

September 29, 2010

MEMORANDUM TO: Peter R. Wilson, Deputy Director
Division of Reactor Safety
Region I

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

SUBJECT: FINAL RESPONSE TO TASK INTERFACE AGREEMENT –
PEACH BOTTOM ATOMIC POWER STATION LICENSING BASIS FOR
DEGRADED GRID RELAYS (TIA 2009-007)

Region I, Division of Reactor Safety, requested assistance from the Office of Nuclear Reactor Regulation (NRR) in answering the following questions regarding the licensing basis for degraded voltage relays at Peach Bottom Atomic Power Station (PBAPS) to resolve the Unresolved Item identified in U.S. Nuclear Regulatory Commission Region I Inspection Report 05000277/2008007 and 05000278/2008007, Agencywide Documents Access and Management Accession No. ML081420740.

1. Does the PBAPS current licensing basis for degraded voltage relay settings include credit for the load tap changers on the startup transformers to protect the Class 1E equipment during a design basis loss of coolant accident?
2. What is the current licensing basis for degraded bus voltage protection?

The NRR staff's assessment is documented in the enclosed staff evaluation.

Docket No: 50-277, 50-278

Enclosure:
As stated

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

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TASK INTERFACE AGREEMENT (TIA) 2009-07
PEACH BOTTOM ATOMIC POWER STATION LICENSING BASIS FOR DEGRADED GRID
RELAYS

1.0 INTRODUCTION

The Nuclear Regulatory Commission (NRC) Region I Office requested the Office of Nuclear Reactor Regulation (NRR) to evaluate and provide concurrence on a draft Task Interface Agreement (TIA) memorandum regarding the licensing basis for degraded voltage relays at Peach Bottom Atomic Power Station (PBAPS) to resolve the Unresolved Item (URI) identified in NRC Region I Inspection Report 05000277/2008007 and 05000278/2008007, Agencywide Documents Access and Management (ADAMS) Accession No. ML081420740. The URI relates to the licensee's crediting of the operation of a non-safety-related load tap changer during a loss of coolant accident (LOCA). This TIA addresses the following questions presented by the URI:

1. Does the PBAPS current licensing basis for degraded voltage relay settings include credit for the load tap changers (LTCs) on the startup transformers to protect the Class 1E equipment during a design basis loss of coolant accident?
2. What is the current licensing basis for degraded bus voltage protection?

2.0 BACKGROUND

During the Peach Bottom 2008 Component Design Basis Inspection (CDBI), the inspection team verified the adequacy of voltage to various components during design basis events. The inspection team found that the load flow analysis of the safety related loads assumed voltage levels higher than that were afforded by the Function 4 - Reduced Voltage Relays. The higher voltages used for assessing equipment operability were based on expected voltages rather than the minimum voltage allowed by the undervoltage relay protection scheme. To explain the assumption of availability of these higher voltages, the licensee (Exelon) credited automatic operation of the startup transformer LTC. The voltage used in the PBAPS calculations (PE-0048, PE-0093 and MIDAS motor operated valve (MOV) Calculations) was based on a transient voltage study (PE-0121) performed by the licensee that simulates the voltage variations during a large break loss of coolant accident (LOCA).

The inspection team reviewed the PBAPS licensing record relating to degraded voltage protection and was not able to find a claim of credit for either LTC operation relative to equipment operability, or explicit NRC acceptance of this approach. The inspection team found that the voltage transient study had been submitted on the docket and did include operation of the LTC, but only to demonstrate offsite power availability. Therefore, the inspection team believed this study could only be used to determine the minimum grid voltage level that would not result in the actuation of the degraded grid relays during a grid voltage transient as it relates to offsite power availability. The licensee stated that the transient study was submitted on the docket for both offsite power availability and safety related equipment operability and, therefore, was acceptable because the methodology had been submitted, reviewed, and approved by the NRC. The inspection team also reviewed the license amendment requests and associated

ENCLOSURE

safety evaluations for Amendment 97/99, ADAMS Accession No. ML011350467, Amendment 143/145, ADAMS Accession No. ML011380049 and Amendment 230/235, ADAMS Accession No. ML993320097, but did not find any discussion of the use of the LTC for vital bus equipment protection during design basis events.

