



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

January 5, 2018

MEMORANDUM TO: Samuel S. Lee, Chief  
Licensing Branch 1  
Division of New Reactor Licensing  
Office of New Reactors

FROM: Omid Tabatabai, Senior Project Manager /RA/  
Licensing Branch 1  
Division of New Reactor Licensing  
Office of New Reactors

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION STAFF REPORT  
ON THE AUDIT OF NUSCALE'S ENGINEERING DOCUMENT,  
EC-0000-3070, "STATION BLACKOUT TRANSIENT ANALYSIS,"  
REVISION 1 (DOCKET NO. 52-048)

On November 8, 2017, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit of a NuScale Power, LLC (NuScale), document to facilitate the review of Tier 2, Chapter 8, "Electric Power," of NuScale's design certification application. Specifically, the NRC staff audited NuScale's engineering document, EC-0000-3070, "Station Blackout Transient Analysis," Revision 1.

During the audit, the NRC staff (1) reviewed NuScale's station blackout transient sensitivity case, (2) discussed specific areas in Section 8.4, "Station Blackout," of NuScale's final safety analysis report with the NuScale staff, and (3) reviewed the applicant's methodology to determine whether NuScale's design certification application meets the applicable regulations (i.e., Title 10 of the *Code of Federal Regulations* (10 CFR) 50.63, "Loss of All Alternating Current Power). The NRC staff conducted its audit of the above mentioned analysis online via NuScale's electronic reading room and held a videoconference meeting with the NuScale technical staff on November 8, 2017.

The staff's audit plan, dated September 27, 2017, is available through the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML17264A677. The NRC staff conducted the audit in accordance with Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits," dated April 2, 2009.

Docket No. 52-048

Enclosure:  
As stated

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# **SUMMARY OF THE U.S. NUCLEAR REGULATORY COMMISSION STAFF AUDIT OF THE NUSCALE POWER, LLC, STATION BLACKOUT TRANSIENT SENSITIVITY ANALYSIS**

## **U.S. NUCLEAR REGULATORY COMMISSION AUDIT TEAM**

- Tania Martinez Navedo, Acting Chief, Electrical Engineering Branch (EENB)
- Fanta Sacko, Audit Team Lead
- Sheila Ray, Senior Electrical Engineer
- Swagata Som, Senior Electrical Engineer
- Omid Tabatabai, Senior Project Manager

## **I. SUMMARY**

On November 8, 2017, the U.S. Nuclear Regulatory Commission's (NRC) EENB staff conducted an audit of the NuScale Power, LLC (NuScale), station blackout (SBO) transient sensitivity analysis. The NRC staff conducted this audit in support of its review of NuScale's design certification application (DCA). The results from the audit will support the safety conclusions related to Tier 2, Section 8.4, "Station Blackout," of NuScale's final safety analysis report (FSAR). More specifically, the review will support the staff's review of NuScale's methodology and assumptions that determined that the design does not rely on direct current (dc) power from the highly reliable dc power system (EDSS) to meet the requirements of Title 10 of the *Code of Federal Regulations* (CFR) 50.63, "Loss of All Alternating Current Power." The NRC staff will reference this information in its final safety evaluation report (FSER) on the methodology and assumptions of NuScale's DCA in regard to how the electrical systems meet the applicable regulations, the regulatory guidance, and the design-specific review standard (DSRS) related to NuScale's plant design.

## **II. BACKGROUND AND SCOPE**

NuScale's plant design describes how the NuScale plant shows compliance with 10 CFR 50.63 by coping with a loss of all alternating current (ac) power (i.e., SBO) and the resulting plant trip.

In the DCA, FSAR Tier 2, Section 8.4.1, "Station Blackout Analysis Assumptions," states that power from the EDSS is available during an SBO event. In addition, FSAR Tier 2, Section 8.4.3, "Station Blackout Coping Equipment Assessment," states that an SBO transient sensitivity case that considered a simultaneous loss of all ac and dc power was evaluated and demonstrates that NuScale's power plant design does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63.

In the Request for Additional Information (RAI)-8824, Question 08.04-1, dated May 26, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17146B298), the staff asked the applicant to provide additional information on the assumptions and to summarize the SBO transient sensitivity evaluation that NuScale performed to show compliance with 10 CFR 50.63. In its response dated June 28, 2017, to RAI-8824, Question 08.04-1 (ADAMS Accession No. ML17179A979), the applicant stated the following:

Consistent with the definition of a Station Blackout in 10 CFR 50.2, "Definitions" the SBO transient analysis identified in FSAR [Tier 2] Section 8.4 assumes

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operation of the EDSS during the event, which in part forms the basis for compliance with 10 CFR 50.63. FSAR [Tier 2] Section 8.4 includes the assumptions and a summary for the analysis of record. The model and assumptions for the sensitivity case are the same as the base case except the sensitivity case includes a simultaneous failure of the EDSS at the outset of the event, which represents an additional failure that is precluded by the SBO definition. Consequently, the sensitivity evaluation is not used to show compliance with 10 CFR 50.63, and NuScale does not believe that the results of the sensitivity study should be included in the FSAR. The analysis that documents the assumptions and results of the sensitivity case can be made available for NRC audit upon request.

