays would drop out during load sequencing on offsite power and may not reset, resulting in a load shed, the closing of the EDG breakers, and resequencing of loads on to the EDG. The licensee addressed this design issue in license amendment No. 123. The staff determined that this amendment was to address the specific design issue (double sequencing) at PVNGS and did not change the licensing requirements for the degraded voltage protection at PVNGS.

Question 1: What are the licensing basis and purpose for the Degraded Voltage Function setpoints in PVNGS TS SR 3.3.7.3?

Response: The licensing basis for degraded bus voltage protection for safety-related systems during design basis events includes compliance with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, licensee commitments and amendments pertaining to the unnumbered GL dated June 2, 1977, GL 79-36, license amendments Nos. 96, 84, and 67, respectively, for Units 1, 2, and 3, and amendment No. 123 for Units 1, 2, and 3, the NRC SER (NUREG-0857) dated November 1981, UFSAR Section 8, Section 8.3.1.1.3.13, and TS Section 3.3.7, "Diesel Generator (DG) -Loss of Voltage Start (LOVS)," and the allowable values specified in TS SR 3.3.7.3.

The NRC outlined the purpose of the degraded voltage relays to protect Class 1E safety related buses from sustained degraded voltage conditions on the offsite power system under accident and non-accident conditions in Branch Technical Position (BTP) PSB-1, Revision 0, "Adequacy of Station Electric Distribution System Voltages," dated July 1981, ADAMS Accession No. ML052350520, and in the current BTP 8-6, Revision 3, "Adequacy of Station Electric Distribution System Voltages," dated March 2007, ADAMS Accession No. ML070710478. The Class 1E buses should separate from the grid within a few seconds if an accident should occur during sustained degraded voltage conditions. During normal plant operation, the Class 1E buses should automatically separate from the offsite power system if operator action fails to restore adequate voltages within a short interval. The time delay is optimized to ensure that permanently connected Class 1E loads are not damaged under degraded voltage conditions. The staff considers degraded voltage conditions coincident with an accident as a credible event.

The TS SR 3.3.7.3 Degraded Voltage Function Setpoint Allowable Values are as follows:

Degraded Voltage Function ≥ 3697 V and ≤3786 V
Time delay: ≥ 28.6 seconds and ≤ 35 seconds

The PVNGS UFSAR Section 8.3.1.1.3.13 states that the degraded voltage relays satisfy the following criteria:

1. The selection of voltage and time setpoints was determined from an analysis of the voltage requirements of the safety-related loads at all onsite system distribution levels.

2. Coincident (two-out-of-four) logic is used to preclude the spurious trip of the offsite source.

3. The time delays are such that:

   - The selected time delay minimizes the ability of short duration disturbances to reduce the availability of the offsite power source(s).

   - The allowed time duration of a degraded voltage condition at all distribution system levels does not result in failure of safety systems or components.

4. The voltage sensors will automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time delay limits have been exceeded.

5. The voltage sensors are designed to satisfy the applicable requirements of IEEE [Institute of Electric and Electronics Engineers] Standard 279-1971, Criteria for Protection Systems for Nuclear Power Generating Stations.

6. The [TS] include limiting conditions for operation, surveillance requirements, and allowable values for the degraded voltage relay voltage and time settings.

   Each 480V load center bus is equipped with an undervoltage relay for annunciation in the control room.

Therefore, the purpose for the Degraded Voltage Relay setpoints is to ensure that the trip setpoint adequately protects the Class 1E equipment powered by the safety related ESF bus from a potentially damaging degraded voltage condition. The degraded voltage sensors will automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time delay limits specified in TS 3.3.7.3 have been exceeded. Specifically for PVNGS, all safety related equipment connected to Class 1E buses should be able to function satisfactorily at or above 3697 V on the 4160V buses for all plant conditions. Furthermore, operation of equipment at (or below) 3697 V for 35 seconds should not lead to equipment damage or component malfunctions.

<u>Question 2</u>: What are the licensing basis and purpose for PVNGS LCO 3.8.1 ACTION G?

