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

March 27, 2018

MEMORANDUM TO: Jennifer Dixon-Herrity, Chief
Licensing Branch 4
Division of New Reactor Licensing
Office of New Reactors

FROM: Donald Habib, Project Manager ***/RA/***
Licensing Branch 4
Division of New Reactor Licensing
Office of New Reactors

SUBJECT: AUDIT SUMMARY FOR VOGTLE ELECTRIC GENERATING PLANT UNITS 3 AND 4, REQUEST FOR LICENSE AMENDMENT AND EXEMPTION, CLASS 1E MOTOR-OPERATED VALVE TERMINAL VOLTAGE TESTING (LAR 17-018)

The U.S. Nuclear Regulatory Commission staff conducted an audit of documents related to the Vogtle Electric Generating Plant (VEGP) Units 3 and 4, combined licenses, specifically documents related to VEGP License Amendment Request (LAR) 17-018 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML17242A279 and ML18012A704). The audit was conducted using the Westinghouse electronic reading room and included an audit teleconference between the staff and licensee representatives on February 8, 2018.

The plan for this audit is available in ADAMS under Accession No. ML17333A108. A summary of the audit is enclosed.

Docket Nos.: 52-025 and 52-026

Enclosure:
As stated

CONTACT: Donald Habib, NRO/DNRL/LB4
301-415-1035

SUBJECT: AUDIT SUMMARY STAFF REVIEW OF DOCUMENTATION ASSOCIATED WITH THE TESTING AND ANALYSES FOR VOGTLE ELECTRIC GENERATING PLANT UNITS 3 AND 4 REQUEST FOR LICENSE AMENDMENT AND EXEMPTION: CLASS 1E MOTOR-OPERATED VALVE TERMINAL VOLTAGE TESTING (LAR-17-018), TIER 1 TABLE 2.6.3-3 ITAAC 4.I DATED MARCH 27, 2018

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Audit Summary
Staff Review of Documentation Associated with the Testing and Analyses for Vogtle Electric Generating Plant Units 3 and 4 Request for License Amendment and Exemption: Class 1E Motor-Operated Valve Terminal Voltage Testing (LAR-17-018), Tier 1 Table 2.6.3-3 ITAAC 4.i

March 2018

Purpose

The Regulatory Audit was conducted to (1) examine and evaluate technical information, and (2) to understand or verify the key assumptions, methodology, analyses, and calculations to support the basis of regulatory license amendment request (LAR) decisions related to the Class 1E direct-current (dc) and uninterruptible power supply system (IDS) batteries and Motor-Operated Valve (MOV) Voltage Testing required by Vogtle Electric Generating Plant (VEGP) Updated Final Safety Analysis Report (UFSAR) Tier 1, Table 2.6.3-3, "Inspection, Tests, Analysis, and Acceptance Criteria (ITAAC)," No. 4.i. The staff's review of the VEGP Units 3 and 4 licensee's documentation during this audit supports the staff's review of LAR 17-018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17242A279) met applicable regulations and guidance. The purpose for the audit is documented in the audit plan (ADAMS Accession No. ML17333A108).

Background

On August 30, 2017, Southern Nuclear Operating Company (SNC) submitted VEGP Units 3 and 4, "Request for License Amendment and Exemption: Class 1E MOV Terminal Voltage Testing, proposed LAR 17-018," to the U.S. Nuclear Regulatory Commission (NRC). The requested amendment includes changes to the UFSAR in the form of departures from the incorporated plant-specific Design Control Document Tier 2 information and involves related changes to combined license (COL) Appendix C (and corresponding plant-specific Tier 1) information. This amendment request proposes to revise UFSAR Tier 1, Table 2.6.3-3, ITAAC No. 4.i to prescribe voltage tests in conjunction with analyses, rather than voltage testing only. Tier 1, Table 2.6.3-3, ITAAC No. 4.i tests and analyses are intended to ensure that Class 1E IDS functionality supports the actuation of Class 1E MOVs. In response to a staff request for additional information (RAI) issued December 1, 2017 (ADAMS Accession No. ML17338A463), SNC supplemented the LAR on January 12, 2018 (ADAMS Accession No. ML18012A704).

