



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

February 26, 2018

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

FROM: William (Billy) Gleaves */RA/*
Licensing Branch 4
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SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION'S AUDIT REPORT
RELATED TO LICENSE AMENDMENT REQUEST (LAR 17-025)
REGARDING CHANGE TO RX VESSEL HEAD VENT CAPACITY

The U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit of documents related to the Vogtle Electric Generating Plant Units 3 and 4 proposed license amendment request (LAR) 17-025. The audit was conducted at various dates and times between October 30, 2017 and December 14, 2017 at the Southern Nuclear Operating Company's/Westinghouse Electric Company's Electronic Reading Room.

The audit plan can be found in the NRC's Agencywide Documents Access and Management System (ADAMS) under Accession Number ML17303A665 dated October 31, 2017. A summary report of the audit is enclosed.

Docket Nos.: 52-025 and 52-026

Enclosure:
As stated

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION'S AUDIT REPORT RELATED TO LICENSE AMENDMENT REQUEST (LAR 17-025) REGARDING CHANGE TO RX VESSEL HEAD VENT CAPACITY DATED FEBRUARY 26, 2018

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**U.S. NUCLEAR REGULATORY COMMISSION'S (NRC) AUDIT REPORT OF REPORTS AND
CALCULATIONS IN SUPPORT OF REQUEST
FOR LICENSE AMENDMENT AND EXEMPTION RELATED TO REACTOR VESSEL
HEAD VENT CAPACITY**

**SOUTHERN NUCLEAR OPERATING COMPANY
VOGTLE ELECTRIC GENERATING PLANT, UNITS 3 AND 4
DOCKET NOS. 52-025 AND 52-026**

NRC Audit Team

William Gleaves, Senior Project Manager
Donald Palmrose, Senior Reactor Engineer
John Budzynski, Reactor Systems Engineer

NRC Audit Dates

Various dates and times between October 30, 2017, and December 14, 2017.

NRC Audit Location

Audit of Calculation files located in the Southern Nuclear Operating Company's/Westinghouse Electric Company's Electronic Reading Room (ERR).

1.0 Purpose

The purpose of the audit is to review the reports and calculations needed by staff to verify the information and conclusions in the "Request for License Amendment and Exemption: Reactor Vessel Head Vent Capacity (LAR 17-025)" submitted by Southern Nuclear Operating Company (SNC) for the Vogtle Electric Generating Plant (Vogtle) Units 3 and 4, on July 28, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17209A185).

2.0 Background

In LAR 17-025, SNC proposes to depart from approved AP1000 Design Control Document (DCD) Tier 2 information (text and tables) as incorporated into the Updated Final Safety Analysis Report (UFSAR) as plant-specific DCD information, and also proposes to depart from involved plant-specific Tier 1 information (and associated Combined License (COL) Appendix C information). Pursuant to the provisions of Title 10 of the *Code of Federal Regulations*, 52.63(b)(1), an exemption from elements of the design as certified in the 10 CFR, Part 52, Appendix D, design certification rule is also requested for the plant-specific Tier 1 material departures.

The requested amendment proposes changes to update Reactor Coolant System (RCS) requirements for reactor vessel head vent (RVHV) mass flow rate. This includes proposed changes to ITAAC Table 2.1.2-4 Item 8.e (ITAAC Item 8.e) and UFSAR information in two locations.

The Office of New Reactors (NRO) Projects staff determined that an audit of the reports and calculations supporting this LAR is the appropriate method to verify this proposed change rather than by issuing multiple rounds of requests for additional information (RAIs).

3.0 Regulatory Basis

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 license amendment request.

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) information, 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 50.46a provides requirements and criteria for high point vents for the reactor vessel head.

10 CFR Part 50, Appendix A, GDC 15 requires the reactor coolant system and associated auxiliary, control, and protection systems to be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.

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.

4.0 Audit Scope

The primary scope of this audit is the review of safety analyses referenced in LAR 17-025 to support the proposed changes to the UFSAR Tier 2 and COL Appendix C (and plant-specific Tier 1) in regards to the following text in LAR 17-025.

In Enclosure 1 of the LAR on page 3 of 10 is the statement:

"A revised plant safety analysis based on the AP1000 design pressure of 2500 pounds per square inch absolute (psia) has been performed and identified the need to update these required values. The updated analysis has the RVHV opening at a different RCS pressure and requires a higher minimum mass flow rate through the RVHV line to accomplish the emergency letdown function."

In Enclosure 1 on page 4 of 10 in the first paragraph under "Change Description" is the following:

"A revised AP1000 safety analysis has been performed in which the valves open at 2500 psia. The safety analysis concludes that 9.0 pounds-mass per second (lbm/sec) is required at this pressure to adequately support the emergency letdown function. Based on the updated analysis, if the RVHV capacity is 9.0 lbm/sec when the RCS pressure is 2500 psia, there will be sufficient capacity in the system to prevent the pressurizer from overfilling."

