August 28, 2017

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

FROM: Rani L. Franovich, Senior Project Manager ***/RA/***
Licensing Branch 1
Division of New Reactor Licensing
Office of New Reactors

SUBJECT: SUMMARY REPORT FOR THE REGULATORY AUDIT OF DESIGN BASIS ACCIDENT RADIOLOGICAL CONSEQUENCE ANALYSES FOR NUSCALE POWER, LLC

NuScale Power, LLC (NuScale) submitted by letter dated December 31, 2016, to the U.S. Nuclear Regulatory Commission (NRC), a Design Control Document for its Design Certification (DC) application of the NuScale design (Agencywide Documents Access and Management System Accession No. ML17013A229). The NRC staff started its detailed technical review of NuScale's DC application on March 27, 2017.

The purpose of the NRC's Regulatory Audit of Design-Basis-Accident (DBA) radiological consequence analyses was to: (1) gain a better understanding of NuScale DBA radiological consequence analysis development, (2) verify information in the DC application and evaluate its conformance with the standard review plan or technical guidance, and (3) identify any information needed on the docket to support the basis of a reasonable assurance finding.

The audit began May 10, 2017, and ended on June 16, 2017. The audit report is enclosed.

Docket No.: 52-048

Enclosure:
1. Summary Report of Audit of Regarding Design Basis Accident Radiological Consequence Analyses

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cc w/encl.: DC NuScale Power, LLC Listserv

SUBJECT: SUMMARY REPORT FOR THE REGULATORY AUDIT OF DESIGN BASIS ACCIDENT RADIOLOGICAL CONSEQUENCE ANALYSES FOR NUSCALE POWER, LLC DATE: 8/28/2017

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NUSCALE POWER, LLC
SUMMARY REPORT OF AUDIT
REGARDING DESIGN BASIS ACCIDENT
RADIOLOGICAL CONSEQUENCE ANALYSES

NRC Audit Team:

Members of the audit team, listed below, were selected based on their detailed knowledge of design-basis-accident (DBA) radiological consequence assessment, severe accident progression, and aerosol transport and deposition; their experience supporting previous design certification (DC) reviews; and their knowledge regarding implementation of the review framework for small modular reactors documented in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," and related design specific review standards:

- Lawrence J. Burkhart, Branch Chief (NRO/DSEA/RPAC)
- Michelle L. Hart, Sr. Reactor Engineer (NRO/DSEA/RPAC)
- Jason H. Schaperow, Sr. Reliability and Risk Analyst (NRO/DSRA/SPRA)
- Marie A. Pohida, Sr. Reliability and Risk Analyst (NRO/DSRA/SPRA)
- Shawn A. Campbell, Reactor Systems Engineer (RES/DSA/FSCB)
- Hossein Esmaili, Sr. Reactor Systems Engineer (RES/DSA/FSCB)

1.0 PURPOSE

The audit was conducted on May 10, 2017 – June 16, 2017. The audit was performed to gather information from NuScale Power, LLC (NuScale) safety analyses evaluating the radiological consequences of DBAs, including the Control Room (CR) and Technical Support Center (TSC) radiological habitability.

2.0 BACKGROUND AND AUDIT BASES

The NuScale DC application included a final safety analysis report (FSAR) that describes the DBA radiological consequence analyses performed by NuScale to show compliance with the regulatory safety analysis requirements in Title 10, *Code of Federal Regulations* (CFR) 52.47. 10 CFR 52.47(a)(2)(iv) requires that an application for a DC include an FSAR that provides a description and safety assessment (SA) of the facility. The SA analyses are done, in part, to show compliance with the radiological consequence evaluation factors in 10 CFR 52.47(a)(2)(iv)(A) and 10 CFR 52.47(a)(2)(iv)(B) for offsite doses; 10 CFR Part 50, Appendix A, General Design Criterion 19 for CR radiological habitability; and the requirements related to the TSC in 10 CFR 50.47(b)(8) and (b)(11) and Paragraph IV.E.8 of Appendix E to 10 CFR Part 50. The NuScale FSAR refers to NuScale licensing topical report (TR)-0915-17565-P, Revision 1, "Accident Source Term Methodology" (currently under U.S. Nuclear Regulatory Commission (NRC) review), as the basis for the DBA radiological consequence analysis methodology.

A regulatory audit is a planned, license or regulation-related activity that includes the examination and evaluation of primarily non-docketed information. A regulatory audit is conducted with the intent to gain understanding, to verify information, and/or to identify information that will require docketing to support the basis of the licensing or regulatory decision. The NRC staff determined to conduct an audit of the non-docketed and proprietary NuScale DBA radiological consequence analyses to aid in its understanding of the analyses and assist in the review of the NuScale DC application.

3.0 AUDIT OBJECTIVES

The NRC staff's objective in conducting this audit was to gather information on the applicant's DBA radiological consequence analyses and supporting calculations and analyses with the following goals:

- Determine if the applicant's analysis inputs and assumptions are consistent with the staff's understanding through reading the NuScale DC FSAR

- Observe the implementation of methodology from the NuScale licensing TR-0915-17565-P, Revision 1, "Accident Source Term Methodology," (currently under NRC review) in the applicant's analyses

- Specifically for the maximum hypothetical accident (MHA), the following topics

    - Selection of severe accident sequences
    - Aerosol transport and deposition modeling

- Compare analyses to regulatory guidance, if referenced by applicant

- Develop any needed requests for information (RAIs) to clarify understanding of analyses

4.0 SCOPE OF THE AUDIT AND AUDIT ACTIVITIES

The NRC staff conducted the audit through remote access to documents located in NuScale's Electronic Reading Room. The NRC staff conducted the audit in accordance with the Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits." (Reference 1).

