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

October 31, 2014

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3D-C
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 – AUDIT PLAN FOR REVIEW OF DEGRADED VOLTAGE PROTECTION SCHEME

Dear Mr. Shea:

BACKGROUND AND AUDIT BASIS

In Supplement 22 of NUREG-0847, "Safety Evaluation Report Related to the Operation of Watts Bar Nuclear Plant, Unit 2" (SSER 22) the U.S. Nuclear Regulatory Commission (NRC) staff documented the results of their review of the Tennessee Valley Authority (TVA) response to the NRC staff's request for additional information regarding the Degraded Voltage Relay (DVR) settings. Specifically, TVA stated that the degraded voltage analysis evaluates the capability to individually start and run Class 1E motors at steady-state conditions. This analysis ensures that all motors have adequate starting voltage at the upper boundary of the DVR setpoint (6672 volts (V)) and adequate running voltage at the lower boundary of the DVR setpoint (6555 V). The upper boundary represents the lowest voltage that guarantees offsite power supply recovery following a transient from a design-basis event. TVA revised the upper boundary setpoint to 6681 V; therefore, the analysis performed with the value of 6672 V is conservative.

In the above safety evaluation staff stated that TVA should confirm that all safety-related equipment (in addition to the Class 1E motors) will have adequate starting and running voltage at the most limiting safety-related components (such as motor-operated valves, contactors, solenoid valves or relays) at the DVR setpoint dropout setting. TVA should also confirm that (1) the motor starting transient studies are based on the dropout voltage value of DVR and time delay, (2) the steady-state voltage drop studies are carried out by maximizing running loads on the Class 1E distribution system (bounding combination of safety systems loads), with the voltage at 6.9 kilovolts (kV) Class 1E buses (monitored by the DVRs) at or just above the DVR dropout setting, and (3) the DVR settings do not credit any equipment operation (such as load tap changer (LTC) transformers) upstream of the 6.9 kV Class 1E buses. In addition, TVA should also confirm that the final technical specifications are properly derived from these analytical values for the degraded voltage settings. This item was identified as Open Item 30 in SSER 22, Appendix HH.

In 2010, NRC inspectors identified during a Component Design Basis Inspection (CDBI) that TVA was not using worst-case values in analyzing this condition (this resulted in a non-cited violation). Subsequent to this finding, Electrical Engineering Branch (EEEB) staff identified that the existing DVR setpoints were not adequate to protect the safety-related components during degraded voltage conditions. When a plant experiences degraded voltage, the voltage dips below the required voltage for full operation of all safety-related loads, but not low enough for

the plant to recognize a loss of voltage and therefore immediately switch over to the emergency diesel generators. Since the CDBI finding, TVA has provided the staff with case studies and calculations to show that equipment will perform its intended safety functions. However, based on the staff's review, these case studies were not consistent with the design basis of the plant. TVA and the staff have had frequent communication on the topic and have discussed most of the staff's concerns through the Request for Additional Information (RAI) process. The main focus of the staff's current concerns are related to the requirement that Watts Bar Units 1 and 2 have adequate bus voltages at the safety-related buses during a design basis actuation of safety loads concurrent with degraded grid conditions. If the bus voltage drops below an acceptable level, then the safety-related loads should not be adversely impacted (trip and lockout) and should be able to sequence on to the onsite power sources to mitigate the consequences of postulated design-basis events.

On June 7, 2012 (ADAMS Accession No. ML12160A350), TVA submitted updated information related to the offsite and onsite power system degraded voltage studies for safety-related electrical equipment. The submittal included excerpts from STUDY-EEB-WBN-12-001, "Sensitivity Study of Degraded Voltage Relay (DVR) Protection During Motor Starting," Revision 1. The staff provided feedback in July 2012, during an RAI conference call with TVA. The staff informed TVA that there were issues associated with the assumptions used in their calculation.

In a public meeting on April 24, 2014, TVA explained that the DVR analyses was complete and met the requirements of NRC guidelines. On June 13, 2014, TVA submitted a formal response for staff review. The staff's review of the response identified several concerns with the methodology used to establish the adequacy of the DVR setpoint. As an example, the analysis stated that, "The 6.9 kV shutdown boards were disconnected from all offsite power source(s) and a dedicated fixed voltage source was added to each 6.9 kV shutdown board." The staff determined that the voltage drop through common station service transformers (CSSTs) A, B, C, and D needs to be accounted for when block starting or sequential starting of emergency loads in the analyses provided to validate that engineered safety feature loads can start and run and meet the accident analysis assumptions. The existing modeling did not account for the grid interactions with plant safety system operating scenarios. This is a significant flaw in TVA's analysis. Since June 13, 2014, the staff has provided verbal comments to TVA staff to clearly delineate the basis of the review. On August 7, 2014, the EEEB staff provided feedback and proposed additional RAIs to TVA. On October 8, 2014, staff participated in a public meeting/conference call with TVA to discuss DVR questions and provide clarification, as needed. TVA is currently developing responses to the questions and will inform NRC when the supporting documentation for adequacy of DVR setpoint is available for potential site visit/audit to discuss further before final responses are submitted. The RAIs are discussed in the "INFORMATION NEEDS" section of this audit plan.

