UNITED STATES
NUCLEAR REGULATORY COMMISSION
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October 26, 2018

MEMORANDUM TO: Jennifer L. Dixon-Herrity, Chief
Licensing Branch 4
Division of Licensing, Siting,
and Environmental Analysis
Office of New Reactors

FROM: William (Billy) Gleaves, Senior Project Manager ***/RA/***
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SUBJECT: US NRC AUDIT REPORT RELATED TO LICENSE AMENDMENT REQUEST (LAR 17-043) – CONTAINMENT PRESSURE ANALYSIS

The U.S. Nuclear Regulatory Commission staff conducted an audit of documents related to the Vogtle Electric Generating Plant Units 3 and 4 proposed license amendment request (LAR) 17-043, “Containment Pressure Analysis.” The audit was conducted at various dates and times, as planned, between April 25 and August 28, 2018 at the virtual Southern Nuclear/Westinghouse Electronic Reading Room. A summary report of the audit is enclosed.

Docket Nos: 52-025 and 52-026

Enclosure:
As stated

cc: S. Ray
B. Travis
R. Nolan

US NRC AUDIT REPORT RELATED TO LICENSE AMENDMENT REQUEST (LAR 17-043) – CONTAINMENT PRESSURE ANALYSIS DATED: OCTOBER 26, 2018

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ADAMS Accession No.: ML18267A370 ***via e-mail** **NRO-008**

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DATE	9/25/18	10/25/18	9/21/18	10/26/18

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AUDIT REPORT IN SUPPORT OF
LICENSE AMENDENT REQUEST (LAR 17-043) REGARDING
CONTAINMENT PRESSURE ANALYSIS

SOUTHERN NUCLEAR OPERATING COMPANY
VOGTLE ELECTRIC GENERATING PLANT, UNITS 3 AND 4
Docket Nos. 52-025 and 52-026

Background

By letter dated December 21, 2017, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18029A243) Southern Nuclear Operating Company (SNC), the licensee for Vogtle Electric Generating Plant (VEGP) Units 3 and 4, requested the U.S. Nuclear Regulatory Commission (NRC) approval of an amendment of the combined licenses (COL) for VEGP Units 3 and 4, nuclear power facility (NPF) COL Numbers NPF-91 and NPF-92, respectively. As part of the License Amendment Request (LAR) 17-043, the applicant proposed changes to the Updated Final Safety Analysis Report (UFSAR) in the form of an update to "WGOTHIC Application to the AP600 and AP1000" (WCAP-15846) in addition to departures from the incorporated plant specific Design Control Document (DCD) Tier 1 and Tier 2 information. These changes served to reconcile a number of detailed design changes and modeling methodology changes made in analyzing containment pressure. The NRC staff determined that an audit of the supporting reports and calculations was the appropriate method to verify the proposed changes, to reduce the likelihood of issuing multiple rounds of requests for additional information (RAIs), and provide the staff an appropriate venue to evaluate the large, complex calculations supporting the LAR.

1.0 Bases

This regulatory audit was based on the following:

- 10 CFR 52.98(f) requires NRC approval for any modification to, addition to, or deletion from the terms and conditions of a COL. This activity involves a departure from COL Appendix C information and corresponding plant-specific Tier 1 information; therefore, this activity requires an amendment to the COL. Accordingly, NRC approval is required prior to making the plant-specific changes in this LAR.

- 10 CFR 52, Appendix D, Section VIII.B.5.a allows an applicant or licensee who references this appendix to depart from Tier 2 information, without prior NRC approval, unless the proposed departure involves a change to or departure from Tier 1 information, Tier 2* information, or the Technical Specifications, or requires a license amendment under paragraphs B.5.b or B.5.c of the section. The proposed change to UFSAR (Tier 2) design information involves changes to plant-specific Tier 1 (and corresponding changes to COL Appendix C) and Tier 2* information, and meets the criteria under B.5.b and thus requires NRC approval for the Tier 2 and involved Tier 1 departures.

- 10 CFR Part 52, Appendix D, Section VIII.A.4 and 10 CFR 52.63(b)(1) govern the issuance of exemptions from elements of the certified design information for AP1000 nuclear power plants. 10 CFR 52, Appendix D, VIII.A.4 requires a Tier 1 change shall

not result in a significant decrease in the level of safety otherwise provided by the design.

- 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 16 — Containment design, which requires in part that a reactor containment be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

- 10 CFR Part 50, Appendix A, GDC 38 — Containment heat removal, requires in part that a system to remove heat from the reactor containment be provided, such that the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

- 10 CFR Part 50, Appendix A, GDC 50 — Containment design basis, requires in part that the reactor containment structure, including the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident. The licensee's revised analyses submitted as part of this LAR demonstrate containment integrity for the limiting spectrum of design basis accidents for the duration of the accident in order to support the above GDCs, and the supporting calculations are the subject of this audit.

- The NRC staff followed NRO Office Instruction NRO-REG-108 (Revision 0), "Regulatory Audits," (ADAMS Accession No. ML081910260) in performing the audit of the reports and calculations cited below.