Enclosure 1 on page 5 of 10 is the following:

"The safety analysis and the safety analysis model credit an emergency letdown mass flow rate of 9.0 lbm/sec at an RCS pressure of 2500 psia. At these conditions, long term pressurizer overfill is prevented. An RCS RVHV calculation note shows that the expected mass flow rate through the emergency letdown path will be 12.34 lbm/sec. Therefore, the safety analysis calculation, and the corresponding mass flow rate and RCS pressure values used in the proposed licensing basis changes, is conservative and bounded by the expected mass flow rate."

Enclosure 3 on page 2 under the revised Subsection 5.4.12.4.1, "Flow Testing," states:

"A low pressure flow test and associated analysis is conducted to determine the capacity of each reactor vessel head vent flow path." [Staff emphasis added.]

and

"The measured flow rate at low pressure is such that the head vent flow capacity is at least 9.0 lbm/sec at an RCS pressure of 2500 psia." [Staff emphasis added.]

However, there are no references to the prior analysis and the revised analysis. Therefore, the staff reviewed licensee-provided revised safety analysis calculations related to this mass flow rate to verify the licensee statement that the proposed revisions are "consistent with the current AP1000 plant safety analysis" as stated in LAR 17-025. Additionally, the staff will verify the RCS pressure range that is appropriate for "low pressure flow test."

5.0 Audit Results

In LAR 17-025, the licensee summarizes its proposed changes to the COL and UFSAR for Vogtle Units 3 and 4 related to changes to update RCS requirements for RVHV mass flow rate to be tested from 8.2 lbm/sec at 1250 psia to 9.0 lbm/sec at 2500 psia. This includes proposed changes to ITAAC Item 8.e and UFSAR information in two locations. As discussed above in the Audit Scope section, there were calculation files that substantiate that a certain mass flow rate at a given RCS pressure would release enough RCS fluid so that the pressurizer would not overfill under loss of heat sink transients.

The AP1000 RVHV capacity is sized to perform the following functions:

- Provide an emergency letdown path that can be used to prevent long-term pressurizer overfill following loss of heat sink events, and
- Normal RCS venting and filling operations during startup

Based on information provided by the licensee, there are four calculations that support the RCS requirements for the ITAAC Item 8.e acceptance criteria. From a review of the provided documents and subsequent information provided by the licensee, the purpose and conclusions from the calculations are presented in this section.

RCS-M3C-025, Revision 0, was issued on March 8, 1995, to determine the requirements for the AP600 RCS RVHV line. The assessment calculated the allowable resistance criteria for RVHV piping and fittings to relieve enough RCS coolant to prevent the pressurizer from overfilling following actuation of the Core Makeup Tanks (CMTs) for a non-LOCA event (CMT water-solid recirculation mode) and to size the head vent inlet and discharge line. The analysis was based on a CMT net injection flow rate of 8.2 lbm/s at RCS pressure of 1250 psia (the acceptance criteria of ITAAC Item 8.e) as the flow rate the RVHV vent valves must be designed to accommodate. The staff's assessment for the AP600 RVHV system being acceptable was provided in Section 5.4.12.1, "Reactor Vessel Head Vent System," of NUREG-1512 published in September 1998.

APP-RCS-M3C-025, Rev. 0, was issued in February 2004 in support of the AP1000 certification and applied the same computer code model of the RVHV system (and the same flow areas and flow resistances for the RVHV flow path) as was used for the AP600 design certification review (i.e., RCS-M3C-025, Revision 0). This calculation demonstrated that the AP600 RVHV sizing was adequate for the AP1000 and the licensee informed the staff during the audit this calculation provided the details in an RAI response on this topic during the AP1000 design certification (see AP1000 design certification review RAI 440.048 Response Revision 1, dated March 13, 2003, provided under ADAMS Accession Number ML030760701). This RAI response provides confirmation that an RVHV flow rate of 9 lbm/s at 2500 psia would be enough to avoid pressurizer overfilling. RAI 440.048 Response Revision 1 also cited the ITAAC Item 8.e requirement of 8.2 lbm/s at 1250 psia and provided a markup of the licensing basis that specified the 8.2 lbm/s at 1250 psia requirement as the basis for the safety analyses (see Table 5.4-18 provided in RAI 440.048 Response Revision 1). The staff's assessment for the AP1000 RVHV system being acceptable was provided in Section 5.4.12.1, "Reactor Vessel Head Vent System," of NUREG-1793 published in September 2004.

Revision 3 of APP-RCS-M3C-067 states the 8.2 lbm/s at 1250 psia sizing basis is consistent with the LOFTRAN base deck for the AP1000 safety analyses. This is consistent with (or conservatively bound) with calculation file APP-RCS-M3C-025, Revision 0, which concluded that the AP600 RVHV sizing was adequate for AP1000 and the sizing basis of 8.2 lbm/s at 1250 psia would be conservative for AP1000. Additionally, while RCS-M3C-025 is the source for the 8.2 lbm/s at 1250 psia sizing basis, APP-RCS-M3C-025, Rev. 0 and APP-RCS-M3C-067 Rev. 3 both reference the same calculation documenting the LOFTRAN RVHV code model (CN-TA-94-048, Rev. 0). However, as the licensee informed the staff during the audit, the actual RVHV computer code model used for the AP600 and AP1000 analyses may not directly correspond to the sizing basis of 8.2 lbm/s at 1250 psia. Therefore, to ensure consistency with the analysis of APP-RCS-M3C-025, Rev. 0, the licensee reassessed the RVHV orifice size to the ITAAC acceptance criteria conditions of 9 lbm/s at 2500 psia in a further revision.