AUDIT SCOPE

As discussed, onsite audits will be performed per Office Instruction LIC-111, "Regulatory Audits," to support the staff's safety review of TVA's resolution of Open Item 30 documented in SSER 22, Appendix HH. The purpose of the audit is to obtain and review information regarding how TVA resolved the staff's RAI dated October 7, 2014.

AUDIT GUIDANCE

NRC staff will use the following requirements and guidance to conduct the audit:

Title 10, *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, General Design Criteria, Criteria 17 and 18.

10 CFR 50.36, Technical Specifications.

Standard Review Plan, Chapters 8.2 and 8.3.

Branch Technical Position 8-6, PSB-1, "Adequacy of Station Electric Distribution System Voltages."

Regulatory Issue Summary 2011-12, "Adequacy of Station Electric Distribution System Voltage," Revision 1.

NRC Region II Integrated Inspection Report identified Non-Cited Violation 500090/2010005-03, "Failure to Use Worst Case 6900 VAC Bus Voltage in Design Calculations" during an inspection conducted between October 1 and December 31, 2010, at Watts Bar Nuclear Plant, Unit 1 (ADAMS Accession Nos. ML110280456 and ML110960591).

Institute of Electrical and Electronics Engineers Standard 279, "Criteria for Protection Systems for Nuclear Power Generating Stations."

NRC letter dated July 2, 1977, regarding DVRs.

NRC AUDIT TEAM

G. Matharu, EEEB
R. Mathew, EEEB
J. Zimmerman, EEEB
M. Miernicki, Division of Operating Reactor Licensing

OBSERVERS

C. Julian, RII
G. Crespo, RII

LOGISTICS

The audit will be conducted at the TVA Corporate Office in Chattanooga, TN, November 4 - 5, 2014. Entrance and exit briefings will be held with the licensee at the beginning and end of the audit, respectively, as well as daily briefings of team activities. Additional details will be addressed over the phone.

A private conference room is requested for NRC audit team use with access to audit documentation upon arrival and as needed.

DELIVERABLES

An audit summary or safety evaluation will be issued to the licensee within 45 days from the end of the audit.

INFORMATION NEEDS

A written draft response to the staff's following RAIs dated October 7, 2014, must be provided at least a week before the audit. In addition, the TVA staff must be available to discuss and demonstrate software simulations used for the study.

QUESTION 1:

I. Confirm that the analyses in Appendix H of Calculation: STUDY-EEB-WBN-12-001, Revision 2 assumes that at the onset of the event in one unit, all operating loads are transferred to one offsite power source for both units concurrent with start of emergency core cooling system loads.

QUESTION 2:

I. Clarify that the analysis in Appendix H was performed with the Phase A Start Sequence that evaluates a Safety Injection Initiation without receipt of a Phase B Containment Isolation (High Containment Pressure) as this is considered the most limiting case.

II. For the analysis performed in Appendix H, explain why a large pipe break requiring safety injection (SI) with containment isolation and actuation of containment spray imposes a lower loading on the offsite power system at the onset of the event. Provide a summary analysis of loads and corresponding limiting bus voltages (6.9 kV, 480 V and 120 V) considered for Phase A and Phase B loads at the ONSET of the event.

QUESTION 3:

I. For CSSTs C and D, confirm that after adjusting the voltage at the shutdown boards at a value equal to the trip setpoint of the degraded voltage relays, no more voltage adjustments were made by the LTCs.

II. Detailed evaluation was performed for 6.9 kV Shutdown Board 1A-A only (aligned to CSSTs A, B, C, or D) as the results are considered to be representative of the other Shutdown Boards for the purposes of these analyses. Clarify that the loading and system impedances for Shutdown Board 1A-A provide the limiting case for all shutdown boards. Provide a summary of the analyses that was performed to establish the limiting case for Shutdown Board loadings.

III. Provide a summary of the loading (kilowatt and kilovolt ampere reactive) for each of the transformers connected to the offsite power source for the following conditions:

- prior to event
- at the onset of the event
- a few seconds after the event (e.g., 4 seconds)

IV. Provide the corresponding loads and voltages at the switchyard bus, the 6.9 kV shutdown boards, 480 V and 120 V system buses. NOTE: The tabulated format used in Appendix A of calculation Calc. STUDY-EEB-WBN-12-001 or a marked up single line diagram is acceptable.

QUESTION 4:

I. To illustrate that the outcome of Appendix H is not affected by the assumptions in the study cases, provide a comparison of voltage drop and motor starts for the design-basis configuration and the limiting case for the various studies that have been performed. Confirm that the simulation assumes a block loading of plant emergency core cooling loads.