Regulatory Bases

This regulatory audit is based on the following:

- Part 50, "Domestic Licensing of Production and Utilization Facilities," in Title 10, "Energy," of the *Code of Federal Regulations* (10 CFR Part 50), Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 17, "Electric Power Systems"
- 10 CFR 52.80(a), "Contents of Applications; Additional Technical Information"

Applicable Guidance

- NUREG-0800, Standard Review Plan (SRP), Section 8.3.2 “DC Power Systems”

Audit Location and Date

This audit took place January 16, 2018, through February 16, 2018. The audit was conducted through the Westinghouse Electric Company (Westinghouse) electronic reading room (eRR) and a teleconference with Westinghouse on February 8, 2018.

Audit Team Assignments

- Ngola Otto, Audit Lead, Electrical Engineer, Electrical Engineering New Reactor and License Renewal Branch (EENB), Office of Nuclear Reactor Regulation (NRR)
- Sheila Ray, Senior Electrical Engineer, EENB, NRR
- Tania Martinez-Navedo, Chief, EENB, NRR
- Thomas Scarbrough, Senior Mechanical Engineer, Mechanical Engineering Branch, Office of New Reactors (NRO)
- Don Habib, Project Manager, Licensing Projects Branch 4, NRO

Documents Audited

- APP-IDS-E0C-004, “IDS Power Cable Sizing and Voltage Drop Analysis,” Rev. 4, December 2017
- APP-IDS-E0C-018, “MOV Acceptance Voltage During Safety Related DC MOV Field Testing,” Rev. 0, February 2017
- APP-PV01-Z0-001, “Design Specification for 3” and Larger Motor Operated Gate and Globe Valves,” Rev. 9, May 2016
- APP-PV11-Z0-001, “Design Specification for Butterfly Valves,” Rev. 10, May 2016
- APP-ZAS-E0C-001, “AC Electrical System Load Flow, Short Circuit and Motor Starting Calculation,” Rev. 1, November 2017
- APP-ECS-E3-001, “AC Power System Station One Line Diagram,” Rev. 2, September 2015
- APP-ECS-E3-002, “AC Power System, Station One Line Diagram,” Rev. 4, September 2015
- APP-IDSA-E3-DK101,” One Line Diagram Class 1E 250V DC MCC IDSA-DK-1 Auxiliary Bldg., Rev. 2, January 2016
- APP-IDSA-E3-DK102, “One Line Diagram Class 1E 250V DC MCC IDSA-DK-1 Auxiliary Bldg., Rev. 2, January 2016
- APP-IDS-E3-001, “Class 1E DC System Station One Line Diagram Divisions A & C” Rev. 2, February 2016
- APP-IDS-E3-002, “Class 1E DC System Station One Line Diagram Divisions B, D & Spare,” Rev. 2, February 2016
- CAPAL 1000504136, “Discrete Issue/Suggestion for Improvement,” November 2017

Audit Activities/Summary

During the audit, the NRC staff reviewed the above documents and discussed questions during a conference call held on February 8, 2018. The licensee had performed the analyses

described in the Tier 1, Table 2.6.3-3, ITAAC 4.i to verify that the MOV terminal voltages would be greater than or equal to the applicable minimum design voltage (either 180 volt(V)dc, or 185 Vdc), with the Class 1E IDS battery terminal voltage at 210 Vdc, as stated in the LAR.