The audit plan is available in ADAMS under Accession No. ML18115A124.

2.0 Audit Location and Dates

Location: The audit was conducted at Westinghouse Electric Company's (the vendor's) electronic reading room.

Date: April 25, 2018 through August 28, 2018.

3.0 Audit Team Members

The following NRC staff members participated in substantive discussions during the audit:
Billy Gleaves, Senior Project Manager (Licensing Branch 4)
Boyce Travis, Reactor Systems Engineer (Containment and Ventilation Branch)
Ryan Nolan, Reactor Systems Engineer (Reactor Systems Nuclear Performance and Code Review Branch)
Sheila Ray, Senior Electrical Engineer (Electrical Engineering New Reactors and License Renewal Branch)

4.0 Applicant and Industry Staff Participants

Julie Keys, SNC

Wes Sparkman, SNC
Mark Wilson, SNC
James Chamberlain, SNC
Tom McCallum, SNC
Amy Chamberlain, SNC
Eddie Grant, SNC

5.0 Documents Audited

- APP-SSAR-GEF-069, “Updates to Minimum Containment Pressure Analysis for Large Break LOCA Safety Analysis,” Revision 0

- APP-SSAR-GEF-042, “Passive Heat Sinks Multiplier for Minimum Backpressure Calculations,” Revision 0

- APP-SSAR-GSC-191, “AP1000 LOCA Mass/Energy Releases with SATAN78 and Long Term LOCA Mass/Energy Release Spreadsheet Methodology,” Revision 1

- APP-GW-GLR-096, “Evaluation of the Effect of the AP1000 Enhanced Shield Building Design on the Containment Response and Safety Analysis,” Revision 3

- APP-GW-VPR-008, “Evaluation of Environment Conditions Envelope Exceedances,” Revision 0

- APP-SSAR-GEF-067, “Miscellaneous Clarifications and Corrections to LOCA and SLB Containment Safety Analyses,” Revision 0

- APP-SSAR-GEF-086, “Containment Analysis Update to Address PCS Testing Lessons Learned,” Revision 0

- APP-SSAR-GSC-157, “AP1000 Long-Term LOCA Containment Integrity Analysis with WGOTHIC,” Revision 1

- APP-SSAR-GSC-161, “AP1000 WGOTHIC Minimum Containment Backpressure Analysis for Large Break LOCA,” Revision 1

- APP-SSAR-GSC-166, “AP1000 Steamline Break Containment Integrity Analysis,” Revision 1

- APP-SSAR-GSC-172, “AP1000 Steamline Break Mass and Energy Release Inside Containment Analysis,” Revision 1

- APP-SSAR-GSC-768, “AP1000 WGOTHIC Evaluation Model for Peak Containment Pressure Analyses,” Revision 0

- APP-SSAR-GSC-786, “AP1000 WGOTHIC Minimum Containment Backpressure Model and Analyses,” Revision 1

- APP-SSAR-GSC-793, “Control Volumes Inside Containment for AP1000 WGOTHIC Model,” Revision 0

- APP-SSAR-GSC-794, “Recalculation of the Structurally Based Flow Paths for the AP1000 WGOTHIC Containment Model,” Revision 0

- APP-SSAR-GSC-795, “Summary of the AP1000 Heat Sinks Inside Containment for the WGOTHIC Model,” Revision 0

- APP-SSAR-GSC-811, “Modeling Method to Address PCS Rainout from Baffle Supports,” Revision 0

- CN-CRA-14-18, “WGOTHIC_S Version 4.3.1 Validation,” dated August 27, 2014

- WCAP-15846-P Addendum 1, “Effective Thermal Conductivity Model of Inorganic Zinc Coating for Application to AP1000,” Revision 0

- WNS-DCP-002241, “Conservatism in AP1000 Heat Sinks in WGOTHIC Evaluation Model for Peak Containment Pressure,” dated June 18, 2018

6.0 Description of Audit Activities and Summary of Observations

To gain the necessary understanding of the proposed changes, staff reviewed the above documents in their entirety. Specific observations and insights from individual documents are detailed below.

APP-SSAR-GSC-795 documents the heat sinks used in the WGOTHIC model. The licensee increased the total metal volume by approximately 30 percent, not all of which is credited in the analysis. The calculation included a discussion of the heat sinks that were not credited in the design and the motivations and reasoning behind the choices. The original model included metal that was not credited for various reasons, many of which incorporated additional conservatism in the model. As such, many of the heat sinks added had a strong basis for being credited. Further metal beyond that not credited was appropriately turned off for physical reasons (temperature conditions, being covered by water). Staff reviewed the licensee’s treatment of heat sinks and the degree of conservatism involved in heat sinks not credited was assessed both as part of the LAR and in a sensitivity analysis performed by the licensee as a result of an RAI.