Calculation PE-0121 - Voltage Regulation Study, used to evaluate load sequencing cases, assumes that the startup transformer LTCs are operating. The inspection team's review of Electric Transient Analysis Program (ETAP) runs indicated that the effect of this assumption is to predict higher voltages, especially during the latter stages of load sequencing, than would be available without the tap changer. If the LTC was not available, it would be reasonable to expect 4,160 volts (V) safety bus recovery voltage to decline as loads were applied during load sequencing. For instance, if minimum recovery voltage is used to evaluate equipment operability, the voltage level for the analysis is the voltage on the 4,160 V bus that was no higher than the minimum degraded relay reset voltage (approximately 3,800 V). Calculation PE-0121 ETAP runs show considerably higher 4,160 V bus voltages (approximately 4,027 V) and correspondingly higher 480 V bus voltages immediately following load sequencing.

The analysis also credited the LTCs for providing improved voltage for steady state conditions after load sequencing, in lieu of considering the trip setpoint of reduced voltage (Function 4) relays. The ETAP load sequencing cases extend to 600 seconds, which is the steady state condition after load sequencing is completed. The ETAP runs in Calculation PE-0121 modeled grid voltage within the expected range but included automatic LTC operation, so that 4,160 V bus voltage is restored to normal voltage via tap changer operation rather than a degraded voltage level following load sequencing. As a result, the motor control center (MCC) voltages used in motor operator valve (MOV) and 480 V motor voltage calculations assume normal system voltages (approximately 480 V). The inspection team found that MCC voltage afforded by the Function 4 relays when the 4,160 V bus is at the design limit (<3,780 V) was not tabulated; however, a simplified calculation performed by the team showed expected MCC voltages could be less than 430 V. This data indicates that the minimum MCC voltages afforded by the Function 4 relays under steady state LOCA conditions are approximately 10% lower than the values used by the licensee for Generic Letter (GL) 89-10 MOV calculations for MOVs. The inspection team identified this issue as URI 05000277; 278/2008007-003, Vital Bus Degraded Voltage Protection.

Licensee's Position

PBAPS provided a White Paper to Region I on July 14, 2009, ADAMS Accession No. ML091960201, entitled "PBAPS Input for Resolution of NRC URI Concerning Vital Bus Degraded Voltage Protection." In the submittal, PBAPS summarized its position to state that:

Based on a review of licensing documentation approved by an NRC Safety Evaluation Report (SER), it can be concluded that the NRC was cognizant of the fact that the load tap changers (LTCs) for the startup transformers were assumed to operate for applicable voltage regulation case studies, including the LOCA case. The principle evidence is found in the licensing correspondence...involving License Amendment No. 143/145 approved in 1989. Because this SER was used to amend the PBAPS license, credit for the load tap changers function has been approved by the NRC. This NRC license amendment approval takes

precedence over the two generic letters [GLs] (i.e., June 2, 1977 and GL 79-36) discussed in the URI description. Neither the June 2, 1977 letter, nor GL 79-36 were specifically invoked in the approval of the NRC SER. Secondary evidence can also be found in a NRC Amendment (including Lawrence Livermore technical input) associated with license Amendment No. 97/99.

3.0 LICENSING BASIS HISTORY

3.1 Amendment History

NRC letter dated June 2, 1977, ADAMS Accession No. ML100610489, requested that PBAPS review the current emergency power system's design with respect to the NRC staff positions contained in the letter enclosures. The purpose of the review was to assess the susceptibility of safety-related electrical equipment with regard to: (1) sustained degraded voltage conditions at the offsite power sources; and (2) interaction between that offsite and onsite emergency power systems.

Generic Letter 79-36, "Adequacy of Station Electric Distribution Systems Voltages," ADAMS Legacy No. 7908230155, expanded the review described in the June 2, 1977 letter. The review was expanded to include the acceptability of the voltage conditions on the station electric distribution systems with regard to both: (1) potential overloading due to transfers of either safety or non-safety loads; and (2) potential starting transient problems. Amendment requests were submitted to the NRC as a result of the PBAPS review of GL 79-36 and the associated June 2, 1977, letter. On April 11, 1984, the NRC issued Amendment Nos. 97/99, ADAMS Accession No. ML011350467, to PBAPS that approved limiting conditions for operation and surveillance requirements associated with a modification that would provide a second level of undervoltage protection with a time delay for safety-related loads (degraded grid voltage protection system).