Response: Degraded voltage conditions in the transmission network to the site could adversely affect the ability of the safety-related loads to perform their function. The licensing basis and purpose for PVNGS LCO 3.8.1 ACTION G is to assure that offsite power is operable, available during plant operation with adequate post-trip voltages to safety-related loads, and the offsite power source has sufficient capacity and capability to ensure that: (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences; and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

Question 3: Does the basis for PVNGS LCO 3.8.1 ACTION G bound that of the degraded voltage function setpoints in PVNGS TS SR 3.3.7.3?

Response: No.

The offsite power system is the preferred and the most reliable source of power for nuclear plant safety systems. Therefore, plants remain connected to the preferred source for as long as possible, that is, for as long as the capability and capacity of the offsite source permits, before switching to the emergency diesel generators. TS LCO 3.8.1 ACTION G is taken if one or more offsite circuit(s) does not meet the required capability consistent with the design basis such that if inoperable AC electrical power sources cannot be restored to OPERABLE status within the required Completion Time, the unit must be brought to a MODE in which the LCO does not apply. Currently, Condition G of TS 3.8.1 provides requirements that must be taken when the PVNGS switchyard voltage is less than the limits specified in the TS Bases.

As discussed earlier, TS SR 3.3.7.3 setpoint is to ensure that the trip setpoint adequately protects the equipment powered by the 4.16 kV ESF bus from a potentially damaging degraded voltage condition. The degraded voltage sensors will automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time delay limits specified in TS 3.3.7.3 have been exceeded.

4.0 REGULATORY REQUIREMENTS

In 10 CFR 50, Appendix B, Criterion III, “Design Control” requires that measures be established to assure that design bases for structures, systems, and components are correctly translated into specifications, drawings, procedures and instructions.

In 10 CFR 50, Appendix A, General Design Criterion (GDC) 17, “Electric power systems,” requires, in part, that nuclear power plants have onsite and offsite electric power systems to permit the functioning of structures, systems, and components that are important to safety. The onsite system is required to have sufficient independence, redundancy, and testability to perform its safety function, assuming a single failure. The offsite power system is required to be supplied by two physically independent circuits that are designed and located so as to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. In addition, this criterion requires provisions to minimize the probability of losing electric power from the remaining electric power supplies as a result of loss of power from the unit, the offsite transmission network, or the onsite power supplies.

10 CFR 50.34(b) requires that “The final safety analysis report shall include information that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the structures, systems, and components and of the facility as a whole, and shall include … (2) A description and analysis of the structures, systems, and components of the facility, with emphasis upon performance requirements, the bases, with technical justification therefore, upon which such requirements have been established, and the evaluations required to show that safety functions will be accomplished. The description shall be sufficient to permit understanding of the system designs and their relationship to safety evaluations….”

10 CFR 50.55a (h) (2) requires that protection system must meet IEEE Standard 279. The PVNGS UFSAR Section 8.3.1.1.3.3 states that the degraded voltage relays satisfy the applicable requirements of IEEE Standard 279-1971, Criteria for Protection Systems for Nuclear Power Generating Stations.

5.0 CONCLUSION

Based on its review of TIA 2010-02, the NRR/EEEB [Electrical Engineering Branch] finds the following:

1. The purpose for the degraded voltage function setpoints is to ensure that the trip setpoint adequately protects the equipment powered by the 4.16 kV ESF bus from a potentially damaging degraded voltage condition. The degraded voltage sensors will automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time delay limits specified in TS 3.3.7.3 have been exceeded.

2. The licensing basis and purpose for PVNGS LCO 3.8.1 ACTION G is to assure that offsite power is operable, available during plant operation with adequate post-trip voltages to safety-related loads, and the offsite power source has sufficient capacity and capability.

3. PVNGS LCO 3.8.1 ACTION G does not bound the degraded voltage function setpoints in PVNGS TS SR 3.3.7.3. When the offsite source voltage is too low or sustained degraded voltage conditions may degrade safe operation of safety-related equipment, the protection schemes will automatically transfer to onsite sources to mitigate the consequences of design basis events including loss of coolant accidents.

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Date: October 13, 2010