On May 10, 2017, an entrance meeting was held by phone to review key elements of the audit plan (Agencywide Documents Access and Management System Accession No. ML17129A462). The NRC staff audited the applicant's DBA radiological consequence analyses and related calculations and analyses from May 10, 2017, through June 19, 2017. The documents reviewed by the NRC staff during the audit are listed below:

- EC-0000-1674, Revision 1, "Radiological Consequences of Fuel Handling Accident"
- EC-0000-1963, Revision 2, "Radiological Consequences of Steam Generator Tube Failure"
- EC-0000-1964, Revision 1, "Radiological Consequences of Control Rod Ejection Accident"

- EC-0000-1965, Revision 2, “Radiological Consequences of a Main Steam Line Break Accident”

- EC-0000-2811, Revision 2, “Radiological Consequences of the Failure of Small Primary Coolant Lines”

- EC-0000-1586, Revision 3, “Realistic Rx Coolant and Secondary Coolant Activity”

    - Engineering change notice ECN-0000-4892, Rev 0 “ECN of the Realistic Rx Coolant and Secondary Coolant Activity”

- EC-0000-1592, Revision 0, “Bounding Isotopic Inventory Calculation”

- EC-0000-1588, Revision 0, “Isotopic Cross-Section Library Generation”

- EC-0000-2291, Revision 1, “Control Room Shine Doses”

- EC-0000-2281, Revision 1, “Reactor Building Pool Boiling Radiological Consequences”

- EC-0000-2204, Revision 1, “Equipment Qualification Post-Accident Radiological Source Term”

- EC-0000-2274, Revision 2, “Radiological Consequences of Design Basis Source Term”

- EE-P060-3637, Revision A, “Intact Containment Core Damage Sequences for Source Term Analysis” SUPERSEDED by ER-P060-5275

- ER-P060-5275, Revision 0, “Severe Accident Evaluation Supporting Design Basis Source Term”

- ER-0000-5278, Revision 0, Accident Radiological Analysis Sensitivity to Severe Accident Analysis

- EC-0000-3551, Revision 3, “Containment Aerosol Transport and Removal”

- EC-0000-2215, Revision 1, “Post-Accident pH_T Analysis”

During the audit, the NRC staff contacted NuScale staff to address NRC staff’s questions while reviewing documents. An audit exit meeting was held June 19, 2017, to discuss feedback from the NuScale staff and the NRC staff. The staff’s summary of observations given below is based on the notes taken by the NRC staff during the audit. The NRC staff did not acquire any documents during the audit.

5.0 SUMMARY OF OBSERVATIONS

Based on the NRC staff’s audit of the applicant’s documentation of DBA radiological consequence analyses and related calculations and analyses, the staff observed the following:

1. The applicant’s DBA radiological consequence analysis documentation is consistent with the staff’s understanding of the analyses as discussed in the NuScale DC FSAR.

2. Where applicable, the applicant's DBA radiological consequence analyses methods are consistent with the referenced topical report TR-0915-17565-P, Revision 1, "Accident Source Term Methodology."

3. The applicant's DBA radiological consequence analyses methods are generally consistent with referenced regulatory guidance, including RG 1.183, "Alternative Radiological Source Terms for Evaluating DBAs at Nuclear Power Reactors." The staff had some clarifying questions on the applicant's dose equivalent iodine-131 (DE I-131) and dose equivalent xenon-133 (DE Xe-133) calculations for primary coolant activity concentration source terms used as input for DBAs other than the MHA that include coolant release to the environment. As a result, the applicant entered an item into their corrective action program to address the issue raised.

4. The staff discovered that TSC modeling assumptions are different than CR assumptions in the DBA radiological consequence analyses. Follow-up RAI 8897, Question 15.00.03-7 was issued to request information on TSC modeling in the DBA dose analyses.

5. With respect to the severe accident scenarios used in the basis for the MHA source term, calculation EE-P060-3637, Revision A, "Intact Containment Core Damage Sequences for Source Term Analysis," which includes four scenarios, is marked as being superseded by ER-P060-5275, Revision 0, "Severe Accident Evaluation Supporting Design Basis Source Term," which includes five scenarios. Because of this, the staff requested to audit an additional sensitivity calculation, ER-0000-5278, Revision 0, "Accident Radiological Analysis Sensitivity to Severe Accident Analysis," in order to assess the applicant's position that information in the DC FSAR does not need to be revised to reflect the superseded calculation. The staff is assessing whether an additional RAI is necessary.

6. The staff notified NuScale that the audit team identified what appears to be a typo in FSAR Table 12.2-29 when comparing the audited calculations to the DC FSAR information. NuScale confirmed that the values for the alkaline (earths) group and the tellurium group are transposed in the FSAR table and stated that a corrective action was added to their system to correct the error through revision of the FSAR.

7. The MELCOR simulations in ER-P060-5275, Revision 0, for scenarios with spurious reactor recirculation valve (RRV) actuation predicted water in the containment gravity draining back into the reactor reflooding the core, terminating core damage and limiting the radiological source term. While scenarios with spurious RRV actuation were included in determining the DBA source term, they were screened from the Chapter 19 analysis of severe accident mitigation, leading the staff to issue RAI 8903, Question 19-16, on NuScale's modeling of gravity-driven reflood.

6.0 REFERENCES

1. NRO Office Instruction, NRO-REG-108, "Regulatory Audits," Revision 0, April 2009.

2. RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Revision 0, July 2000.

3. NuScale licensing topical report TR-0915-17565-P, Revision1, "Accident Source Term Methodology."