Subsequent to the issuance of Amendment Nos. 97/99, Amendment Nos. 143/145 were issued to PBAPS on April 13, 1989, ADAMS Accession No. ML011380049, to revise undervoltage relay time delay settings. The revisions to the relay settings were based on a Voltage Regulation Study that was provided to the NRC staff dated March 6, 1989, ADAMS Legacy No. 8903200164, supporting approval of Amendment Nos. 143/145. Section 3, Item #12 on page 3-8 of the Voltage Regulation Study states the following:

In the event of a LOCA, the transformer automatic load tap changers (LTCs) for 2 Startup Transformer 00X03, 3 Startup Transformer 00X05, and 343 Startup Transformer 00X11 will remain fixed in their pre-LOCA [loss of coolant accident] position for 30 seconds. The load tap changers are capable of moving one step (5/8%) every three to five seconds.

The NRC safety evaluation (SE) for Amendment Nos. 143/145 dated April 13, 1989, referenced the March 6, 1989 supplement and specifically described the voltage regulation study as follows:

The March 6, 1989 letter submitted voltage regulation studies that had been completed in January 1989. The amendments would modify the Technical

Specifications (TS) to correct deficiencies in the degraded voltage protection features that were identified as a result of revised voltage regulation studies. The studies were based in part on the consideration that, under certain offsite power emergency conditions, the voltage provided to the station's offsite power supply transformers could be lower than previously assumed. The study also modeled the plant's power distribution system to a greater level of detail.

The licensee's revised amendment request dated January 26, 1989, ADAMS Legacy No. 8902010395, associated with the Voltage Regulation Study, provided a discussion regarding the interface between offsite power sources and Class 1E equipment and the role of the undervoltage relays. Attachment 1, page 3, of the January 26, 1989, submittal states the following:

The 4.16kV bus feeder breakers provide the interface between the two offsite power sources and the plant safety-related AC power distribution system. Each of the four 4.16 kV buses, identified as the 4kV emergency buses at the bottom of Figure 1, in each unit can be powered from a safety-related diesel generator.

Each startup source to each 4.16kV bus is equipped with a solid state undervoltage relay which has a discrete setpoint. Each relay is presently set to initiate at 90% of nominal voltage on the 4.16kV bus. The purpose of these relays is to ensure that adequate levels of voltage are provided to the motors and control components which are powered from the 4.16kV buses.

Section 4, Item I, "Establishment of Setpoints for the Degraded Voltage Relays (Millstone Event)," on page 4-13 of the Voltage Regulation Study submitted with the March 6, 1989 supplement also states the following:

For the bounding plant operating configurations (Section 3.A), the LTC on 2 Startup Transformer 00X03 will not be available in some cases to improve the degraded voltage condition because the tap changer will already be at the maximum boost position prior to the incident. Similarly, 343 Startup Transformer 00X11 may not be able to provide the desired voltage levels in some cases (even though the LTC has not reached the maximum boost position prior to the incident) because the remaining taps are not sufficient. This means that the 460V motors and 480V MCC [motor control center] contactors will experience less than 90% voltage on a 460V base and 480V base, respectively, for a short period of time. This period of undervoltage is short because Devices 127Y and 127B (Appendix A, Table G) will very likely trip the incoming 4.16kV feeder breakers and connect the diesel generator to the 4.16kV buses. The effect of operation of the 460V motors and 480V MCCs at less than 90% voltage for this short period of time will be negligible.

The licensee submitted an amendment request dated December 24, 1998, revising the setpoint calculations based on Improved Instrument Setpoint Control Program methodology. This methodology accounts for relay accuracy, potential transformer accuracy, measurement and test equipment accuracy, and margin above the design limit established within the voltage regulation study. The NRC SE issued for Amendment Nos. 230/235 stated the following:

The LOP [loss of power] relays monitor the voltage of the 4kV emergency buses. The rated 4kV bus voltage is 4160 volts. Offsite power is the preferred source of power for the 4kV emergency buses. If the LOP relays detect low voltage levels on one offsite source, the 4kV buses are disconnected and transferred to the other offsite source, or to their emergency diesel generators, if the second offsite source is unavailable.