VEGP Units 3 and 4 electrical system is comprised of alternating current (AC) and DC systems. The scope of this audit includes the review of the calculations pertaining to the 480 Vac and 250 Vdc systems. The 480 Vac electric system feeds the 250 Vdc battery charger, which feeds the MOVs through the dc switchboard and motor control centers (MCCs). The review of the AC electrical system documents was intended to ensure that adequate voltages were provided from the offsite power through the onsite medium voltage (MV) AC switchgears, low voltage (LV) switchgears, and MCCs to the onsite Class 1E IDS switchboard, and to the MOVs. The audited documents include load flow studies which the licensee used to determine the voltages at all of the AC buses. The licensee used the load flow studies to calculate the minimum and maximum steady state voltages at the MV switchgear, LV switchgear, and MCC buses under minimum and maximum loading and source voltage conditions. The calculated minimum and maximum steady state voltages then establish the range of acceptable voltages for the MV switchgear, LV switchgear, and MCC buses. The acceptance criteria and summary of the calculated minimum and maximum steady state AC voltages for buses (switchboards/switchgear) and motors were provided in the audited documents. The voltages at the buses and MCCs (including 480 V MCC feeding the battery charger) determined from the load flow studies are within the range of acceptable minimum and maximum voltages. The staff finds that the methodology used to determine the voltages at the AC buses is reasonable because all of the voltages at the buses were calculated by the load flow studies for the associated loads including those feeding the Class 1E MOVs.

The Class 1E, 24-hour duty-cycle, 250 Vdc IDS batteries for divisions A, B, C, and D provide power to the respective 250 Vdc division switchboards. The divisional switchboards then feed the associated MCCs for each division which then power the MOVs.

The licensee used the Thevenin equivalent resistance network and a linear voltage divider methodology to calculate the voltage drop from the IDS batteries to the MOVs as described in the LAR 17-018 Supplement dated January 12, 2018 (ADAMS Accession No. ML18012A704). The LAR 17-018 Supplement states that the following inputs are included in calculating the voltage drop at the MOV motor terminal voltage:

- Worst case voltage drop calculated from the spare IDS batteries.
- Source voltage at the battery conservatively assumed at 210V.
- Worst case loading representing maximum voltage drop through the system (e.g., multiple valves operating simultaneously).
- MOV Locked Rotor Amperes (LRAs) at nominal voltage used for derivation of motor equivalent resistance.
- Cable temperatures based on temperature rise using the design basis accident temperature profile with a cable minimum starting temperature of 90°C outside containment and a cable minimum starting temperature of 130°C inside containment.
- Includes resistances of distribution equipment (buses, fuses, and shunts) and margins/ tolerances/conservative conditions.

Therefore, the above inputs provide the assumptions for the calculation of the MOV terminal voltages for the analysis being discussed. The voltages at the MOVs are determined by calculating the voltage drop from the IDS batteries to the MOVs including all points (dc switchboards, and MCCs) in between, using the dc current and resistance values for each equipment and cables in the circuit from the IDS battery to the MOVs. The staff finds that the assumptions are reasonable because they include calculated worst case voltage drop from the IDS battery, MOV LRA for worst case currents, and resistances for equipment from the IDS batteries to the MOVs.

The calculated MOV terminal voltages provided in the audited documents were greater than the minimum design voltages (180 Vdc and 185 Vdc) for each MOV for all Divisions with the IDS battery voltage of 210 Vdc. The staff finds that the licensee's approach is reasonable because the MOV terminal voltages are calculated by voltage drop analysis from the IDS battery to the MOVs and every point in between.

