



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

January 28, 2019

MEMORANDUM TO: Samuel S. Lee, Chief  
Licensing Branch 1  
Division Licensing, Siting, and  
Environmental Analysis  
Office of New Reactors

FROM: Marieliz Vera, Project Manager /RA/  
Licensing Branch 1  
Division Licensing, Siting, and  
Environmental Analysis  
Office of New Reactors

SUBJECT: REGULATORY AUDIT OF NUSCALE POWER LLC'S DESIGN  
CERTIFICATION APPLICATION, FINAL SAFETY ANALYSIS  
REPORT, TIER 1 AND TIER 2, SECTION 3.5.3, "BARRIER  
DESIGN PROCEDURES"

On January 6, 2017, NuScale Power, LLC. (NuScale) submitted a design certification (DC) application for a small modular reactor to the U.S. Nuclear Regulatory Commission (NRC) (Agencywide Documents Access and Management System (ADAMS) Accession Number ML17013A229). The NRC staff started its detailed technical review of NuScale's DC application on March 15, 2017.

The purpose of the subject audit, to be conducted by the NRC staff, is to: (1) review primarily non-docketed information to examine and verify the analyses and calculations, engineering drawings, design assumptions and the technical bases, and related documentations that support that the credited structural missile barriers, consistent with Nuscale DCA Part 2 Tier 2, Revision 2, Sections 3.5.1.3 and 35.3; and (2) identify information that may require docketing to support the basis of the licensing or regulatory decision.

The audit will take place at NuScale's offices in Rockville, Maryland, and/or online via NuScale's electronic reading room. The audit is currently scheduled to start on January 28, 2019, and end on February 4, 2019. The audit plan is enclosed.

Docket No. 52-048

Enclosure:  
Audit Plan

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

CONTACT: Marieliz Vera, NRO/DLSE  
301-415-5861

SUBJECT: REGULATORY AUDIT OF NUSCALE POWER LLC'S DESIGN CERTIFICATION  
APPLICATION, FINAL SAFETY ANALYSIS REPORT, TIER 1 AND TIER 2,  
SECTION 3.5.3, "BARRIER DESIGN PROCEDURES"  
DATED: JANUARY 28, 2019

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ADAMS Accession No: ML19018A112

NRO-002

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DATE	01/18/2019	01/28/2019	01/28/2019

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**REGULATORY AUDIT OF NUSCALE POWER LLC'S DESIGN CERTIFICATION**

**APPLICATION, FINAL SAFETY ANALYSIS REPORT, TIER 1 AND TIER 2, SECTION**

**3.5.3, "BARRIER DESIGN PROCEDURES"**

**DOCKET NO. 52-048**

**AUDIT PLAN**

**APPLICANT:** NuScale Power, LLC (NuScale)

**APPLICANT CONTACT:** Marty Bryan, NuScale

**DURATION:** January 28, 2019 - February 4, 2019

**LOCATION:** NuScale Power, LLC .  
11333 Woodglen Drive, Suite 205  
Rockville, Maryland 20852

**AUDIT TEAM:** Bhagwat Jain, Senior Structural Engineer (NRC),  
Audit Lead  
Maryam Khan, Structural Engineer (NRC)  
John Honcharik, Senior Materials Engineer (NRC)  
Marieliz Vera, Project Manager (NRC)

**I. BACKGROUND**

On December 31, 2016, NuScale submitted to the U.S. Nuclear Regulatory Commission (NRC) a Final Safety Analysis Report (FSAR) for its Design Certification Application (DCA) of the NuScale design (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17013A229) (Reference 1).

On March 15, 2017, the NRC staff accepted the DCA for docketing and initiated its licensing review. The applicant has determined that the use of shielding and barriers represents a more straightforward approach to protecting essential structures, systems, and components (SSC) from turbine missiles than the probabilistic approach described in the DCA. On June 25, 2018, NuScale submitted to the NRC, revised FSAR sections and supporting information for the staff to review. On July 16, 2018, a public meeting was conducted to discuss NuScale's revised methodology for protection against a turbine missile event. During this public meeting, the staff discussed several questions and concerns and requested NuScale to make available, its supporting documentation to address the questions. On September 7, 2018, the staff issued a request for additional information (RAI) to NuScale, for which NuScale submitted a response on October 31, 2018. The applicant in its submittals did not provide sufficient information in order for the staff to review the turbine missile barriers design credited for providing adequate protection against turbine-generated missiles for essential SSCs contained therein.