The voltage at each 4kV emergency bus is monitored at five levels, which can be considered as two different functions: one level of loss of voltage and four levels of degraded voltage. The degraded voltage function is monitored by four (Functions 2 thru 5) undervoltage relays per source, and loss of voltage is monitored by one (Function 1) undervoltage relay for each 4kV emergency bus. The combination of the loss of voltage relaying and degraded grid relaying provides protection to the Class 1E distribution system for all credible conditions of voltage collapse or sustained voltage degradation.

With regard to the degraded voltage LOCA (Function 4) relay, the NRC SE states the following:

Degraded Voltage LOCA (Function 4) relay: The voltage setpoint is changed and the associated allowable value limits are widened for both voltage and time. The licensee states that the higher allowable setpoint limit of 3836V would not unnecessarily transfer the 4kV emergency bus to the other offsite source or to the diesel generators during a design basis accident (DBA). The relay time delay settings are such that the relays will detect and respond to an actual sustained degradation of voltage, but will not actuate in response to normal operational voltage fluctuations. On the other hand, the lower setpoint value of 3766V ensures that the minimum required voltage at the worst case Class 1E 480V motor control center is maintained per the current design basis. Since the Voltage Regulation Study is performed utilizing the name plate load data, the proposed setpoint allowable value limits are conservative.

3.2 Updated Final Safety Analysis Report Review

The PBAPS Updated Final Safety Analysis Report (UFSAR), Section 8.4.5, describes the operation of the startup transformers to supply power to the 4kV emergency switchgear bus. Further description is provided regarding the operation of the startup transformers during a LOCA. The LTCs are not explicitly mentioned in the text. However, UFSAR Section 8.4.5 references drawing E-10, "Single Line Meter & Relay Diagram, Startup & Emergency Power Systems," Rev. 29. Drawing E-10 depicts the LTC as an integral component of the 2 Startup Transformer. It is noted that drawing E-10, depicting the LTC, has been in the UFSAR since initial issuance where it was originally presented as Figure 8.4.5. The drawing includes the LTC range, number of taps, and the voltage variation at each step.

UFSAR Section 8.4.5 describes the startup transformers as supplying power to the 4kV bus during LOCA conditions, if offsite power is available from any of the three offsite sources. UFSAR Section 8.4.6.3 describes the degraded voltage function during a LOCA as being monitored by the degraded undervoltage LOCA relay. Should offsite power not be available from any offsite source, the degraded voltage relay initiates transfer to the diesel generator units to supply power for the 4kV emergency switchgear buses.

The PBAPS UFSAR also addresses single failure criteria that are required to be applied for applicable accident analysis. UFSAR Section 1.5.1.6, "Nuclear Safety Design Criteria, Type S-3 (Accidents)," Item 4, states the following:

Essential safety actions shall be carried out by equipment [of] sufficient redundancy and independence that no single failure of active components can prevent the required actions. For systems or components to which IEEE-279 (1968) is applicable, single failures of passive electrical components are considered, as well as single failures of active components, in recognition of the higher anticipated failure rates of passive electrical components relative to passive mechanical components.

4.0 EVALUATION

The NRR staff reviewed SERs for license amendments 97/99, 143/145, and 230/235, the licensee's (Exelon) white paper, the CDBI inspection report (2008-007), PBAPS UFSAR Section 1.5 and 8.4, Technical Specifications (TS) Section 3.3.8.1, and the background information stated above in preparing the response to the following questions from Region 1.

Questions:

1. Does the PBAPS current licensing basis for degraded voltage relay settings include credit for the load tap changers on the startup transformers to protect the Class 1E equipment during a design basis loss of coolant accident?
2. What is the current licensing basis for degraded bus voltage protection?

Response:

The PBAPS current licensing basis for degraded voltage relay settings does not include credit for the load tap changers on the startup transformers to protect the Class 1E safety-related equipment during a design basis LOCA. The degraded voltage relays are relied upon for the safety-related function to separate from the off-site power source and protect Class 1E equipment if proper voltage is not maintained. The degraded voltage relay setpoints must be determined and used in component design bases calculations such that proper voltage levels will be supplied to Class 1E equipment without reliance on the LTCs.

However, the LTCs are credited in PBAPS current licensing basis to maintain the availability and operability of its offsite sources within its normal operating voltage range when grid voltage fluctuates. The LTC maintains acceptable plant bus voltages within specific limits given the wider normal range of grid voltages during normal plant operation and during a design basis LOCA, without a loss of offsite power, if the LTCs are capable of maintaining proper voltage levels.