In addition to the calculations to determine the MOV motor terminal voltages using the above described voltage drop analyses from the IDS to the MOVs, the staff also reviewed the field testing calculations. In the LAR supplement, the licensee stated that a field testing calculation had been created which compares measured test voltages by way of a voltage drop analysis based on the test environmental and loading conditions. The LAR supplement also states that the calculation uses the same Thevenin equivalent resistance network methodology as the IDS voltage drop design basis calculation, but adjusts the input values to calculate minimum acceptable voltages at the MOVs during testing at as-found conditions. The adjustments to the design-basis calculation in the field testing calculation include: (a) modeling one MOV energized at a time, (b) assuming 250 Vdc source voltage at the battery, (c) removing tolerances on equipment, and (d) adjusting equipment and cable resistance values based on an assumed 60°F (15.6°C) ambient temperature that can be further adjusted to actual temperature measurement in the field. Therefore, the above adjustments provide the assumptions for the field testing calculations being discussed. The staff finds that the assumptions are reasonable because 1) equipment and cable resistance values can be adjusted based on actual temperatures, 2) the minimum acceptable voltage can be adjusted based on the actual measured battery voltage, and 3) the assumed cable and equipment resistance values can be adjusted to the actual temperatures in the field.

In the LAR supplement dated January 12, 2018 (ADAMS Accession No. ML18012A704), the licensee indicated that the voltage analysis converts the voltage drop results obtained during testing into a related IDS voltage drop at design-basis conditions. The design-basis voltage drop calculation shows that the IDS can support each MOV at design-basis conditions. The licensee stated that the field testing calculation adjusts the design-basis calculation to consider those conditions which will be present during completion of UFSAR Tier 1, Table 2.6.3-3, ITAAC No. 4.i. The licensee asserted that the minimum values provided in the field testing calculation will be sufficient to support adequate voltage at the MOVs during the worst-case IDS design-basis conditions included in the IDS voltage drop design-basis calculation. The field testing calculations provided in the audited documents for the acceptance range of IDS battery voltages include MOV voltages for all MOVs in all divisions that are greater than the minimum MOV design voltages.

During the review of the audited documents, the staff observed that a corrective action document, CAPAL 1000504136, had been generated by Westinghouse to document two discrepancies identified in the review of APP-IDS-E0C-018, Rev. 0. The first discrepancy omitted specifying that MOV voltage would be measured across the MOV armature and series winding, and instead stated that the MOV voltage would be measured across the MOV armature. The second discrepancy omitted to include the MOV shunt resistance in the resistance calculations in APP-IDS-E0C-018. The staff's concern was whether these two discrepancies would impact APP-IDS-E0C-018 calculations negatively. Therefore, the staff requested clarification at the February 8, 2018, conference call. The licensee personnel described the planned resolution of the issues identified in the CAPAL and stated that APP-IDS-E0C-018 will be revised to address those issues. In addition, the licensee personnel specified that the field test procedure will be developed to reflect the voltage measurement locations and methods consistent with the field test calculation described in APP-IDS-E0C-018, including resolution of the issues specified in the CAPAL. The staff determined that the planned revision of APP-IDS-E0C-018 related to the first discrepancy would be acceptable because the change will ensure that voltage at the MOVs is measured appropriately.

As it relates to the impact of the second discrepancy, the licensee also explained that the addition of the MOV shunt resistance value would not significantly change the MOV acceptance voltage calculations because the shunt resistance values are two to three orders of magnitude less than the series resistance values already included in the calculation. The staff finds that the licensee's explanation regarding the shunt resistance value in the APP-IDS-E0C-018 calculation is reasonable because the addition of a shunt resistance value would create a negligible increase in the MOV voltages calculated in APP-IDS-E0C-018. Therefore, the staff finds that the licensee's approach is reasonable because the MOV terminal voltage field testing is determined by the voltage drop analysis and assumptions.

The NRC staff reviewed the documents listed in this audit report and verified the assumptions, methodology, calculations, and analyses developed by the licensee to support LAR 17-018. The staff finds the licensee's assumptions, methodology, analyses, and calculations to be reasonable to support LAR 17-018 for VEGP Units 3 and 4 in regard to the proposed revision to ITAAC No. 4.i in UFSAR Tier 1, Table 2.6.3-3.

Exit Briefing

None

Request for Additional Information

None

Open Items and Proposed Closure Path

None

Deviations from the Audit Plan

None