Rev. 4 of APP-RCS-M3C-067 applies the analysis contained in Rev. 3 of APP-RCS-M3C-067 for the conditions corresponding to the 9 lbm/s at 2500 psia conditions in support the ITAAC Item 8.e change. The results of the calculation is choked flow through the RVHV of 12.34 lbm/s. Thus, Rev. 4 of APP-RCS-M3C-067 verifies the RVHV orifice is sized to meet or exceed the ITAAC Item 8.e flow requirement. Rev. 4 of APP-RCS-M3C-067 also assesses in Appendix F, RVHV Preoperational Test, the overall head vent line resistance. This line resistance would be

assessed during preoperational testing and used for satisfying the acceptance criteria of ITAAC Item 8.e. This preoperational testing would be performed at low pressure (based on the RNS pumps discharge pressure, which is less than the ITAAC Item 8.e acceptance criteria reference pressure of 2500 psia. The RVHV flow obtained during the low pressure test would be applied to assess if the corresponding flow resistance correlates to the higher operating conditions to satisfy the ITAAC Item 8.e acceptance criteria.

UFSAR Tier 2, Section 5.4.12.4.1 specifies that initial verification of the capacity of the reactor vessel head vent valves is performed during the plant initial test program. The low pressure flow test and associated analysis is conducted to determine the capacity of each reactor vessel head vent flow path. During the audit, the licensee confirmed that the normal residual heat removal pumps are used to provide injection flow into the reactor coolant system, discharging through the reactor vessel head vent valves. Based on the low pressure test results, the licensee will confirm that the flow corresponds to a flow resistance that would result in exceeding the flow rate of 9.0 lbm/sec at 2500 psia. The staff considers this information provided during the audit to clarify the description of the low pressure test in UFSAR Tier 2, Section 5.4.12.4.1.

Based on the information provided in the supporting calculation files along with the staff's assessment of the RVHV system in the AP600 and AP1000 final safety evaluation reports, the staff finds the changes proposed in LAR 17-025 supports the requirements of 10 CFR 50.46a for high point vents for the reactor vessel head. Additionally, the staff also finds the requirements of 10 CFR Part 50, Appendix A, GDC 15, are met for the reactor coolant system and associated auxiliary, control, and protection systems to have sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences such as a loss of heat sink.

These results were communicated to the licensee by an audit exit conference call on December 15, 2017.

6.0 Conclusions

The NRC staff reviewed the documents listed in this audit report and verified the proper application of calculations and analyses to support LAR 17-025. The staff finds the licensee's analysis, calculations, and conclusions are reasonable to support Vogtle Units 3 and 4 in regards to the update RCS requirements for the RVHV mass flow rate specified in LAR 17-025. The staff may reference this audit report in the safety evaluation report describing the NRC review of LAR 17-025 for Vogtle Units 3 and 4. There are no open items and were no significant deviations from the audit plan.

7.0 Documents Reviewed

The NRC staff reviewed the following documents that were made available in the ERR:

1. APP-RCS-M3C-067, Rev. 3, "AP600 Orifice Calculation," dated September 16, 2014.
2. APP-RCS-M3C-067, Rev. 4, "AP1000 Orifice Calculation," dated September 19, 2016.
3. RCS-M3C-025, Rev. 0, "AP600 Calculation for Head Vent Flow at 1250 psia (RCS Head Vent Line Sizing)," dated March 8, 1995.

4. APP-RCS-M3C-025, Rev. 0, "AP1000 Head Vent Flow at 2500 psia," dated February 23, 2004.

8.0 Personnel Interviewed

Southern Nuclear Operating Company

Corey Thomas
Keith Dorsey
Amy Chamberlain

9.0 References

1. Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, Request for License Amendment and Exemption LAR 17-025: "Reactor Vessel Head Vent Capacity," July 28, 2017 (ADAMS Accession Number ML17209A185).
2. NRO-REG-108, "Regulatory Audits," April 2, 2009 (ADAMS Accession Number ML081910260)
3. Vogtle Units 3 and 4 Updated Final Safety Analysis Report, Revision 6 and Tier 1, Revision 5, March 12, 2017 (ADAMS Accession No. ML17172A218).
4. NUREG-1512, "Final Safety Evaluation Report: Related to Certification of the AP600 Standard Design," September 1998 (ADAMS Accession No. ML0811600453).
5. NUREG-1793, Volume 1, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design," September, 2004 (ADAMS Accession No. ML043570339).
6. Combined License NPF-91 for Vogtle Electric Generating Plant Unit 3, Southern Nuclear Operating Company (ADAMS Accession No. ML14100A106).
7. Combined License NPF-92 for Vogtle Electric Generating Plant Unit 4, Southern Nuclear Operating Company (ADAMS Accession No. ML14100A135).