During the audit, the staff will review pertinent technical information including calculations, design assumptions, engineering drawings, and supporting documentations to:

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- Confirm that the turbine missile spectrum and its design characteristics are bounding.
- Confirm its consistency with the information in Nuscale DCA Part 2 Tier 2 Revision 2, Sections 3.5.1.3, 3.5.3 and related RAI responses.
- Verify that the turbine missile barriers have sufficient thickness to prevent penetration and spalling, perforation, and scabbing that could challenge the safety-related SSC, and that missile barriers are designed to withstand local and overall effects of missile impact loadings from postulated turbine missiles that bound turbine generator sets to be used in the NuScale design.

The audit will be conducted at NuScale's facility.

## **II. PURPOSE**

The purpose of this audit is for the NRC staff to review primarily non-docketed information to examine and verify the analyses and calculations, engineering drawings, design assumptions and the technical bases (including turbine missile size, mass, velocity) and related documentations that support that the credited structural missile barriers are consistent with Nuscale DCA Part 2, Tier 2 Revision 2, Sections 3.5.1.3 and 3.5.3, as follows:

- are designed to a bounding spectrum of turbine missiles;
- have sufficient thickness to prevent penetration and spalling, perforation, and scabbing that could challenge the safety-related SSC; and
- that missile barriers are designed to withstand local and overall effects of missile impact loadings from postulated turbine missiles that bound turbine generator sets to be used in the NuScale design.

## **III. REGULATORY BASIS**

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, General Design Criterion (GDC) 1, as it relates to structures, systems, and components being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

GDC 2, as it relates to the design of the safety-related structures being able to withstand the most severe natural phenomena such as wind, tornadoes, hurricanes, floods, and earthquakes and the appropriate combination of all loads.

GDC 4, as it relates to safety-related structures being appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

## **IV. REGULATORY AUDIT SCOPE**

The scope of this audit is to review information on the analyses, calculations, engineering drawings, procedures, computational tools, design assumptions and the technical bases (including turbine missile size, mass, velocity), and all associated documentations which support

Nuscale DCA Part 2 Tier 2 Revision 2, Sections 3.5.1.3 and 3.5.3 (Barrier Design Procedures) and related RAI responses docketed prior to the beginning of the audit. Attachment A specifies the detailed scope of the audit.

In support of this audit, NuScale should identify the pertinent calculations and documents that are used in its evaluation of barriers structural design for protection from postulated high-trajectory and low-trajectory turbine missiles using the list of essential SSCs contained in Appendix A of Regulatory Guide 1.115 as well as the responses to the related RAIs.

A list of the calculations and all the supporting documents directly related to Audit scope items should be provided to the staff prior to the start of the audit. A pointer to the appropriate calculation or document that addresses each of the staff's audit items in Attachment A should be included so the staff can conduct a comprehensive, efficient and effective audit.

## **V. SPECIAL REQUESTS**

The NRC staff requests that NuScale provide the following:

- Hard copy of calculations and supporting documents should be made available for review during the audit.
- A work space for the duration of the audit.
- A private conference room for NRC staff's internal discussions.
- A teleconference line for the audit entrance and exit meetings.
- An internet connection to be used by the NRC staff to access the NRC systems.

## **VI. AUDIT ACTIVITIES AND DELIVERABLES**

The NRC audit team will review selected portions of the analyses, calculations, design assumptions and associated documentations that were performed or prepared in support of the information provided in the NuScale DCA and associated responses to staff's RAIs, including the areas detailed in Attachment A. The NRC staff will conduct this audit in accordance with the guidance provided in NRO-REG-108, "Regulatory Audits" (Reference 2) and Appendix A to DSRS Section 3.5.3, as applicable. The NRC staff acknowledges the proprietary nature of certain information requested and will handle it appropriately throughout the audit. While the NRC staff will take notes, the staff will not remove hard copies or electronic files from the audit site(s).

The audit entrance and exit briefings will be scheduled at the beginning and conclusion of the audit. The entrance and exit briefings will not be noticed or conducted as public meetings. As needed, the audit lead may consider periodic status briefings with the applicant during the audit to discuss progress and potential issues identified.

The audit will allow the NRC staff to examine and verify technical information including analyses, calculations, engineering drawings, design assumptions, and supporting documentations, and confirm its consistency with the information in Nuscale DCA Part 2, Tier 2 Revision 2, Sections 3.5.1.3 and 3.5.3 and related RAI responses, and with the conclusion that the turbine missile barriers:

- are designed to a bounding spectrum of turbine missiles;

- have sufficient thickness to prevent penetration and spalling, perforation, and scabbing that could challenge the safety-related SSC; and
- are designed to withstand local and overall effects of missile impact loadings from postulated turbine missiles that bound turbine generator sets to be used in the NuScale design.