The scope of the staff's audit included two items, as described in the NRC's audit plan dated September 27, 2017 (ADAMS Accession No. ML17264A677), and was limited to electrical topics only:

1. clarification of NuScale's assumptions and methodology on the SBO transient analysis
2. clarification of the SBO sensitivity case, which demonstrates that NuScale's design does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63

The NRC staff reviewed NuScale's engineering document EC-0000-3070, "Station Blackout Transient Analysis," Revision 1, which evaluates the thermal-hydraulic response of the reactor module for 72 hours during an SBO event. EC-0000-3070 describes the assumptions and methodology and summarizes the SBO transient sensitivity evaluation. The applicant determined that the SBO sensitivity case does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63.

### **III. REGULATORY BASIS**

The following provides the regulatory basis for the staff review:

- 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants"
- 10 CFR 50.63
- 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion 17, "Electric Power Systems"
- NuScale's DSRS, Chapter 8, "Electric Power"

### **IV. OBSERVATIONS AND EVALUATIONS**

NuScale's engineering document EC-0000-3070 evaluates the thermal-hydraulic response of the reactor module to an SBO event. DSRS Section 8.4 states that a passive design such as the NuScale reactor module must be able to withstand an SBO for 72 hours. EC-0000-3070 summarizes NuScale's SBO transient sensitivity evaluation to determine that the reactor does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63.

During the audit, the applicant discussed (1) the acceptance criteria of an SBO in all 12 modules, (2) the assumptions and methodology used for the evaluation in EC-0000-3070, and (3) the results of the base case and the sensitivity case.

The applicant further described the NuScale SBO acceptance criteria as follows: (1) the reactor pressure vessel water level remains above core and (2) the peak containment pressure and temperature remain within design limitations. Additionally, the applicant stated that the evaluation of the SBO assumes normal conditions at 100-percent power and nominal reactor coolant system pressure and temperature. The staff reviewed two SBO transient cases, SBO case-7 and SBO case-8, because these transient cases are associated with the electrical power systems. SBO case-7 is the analysis of record and is used for the evaluation of the acceptance criteria. SBO case-7 provides scenarios in which the EDSS continues to provide power, thus delaying actuation of the emergency core cooling system until 24 hours into the SBO event. SBO case-8 represents the loss of the EDSS at the beginning of the SBO event.

In FSAR Tier 2, Section 8.4.3, the applicant stated that the NuScale design does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63. The applicant further stated that, in SBO case-8 (i.e., immediate loss of the EDSS), the core remains cooled and the acceptance criteria continue to be met. The staff verified that Sections 5.1.1 and 5.1.2 of EC-0000-3070, which discuss the event sequences of SBO case-7 and SBO case-8, respectively, show that core cooling is maintained and containment pressure and temperature are within the acceptance criteria.

The staff verified the methodology and assumptions of the SBO transient sensitivity cases. As a result of the audit, the applicant has provided a markup of the FSAR pages that incorporate revisions to FSAR Tier 2, Section 8.4, by letter dated November 17, 2017 (ADAMS Accession No. ML17321B090). FSER Section 8.4 will include the staff's review of the changes in FSAR Tier 2, Section 8.4. The staff accepts the methodology and the assumptions of the SBO transient sensitivity case as not necessary to meet the requirements of 10 CFR 50.63, as described in EC-0000-3070. The staff verified that, in both scenarios (i.e., SBO case-7 and case-8), the acceptance criteria for core cooling and spent fuel pool temperature are met during an SBO event, indicating that the EDSS is not needed to mitigate an SBO event. FSER Section 8.4 will include the staff's evaluation for compliance with 10 CFR 50.63 in that a passive design must be able to withstand an SBO for 72 hours.

## **V. CONCLUSION**

The staff evaluated (1) NuScale's assumptions and methodology for the SBO transient analysis and (2) the SBO sensitivity case, which demonstrates that the NuScale design does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63. Furthermore, the NRC staff verified (1) the acceptance criteria of an SBO in all 12 modules, (2) the assumptions and methodology used for the evaluation in EC-0000-3070, and (3) the results of the base case and the sensitivity case (i.e., SBO case-7 and case-8) of the NuScale design, as discussed in Section 4 of this report. The staff accepts the methodology and the assumptions of SBO transient sensitivity case-7 and case-8, as described in EC-0000-3070.