The current licensing basis for degraded bus voltage protection for safety-related systems during a design basis LOCA includes compliance with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, licensee commitments pertaining to the GL dated

June 2, 1977, GL 79-36, license amendments 97/99,143/145, and 230/235, Updated Final Safety Analysis Report (UFSAR) Sections 8.4.6.2 and 1.5.1.6, TS Section 3.3.8.1, "Loss of Power Instrumentation," and the allowable values (limiting safety system settings) specified in Table 3.3.8.1-1.

The PBAPS UFSAR Section 8.4.6.2 states that the 4,160 V emergency system is continuously energized by an offsite source during planned plant operation. The voltage for each 4,160 V bus is monitored at five levels, which can be considered as two different undervoltage Functions: one level of loss of voltage and four levels of degraded voltage. The degraded voltage Function is monitored by four (Function 2 through 5) degraded voltage relays per source. The loss of voltage is monitored by one (Function 1) under voltage relay for each 4,160 V bus.

Only safety related or Class 1E relays and schemes are relied upon to protect the safety-related equipment from exposure to prolonged degraded voltage or undervoltage conditions. The NRC staff notes that the PBAPS UFSAR does not provide any discussion of the startup transformer LTCs supporting the degraded voltage relay settings. Specifically, PBAPS UFSAR Sections 8.4.6.2 and 8.4.6.3 do not describe the LTCs as providing protection from a degraded voltage condition above the setpoint of the degraded voltage Functions. The associated analysis and description would have been required in the UFSAR in accordance with 10 CFR 50.34, "Contents of Applications; Technical Information," subsection 50.34(b), "Final Safety Analysis Report," if LTCs were credited for this condition. Although the current licensing basis describes offsite power as the preferred source during a LOCA and the LTCs will ameliorate low voltages of offsite power to the extent they are capable, under certain circumstances the LTCs will not be able to improve degraded voltage conditions. Therefore, the under voltage relay setpoints must be determined and used in component design basis calculations such that proper voltage levels will be supplied to Class 1E equipment without reliance on the LTCs. In addition, the PBAPS UFSAR also addresses single failure criteria that are required to be applied for applicable accident analysis. UFSAR Section 1.5.1.6, "Nuclear Safety Design Criteria, Type S-3 (Accidents)," Item 4, states the following:

Essential safety actions shall be carried out by equipment [of] sufficient redundancy and independence that no single failure of active components can prevent the required actions. For systems or components to which IEEE-279 (1968) is applicable, single failures of passive electrical components are considered, as well as single failures of active components, in recognition of the higher anticipated failure rates of passive electrical components relative to passive mechanical components.

Therefore, the staff determined that LTCs are not credited for protecting the safety-related equipment for any design basis accident since they are not safety related and do not meet the single failure criterion. Nor were the LTCs explicitly approved by the NRC staff as acceptable for this purpose.

Degraded voltage events at Millstone 2 on July 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 including PBAPS to install degraded voltage protection schemes as described in the GL dated June 2, 1977 (ML1006104892). 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. The GL did not provide any guidance in using LTCs for calculating the voltage at the terminals of each safety load. The staff stated that voltage at the terminals of each safety load should be calculated based on the assumption that the grid voltage is at the "minimum expected value." The "minimum expected value" should be selected based on the least of the following:

- a. The minimum steady-state voltage experience at the connection to the offsite circuit.
- b. The minimum voltage expected at the connection to the offsite circuit due to contingency plans which may result in reduced voltage from this grid.
- c. The minimum predicted voltage from grid stability analysis.

The licensee proposed plant modifications and TS amendments and the NRC issued amendments 97/99, 143/145, and 230/235 regarding degraded voltage protection at PBAPS.

The licensee's Voltage Regulation Study, submitted with the March 6, 1989 supplement, Section 3, Item #12 on page 3-8 states the following:

In the event of a LOCA, the transformer automatic load tap changers (LTCs) for 2 Startup Transformer 00X03, 3 Startup Transformer 00X05, and 343 Startup Transformer 00X11 will remain fixed in their pre-LOCA [loss of coolant accident] position for 30 seconds. The load tap changers are capable of moving one step (5/8%) every three to five seconds.