Further, the audit will allow the staff to identify information, if any, that should be docketed to support the staff's licensing decision. The audit will also assist the staff in determining if additional RAIs will be needed to obtain information necessary to complete its licensing review.

Within 90 days of completion of the audit, the audit team will generate a regulatory audit summary which will include a list of documents audited by the team, a description of audit activities, and a description of any new technical issues identified during the audit and proposed closure paths. The staff does not make safety findings in an audit summary; however, the staff may refer to the audit summary in a safety evaluation.

Any questions or concerns related to the conduct of the audit will be communicated to Marieliz Vera (NRC) at 301-415-5861 or via email at [Marieliz.Vera@nrc.gov](mailto:Marieliz.Vera@nrc.gov).

## **VII. REFERENCES**

1. NuScale Power, LLC Letter to the NRC, "NuScale Power, LLC Submittal of the NuScale Standard Plant Design Certification Application," issued December 31, 2016 (ML17013A229).
2. NuScale Standard Plant Design Certification Application, Chapter 3 Part 2 Tier 2, issued March 2018, (ML18086A037).
3. NRO-REG-108, "Regulatory Audits," issued April 2, 2009 (ML081910260).
4. NuScale Power, LLC. Letter to the NRC, "NuScale Power, LLC Submittal of Changes to Tier 1 and Tier 2 of the NuScale Final Safety Analysis Report to Support Safeguarding Essential SSC from Turbine Missiles Using Barriers," issued June 25, 2018 (ML18176A394).
5. NuScale Power, LLC Letter to the NRC, "NuScale Power, LLC Response to NRC Request for Additional Information No. 503 (eRAI No. 9596) on the NuScale Design Certification Application," issued October 31, 2018 (ML18304A305).

## **Attachment A – FSAR Section 3.5 Areas of the Audit**

### **FSAR Section 3.5.1.3 (Missile Selection and Description)**

1. Provide the basis for the assumption of the missile weights and its corresponding striking speed in miles per hour (MPH) considered in the analysis, taking into account, that the design spectrum of turbine missiles would include up to half of the last stage of the rotor with the blades attached.
2. Provide the basis for the NuScale response to staff's RAI that states that analysis for high-trajectory missile was not performed on the basis that its probability is "much smaller than the equivalent probability for low-trajectory missile." Also, provide any documentation concerning the effect of high- trajectory missile on the barrier design evaluation and if it's bounded by the low-trajectory missiles.
3. Provide the basis for the assumptions for a design overspeed of 120 percent and a destructive overspeed of 160 percent when the DCD does not provide a specific model of steam turbine. In addition, historical turbine failures for non-nuclear turbines should be used for justification since the turbines are commercial turbines and not nuclear grade turbines.
4. Provide the basis for the determination of the bounding analysis for NuScale turbine generators. This includes any documentation that supports NuScale's response to RAI 9596, Question 3, which states: "The assumptions used in the analysis (i.e., specifics related to the turbine design used to support the analysis) could change depending on the turbine selected by the COL applicant. For that reason, COL Item 3.5-1 was revised to require the COL applicant to review the analysis against the "site-specific" turbine selected as part of the COL." It should be noted that the revised COL Item 3.5-1 only states that a missile analysis will be provided for the site specific turbine generator, and does not require a comparison to the analysis conducted by NuScale. In addition, provide the turbine model used in the NuScale analysis
5. Provide operating experience and technical data, including number of stages, material, rotor and blade sizes and overspeed protection of turbines from the vendor to be used for the NuScale design in lieu of generic information and operating experience from sales literature.

### **FSAR Section 3.5.3 (Turbine Missile Barrier Design Procedures)**

1. Provide calculations that identify the barrier thickness required to prevent perforation and scabbing. Provide specific empirical formula and its basis that are used for calculating penetration and scabbing thicknesses reported in response to RAI 9596 for the deformable and undeformable blades. Provide technical basis, criteria, and justification for considering blades deformable, since the blades and rotor are solid stainless and alloy steel. Provide the basis of 142 percent reduction (from 40" to 16.5") in penetration depth for the deformable blade.
2. Provide mathematical model sketches, missile impact load time history and its validation, validated computer codes used, and the results (penetration, perforation, scabbing) from the finite element analysis. Provide a comparison of the finite element analysis methodology results with the known missile test results. Outline the analysis

methodology assumptions and limitations including the effect of uncertainty considered in various input parameters.

3. Provide the calculations for the penetration, perforation and scabbing thicknesses for the Control Building walls and slabs. Only qualitative assessment of the Control Building walls and the grade level slab is provided. Control Building walls and slab are thinner and of lesser concrete strength (5000 psi vs 7000 psi).