APP-SSAR-GSC-191 and APP-SSAR-GSC-172 detail the specifics associated with the mass and energy release for the loss of coolant accident (LOCA) and main steam line break (MSLB), respectively. Many of the relevant staff observations from the documents have been incorporated directly into the technical evaluation of the LAR. Notable changes for the LOCA (from APP-SSAR-GSC-191) include:

- Revised assumptions for steam generator (SG) conditions and thermal characteristics
- Adjustments to the secondary side thermal mass in the model
- Revised flow properties for lines leading to the pressurizer and the passive safety systems (accumulators, direct vessel injection (DVI) lines) based on expected conditions
- The SATAN code was discovered to be incorrectly calculating the power shape based on the provided inputs; the core power was further modified through updates to the core stored energy and thermal mass modeled in the core region
- Setpoints in the model were updated based on known uncertainties

Staff documented the detailed thermal values, including stored mass and energy in the reactor coolant system (RCS) and secondary side as well related stored metal energy from the model for use in a confirmatory analysis performed to support the LAR.

Changes for the MSLB (APP-SSAR-GSC-172) include:

- The startup feedwater system and leakage through the feedwater flow control valve were added to the model.
- The main feedwater control function was modified to be a function of steam generator pressure, rather than a function of time. As the LOFTRAN SG model is relatively simple, the new model conservatively bounds the expected feedwater conditions by adding a bias to the calculated LOFTRAN SG pressure for the table determining main feedwater conditions based on SG pressure.
- A number of modification techniques were investigated and imposed on the 30 percent and 0 percent power models to increase stability.
- Heat transfer from secondary side metal (that is not in contact with the RCS) in the steam generators is added to the model.
- Pump heat for the reactor coolant pumps (RCPs) was modeled as nominal, rather than conservatively high.

Staff reviewed the RCP assumptions in additional detail because the change appeared non-conservative upon first inspection. Because the AP1000 pumps do not run for a long period of time, reducing RCP heat inputs, by itself, does not significantly impact the transient. However, due to the nature of the total nuclear system heat input in the code, which is initially reactor heat plus pump heat, lowering pump heat had the effect of increasing reactor heat for the same total nuclear system heat. This resulted in a higher decay heat over the latter portion of the transient.

APP-SSAR-GEF-086 documented the motivation behind some of the smaller scope changes performed as part of the evaluation method revision in the LAR. These include lessons learned from passive containment cooling system (PCS) testing conducted in China on AP1000 plants. Additionally, the calculation provided motivation for enabling and adding a small subset of heat sinks, including those that make up the ring duct, recirculation ductwork and associated supports, and portions of the automatic depressurization (ADS) module.

APP-SSAR-GEF-042 provided a discussion related to the heat sink values used in the minimum containment pressure calculation. In the previous versions of this analysis, a multiplier of 2.1 was used to increase the heat sink surface area and volume to conservatively drive down the containment pressure. The new analysis used a multiplication factor of 1.35. This factor was calculated based on an engineering design assessment applied based on the known level of detail on the assessed heat sinks. These values vary from a very low multiplier applied to walls and RCS components to a much higher value applied to platforms, supports and heat sinks characterized as miscellaneous. A further margin was then applied to account for additional vendor supplied equipment, uncertainty for metal components for which the design is not fully specified, equipment for which the operating temperature can be reasonably expected to greater than ambient, on top of margin for additional conservatism. Although the approach relied primarily on engineering judgement, staff determined there was a clear basis for the values chosen in the analysis and based on the provided level of detailed design. The approach used by the licensee provides margin to the expected nominal heat sink inventory commensurate with the level of knowledge of the components.

As part of an RAI from the staff regarding heat sinks (ADAMS Accession No. ML18197A105) dated July 13, 2018, the licensee placed a draft calculation summary in the electronic reading room for staff review (WNS-DCP-002241 in the above list). The draft calculation highlighted some of the conservatisms inherent in the analysis and proceeds to quantify the effect of some of the more easily highlighted conservatisms. One element of conservatism directly requested from the staff, the impact of the heat sinks that are turned off, resulted in an approximately 2 percent reduction in containment pressure. Additional elements of conservatism, including credit for some heat sinks for the entirety of the transient and reverting to nominal metal and epoxy properties and expected initial containment temperature, result in an approximately 10 percent reduction in containment pressure (higher for LOCA, less for MSLB).

As part of the staff review of APP-SSAR-GSC-157, the staff discovered that the equipment qualification profiles for submerged equipment during a LOCA were exceeded by relatively small amounts for very long periods of time later in the transient. This conflicted with the statement in the LAR that "the updated containment pressure and temperature does not result in a change to the limiting profiles assumed in the equipment qualification testing program." Accordingly, staff issued an RAI, referenced in Section 8 of this report.

7.0 Exit Briefing

The NRC staff's audit exit meeting was conducted on August 27, 2018. SNC and NRC staff discussed the staff's takeaways from the audit and the staff indicated the necessary information within the scope of the audit was provided to assist the staff in their review.

8.0 RAIs Resulting from Audit

The audit resulted in two RAIs (ADAMS Accession Nos. ML18197A105 and ML18248A161).

9.0 Open Items and Proposed Closure Paths

No open items were identified as a result of the audit.

10.0 Deviations from the Audit Plan

No deviations from the audit plan were identified or required.