In addition, the licensee's of the Voltage Regulation Study on page 4-13 states the following:

For the bounding plant operating configurations (Section 3.A), the LTC on 2 Startup Transformer 00X03 will not be available in some cases to improve the degraded voltage condition because the tap changer will already be at the maximum boost position prior to the incident. Similarly, 343 Startup Transformer 00X11 may not be able to provide the desired voltage levels in some cases (even though the LTC has not reached the maximum boost position prior to the incident) because the remaining taps are not sufficient. This means that the 460V motors and 480V MCC [motor control center] contactors will experience less than 90% voltage on a 460V base and 480V base, respectively, for a short period of time. This period of undervoltage is short because Devices 127Y and 127B (Appendix A, Table G) will very likely trip the incoming 4.16kV feeder breakers and connect the diesel generator to the 4.16kV buses. The effect of

operation of the 460V motors and 480V MCCs at less than 90% voltage for this short period of time will be negligible.

The above statements in the Voltage Regulation Study demonstrate that Startup Transformer LTCs cannot function adequately to supply proper voltage to Class 1E equipment in all circumstances. In addition, the LTCs had a built-in time delay of 30 seconds before it reacts to any voltage changes. This time delay was more than the time delay (10 seconds) for the degraded voltage protection relays. Therefore, the LTCs could not have functioned adequately to supply proper voltage to Class 1E equipment. The protection schemes for loss of voltage and degraded voltage conditions (with and without a LOCA) are designed to meet the Class 1E requirements including single failure criteria and the TS requirements for limiting conditions for operation, surveillance requirements and trip setpoints. Allowable values are established to ensure that a highly reliable protection system will be operable during plant operation. 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 an alternate offsite power source or onsite source to mitigate the consequences of a design basis LOCA-without regard to operation of the LTCs.

The degraded bus relay setpoint requirements for PBAPS are provided in TS Section 3.3.8.1, "Loss of Power Instrumentation," and the allowable values (limiting safety system settings) are specified in Table 3.3.8.1-1. The TS bases and clarifications submitted on the docket for TS amendment 230/235, which included a change to the trip setpoints and time delay of the Function 4 relays stated that:

The second level of undervoltage protection is provided by the four levels of degraded grid voltage relays which are set to detect a sustained low voltage condition. These degraded grid relays disconnect the Class 1E buses from the offsite power source if the degraded voltage condition exists for a time interval which could prevent the Class 1E equipment from achieving its safety function. The degraded grid relays also prevent the Class 1E equipment from sustaining damage from prolonged operation at reduced voltage. The combination of the loss of voltage relaying and the degraded grid relaying provides protection to the Class 1E distribution system for all credible conditions of voltage collapse or sustained voltage degradation.

In license Amendment 143/145, staff stated that for Non-LOCA condition:

The 0.98 pu setting is needed to ensure an acceptable voltage level to motor control center (MCC) loads (460 and 120 V). The licensee has stated that contactors are the limiting case control components and that, following installation of the proposed protective relaying; the safety system components will be adequately protected and capable of performing their safety function.

The staff also stated that:

In addition to the proposed emergency core cooling system (ECCS) loading sequence, the licensee will further improve the voltage regulation of the 480 V load centers during a motor starting transient by a combination of plant

modifications which revise the load shedding or sequencing of the emergency service water pumps, the emergency cooling water pump, the residual heat removal (RHR) compartment coolers, the cooling towers and the diesel generator vent supply fans. The licensee will perform these changes pursuant to 10 CFR 50.59 since none involved an unreviewed safety question or a change to the Technical Specifications.”

In amendment 230/235, the licensee updated the setpoints and allowable values provided in Table 3.3.8-1-1 using the Improved Instrument Setpoint Control Program methodology. The voltage setpoint for Degraded Voltage LOCA (Function 4) relay is changed and the associated allowable value limits are widened for both voltage and time. The licensee stated that the higher allowable setpoint limit of 3,836 V would not unnecessarily transfer the 4,160 V emergency bus to the other offsite source or to the diesel generators during a design basis accident (DBA). The relay time delay settings are such that the relays will detect and respond to an actual sustained degradation of voltage, but will not actuate in response to normal operational voltage fluctuations. On the other hand, the lower setpoint value of 3,766 V ensures that the minimum required voltage at the worst-case Class 1E 480 V MCC is maintained per the current design basis. For Degraded Voltage Non-LOCA (Function 5) relay, the voltage setpoint is changed and the associated allowable values are widened for both voltage and time.