The staff notes that the motor starting studies were performed with the 6.9 kV shutdown boards disconnected from all offsite power source(s) and a dedicated fixed voltage source was added to each 6.9 kV shutdown board. The source voltage was set to the DVR dropout setting of 6555 V (Section 5.2). Using the load configuration in the existing Units 1 and 2 ETAP model, the following analyses were performed:

- Dynamic Motor Starting - Safety Injection Signal Phase A (SIA)
- Dynamic Motor Starting - Safety Injection Signal Phase B
- Static Motor Starting (starting individual motor): This analysis is performed with SIA since this provides the worst-case voltages on the 480 V system. For this analysis, motor starting study case is generated to individually start each Class 1E motor. Resolutions to loads requiring additional review are annotated in Appendix A

II. For the Protective Device Analysis (Start-Start scenario) the board voltages at the onset of the event are considered normal (i.e., no preheat). The degraded voltage condition presumes that the voltage does not recover but remains below the degraded voltage relay setpoint. The design calculated worst-case transient voltage dip during the accident loading sequence is used. This is considered conservative, because a lower voltage would produce less starting current for the motors. Confirm that the case studies for protective devices assuming Appendix H configuration, block loading the station buses with design basis configuration will not result in a lower voltage and consequential stalling of the plant motors.

III. Starting Voltage Analysis - Appendix A for summary of the results concludes that all safety related loads have adequate starting voltage during DVR conditions and the existing setpoints for the degraded voltage relay are considered acceptable. Confirm that block loading the plant busses with Appendix H configuration and design basis alignment of the buses, has the same conclusion.

IV. The study notes that Emergency Raw Cooling Water Screen Wash Pumps are not assured to have adequate voltage as analyzed. However per N3-67-4002 this load is not required to be manually placed into service until 12 hours into a design basis event. Please provide the corresponding accident analyses reference in the Final Safety Analysis Report.

V. The adequacy of pickup voltage for the contactors, solenoid valves, and relays were performed as part of the Control Circuit Voltage Drop analysis. This analysis was performed considering a steady state minimum voltage of 432 V. Please confirm that the minimum voltage for the Appendix H analysis yielded a minimum voltage of 432 V.

VI. The analysis notes that the motor control center transient bus voltage under degraded voltage conditions (at DVR dropout voltage of 6555 V) drops below 432 V due to starting of large motors on the 480 V switchgear. This voltage, however, recovers to a value of greater than 432 V within 4 seconds. Please confirm that the Appendix H analyses for a similar transient, results in voltage recovery within 4 seconds and the Westinghouse evaluation for an additional 5-second delay for the startup of the safety injection pumps and an additional 5-second delay in the closure of the feedwater isolation valve is valid.

VII. Confirm that all protective devices were evaluated for maximum overload conditions lasting for 12 seconds (i.e., the duration of degraded bus voltage conditions for Appendix H scenario when the DVR may not be reset).

VIII. The purpose of Appendix B attachment is to demonstrate that any possible voltage transient caused by motor starting during a design-basis event (SI with Phase A or Phase B isolation), including drop to the loss-of-voltage setpoint, will also result in successful recovery above DVR reset within 5 seconds. It has the following assumptions:

- The offsite power LTCs (CSSTs C and D) are not allowed to correct the voltage during the motor starting event. However, they are allowed to adjust the voltage prior to the event. This is conservative because it will result in the worst-case voltage transient with no voltage recovery from the LTCs.

- The auxiliary power system is assumed to be in normal alignment prior to the event (Unit Boards and Reactor Coolant Pump Boards on USSTs, Common Boards on CSSTs A and B, Shutdown Boards on CSSTs C and D). This is conservative, because it puts the least amount of load on the offsite power source prior to the event and thereby results in a “stiffer” offsite power source impedance (i.e., less recovery). In addition, aligning the Shutdown Boards to CSSTs A and B would result in even greater recovery due to the Unit Board load shed feature.

- The 161 kV Switchyard voltage is assumed to be at the minimum operable voltage prior to the event. This is conservative, because it will also result in a "stiffer" offsite power source impedance (i.e., less recovery).

Considering that the degraded grid conditions may not recover in 5 seconds, please provide an explanation as to how the above assumptions are in alignment with the staff guidance provided in Regulatory Issue Summary 2012-11 and should therefore be considered for compliance with DVR setpoint analyses.

If you have any questions on this audit plan, please contact me at 301-415-2048 or by e-mail at Justin.Poole@nrc.gov.

Sincerely,

Justin C. Poole, Project Manager
Watts Bar Special Projects Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No.: 50-391

Enclosure:
Audit plan

cc w/encl: Distribution via Listserv

If you have any questions on this audit plan, please contact me at 301-415-2048 or by e-mail at Justin.Poole@nrc.gov.

Sincerely,

/RA/

Justin C. Poole, Project Manager
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