The staff noted that the voltage used in 1989 PBAPS voltage regulation study was based on computer simulations that modeled both the automatic action of LTCs on the startup transformers and initial grid voltage within the expected range necessary to avoid separation of the offsite power supply. The study indicates that the effect of this assumption is to predict higher voltages, especially during the latter stages of load sequencing, than would be available without the tap changer. Also, the licensee’s study attempted to show no overvoltage conditions during the latter stages of load sequencing with the LTC in circuit.

The PBAPS current licensing basis does not take credit for automatic action of non-safety related LTCs on the startup transformers to restore voltage to an acceptable voltage level to ensure vital bus operability during a design basis LOCA. The LTC allows the licensee to maintain acceptable bus voltages within a wider range of grid voltages during normal plant operation. The LTCs do not provide protection for safety-related equipment. The degraded grid relay setpoints are used to ensure voltage on the vital busses is adequate. Therefore, protection and operability of safety-related equipment is based on the allowed voltage levels afforded by the degraded voltage relay setpoints.

Although the PBAPS licensing review was not done in accordance with NUREG 0800, “Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants,” the staff’s current guidance for reviewing the adequacy of station electric distribution system voltages is provided in Branch Technical Position (BTP) 8-6, “Adequacy of Station Electric Distribution System Voltages,” ADAMS Accession No. ML070710478, of the SRP. It should be noted that IEEE Standard 741-1997, “IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations,” which states in Appendix A that “analyses may consider the effects of voltage compensating equipment, such as automatic [LTC] transformers...,” is referenced in the SRP, but is not endorsed by the NRC staff.

Based on the above, NRR/EEEB finds that the licensee must demonstrate that the existing degraded voltage trip setpoints including allowable values, and time delays shown in PBAPS Table 3.3.8.1, are adequate to protect and provide the required minimum voltage to all safety related equipment during a design basis LOCA without crediting the non-safety related LTCs.

5.0 REGULATORY REQUIREMENTS

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. Appendix H of the PBAPS UFSAR states that Units 2 and 3 conform to the intent of the Atomic Energy Commission (AEC) (NRC) proposed General Design Criteria (GDC) for Nuclear Power Plants, 10 CFR 50, Appendix A, July 1967. GDC 39, "Emergency Power for Engineered Safety Features," states that alternate power systems shall be provided and designed with adequate independency, redundancy, capacity, and testability to permit the functioning required of the engineered safety features. As a minimum, the onsite power system and the offsite power system shall each, independently, provide this capacity assuming a failure of a single active component in each power system.

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 therefor, 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.

6.0 CONCLUSION

Based on its review of TIA 2009-007, the NRR Staff finds the following:

1. The licensee must demonstrate that the existing degraded voltage trip setpoints, including allowable values and time delays shown in PBAPS Table 3.3.8.1, are adequate to protect and provide the required minimum voltage to all safety related equipment. Since the LTCs are not safety-related and are subject to operational limitations and credible single failures, they cannot be relied on to establish degraded voltage relay setpoints and time delay input for design basis calculations.
2. The PBAPS current licensing basis describes operation of the LTCs to supply the design specified voltage to Class 1E equipment during a design basis LOCA if the LTCs are capable of maintaining proper voltage levels and off-site power is available. However, the under voltage relays are relied upon for the safety-related function to separate from the off-site power source and protect Class 1E equipment if proper voltage is not maintained. Therefore, the degraded voltage relay setpoints must be determined and

used in component design bases calculations such that proper voltage levels as defined by GL 79-36 will be supplied to Class 1E equipment without reliance on the LTCs.

The current licensing basis for degraded bus voltage protection for safety-related systems during a design basis LOCA includes the licensee's written commitments and amendments pertaining to the GL dated June 2, 1977 and GL 79-36, compliance with 10 CFR 50 requirements, license amendments 97/99, 143/145, and 230/235, Updated Final Safety Analysis Report (UFSAR) Section 8.4.6.2 and 8.4.6.3, and TS Section 3.3.8.1, "Loss of Power Instrumentation," and the allowable values (limiting safety system settings) specified in Table 3.3.8.1-1.

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Date: