

July 24, 2017

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

FROM: Bruce M. Bavol, Project Manager /RA/  
Licensing Branch 1  
Division of New Reactor Licensing  
Office of New Reactors

SUBJECT: AUDIT PLAN FOR THE REGULATORY AUDIT OF NUSCALE  
POWER, LLC DESIGN CERTIFICATION APPLICATION,  
DESIGN CONTROL DOCUMENT, TIER 2, CHAPTER 5,  
SECTION 5.3.2, "PRESSURE-TEMPERATURE LIMITS,  
PRESSURIZED THERMAL SHOCK, AND CHARPY UPPER-  
SHELF ENERGY DATA AND ANALYSES"

NuScale Power, LLC (NuScale) submitted by letter dated December 31, 2016, to the U.S. Nuclear Regulatory Commission (NRC), a Design Control Document (DCD) for its Design Certification (DC) application of the NuScale reactor 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 NRC staff has identified a need to conduct a regulatory audit on the topic of pressure temperature limits in Tier 2, Section 5.3.2, "Pressure-Temperature Limits, Pressurized Thermal Shock, and Charpy Upper-Shelf Energy Data and Analyses," of the NuScale DCD. The purpose of the audit is to: (1) gain a better understanding of information in the reference technical report; and (2) identify information that will 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 online via NuScale's electronic reading room. The audit entrance meeting will be held July 24, 2017. The content of the audit plan is provided as an enclosure.

Docket No.: 52-048

Enclosure:  
Audit Plan

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

CONTACT: Bruce M. Bavol, NRO/DNRL  
301-415-6715

SUBJECT: AUDIT PLAN FOR THE REGULATORY AUDIT OF NUSCALE POWER, LLC  
DESIGN CERTIFICATION APPLICATION, DESIGN CONTROL DOCUMENT,  
TIER 2, CHAPTER 5, SECTION 5.3.2, "PRESSURE-TEMPERATURE LIMITS,  
PRESSURIZED THERMAL SHOCK, AND CHARPY UPPER-SHELF ENERGY  
DATA AND ANALYSES"

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NRO-002

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NAME	BBavol	SGreen	BBavol
DATE	7/24/2017	7/21/2017	7/24/2017

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**U.S. NUCLEAR REGULATORY COMMISSION**  
**REGULATORY AUDIT OF SECTION 5.3.2, "PRESSURE-TEMPERATURE LIMITS,**  
**PRESSURIZED THERMAL SHOCK, AND CHARPY UPPER-SHELF ENERGY DATA AND**  
**ANALYSES" OF THE NUSCALE STANDARD PLANT DESIGN CERTIFICATION**

**DOCKET NO. 52-048**

**AUDIT PLAN**

**APPLICANT:** NuScale Power, LLC

**APPLICANT CONTACTS:** Marty Bryan  
Darrell Gardner  
Steven Mirsky  
Jennie Wike

**DURATION:** 19 days  
July 24, 2017 through August 11, 2017

**LOCATIONS:** NuScale (Rockville Office)  
11333 Woodglen Drive, Suite 205  
Rockville, Maryland 20852  
  
Electronic Reading Room

**AUDIT TEAM:** Dan S. Widrevitz (NRO/MCB Materials Engineer, Audit Lead)  
Mark T. Kirk (RES/CIB Materials Engineer)  
Patrick A. Raynaud (RES/CIB Materials Engineer)  
Matthew Gordon (RES/CIB Materials Engineer)  
Matthew Mitchell (NRO/MCB Branch Chief)  
Bruce M. Bavol (NRO, Project Manager)  
Supporting staff (as needed)

**BACKGROUND AND OBJECTIVES**

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

The basis for setting operational limits on pressure and temperature for the reactor coolant pressure boundary (RCPB) is presented in DCD Tier 2, Chapter 5.3.2, "Pressure-Temperature Limits, Pressurized Thermal Shock, and Charpy Upper-Shef Energy Data and Analyses."

**Enclosure**

These limits ensure adequate safety margins against non-ductile fracture during normal operation, heat-up, cooldown, anticipated operational occurrences; and system hydrostatic, pre-service, and inservice leakage tests.

Currently, the DCD and referenced, Technical Report (TR)-1015-18177, "Pressure and Temperature Limits Methodology" (henceforth the TR) do not contain sufficient information for the staff to conduct adequate independent verification of the methodology or results.

The NRC staff determined it would be advantageous to audit information supporting the adequacy of the methodology and results. Specifically, the staff intends to audit the following:

- Finite element meshes used for stress and temperature calculations (including boundary conditions) – to help assess TR Tables 4-8 and 4-9;
- Finite element meshes used for K calculations (in particular ensuring that the focused crack tip meshes are fine enough) – to help assess TR Tables 4-8 and 4-9;
- K values extracted from the successive contours for the cracks analyzed, to ensure that the values finally used are accurate or conservative, and to understand the choice of contour used in TR Table 5-1;
- Stress profiles extracted from the finite element models to calculate K at the crack tips: need to ensure a 3<sup>rd</sup> order polynomial fit is an acceptable representation of the stress, particularly for the cracks located at geometric discontinuities to support Tier 2, DCD Section 5.0 results.

The staff will conduct this audit in accordance with the guidance in NRO-REG-108, "Regulatory Audits."

The audit will begin with an entrance meeting on July 24, 2017, via conference call. The audit may be performed via the NuScale electronic reading room (eRR) or at NuScale's Rockville office. During this audit, the NRC staff will examine the referenced documents and analyses listed in this audit plan. These documents and analyses are not incorporated by reference into the design but support information in the DCD.

The objectives of this audit are to enable the NRC staff to:

- Gain a better understanding of information underlying the pressure-temperature limits report;
- Identify information that will require docketing to support the basis of the licensing or regulatory decision.

## **REGULATORY AUDIT BASIS**

Title 10 of the *Code of Federal Regulations* (CFR), Section 52.47(a)(3)(i) states:

A DC application must contain a final safety analysis report (FSAR) that includes a description of principle design criteria for the facility.

An audit is required to examine detailed information related to the applicant's principle design criteria, and reach a safety conclusion on the NuScale application sections in the scope of this audit plan. The NRC staff must have sufficient information to ensure that acceptable risk and reasonable assurance of safety can be documented in the NRC staff's safety evaluation.

This regulatory audit is based on the following regulations:

- 10 CFR 52.47, "Contents of applications; technical information in final safety analysis report."
- General Design Criteria (GDC) 1 and GDC 30 found in Appendix A to 10 CFR Part 50, as they relate to quality standards for design, fabrication, erection, and testing of structures, systems, and components.
- GDC 4, as it relates to the environmental compatibility of components.
- GDC 14, as it relates to prevention of rapidly propagating failures of the RCPB.
- GDC 31, as it relates to material fracture toughness.

### **REGULATORY AUDIT SCOPE**

The specific scope of this audit is information related to the pressure-temperature limits methodology and results. This information supports mainly the following DCD Section:

- Tier 2, Section 5.3.2, "Pressure-Temperature Limits, Pressurized Thermal Shock, and Charpy Upper-Shelf Energy Data and Analyses."

The documents supporting the technical areas listed above are to be made available to the NRC staff in the NuScale eRR or at the NuScale office in Rockville, Maryland. The documents already identified by the staff are listed below. Additional documents will be requested by the staff as needed (when referenced by a document being audited by the staff, for instance), and these documents will be added to the audit report prepared by the staff following the conclusion of the audit.

### **Documents Requested**

1. Design drawings of the reactor vessel;
2. Finite element meshes used for stress and temperature calculations (including boundary conditions) – to help assess TR Tables 4-8 and 4-9;
3. Finite element meshes used for K calculations (in particular ensuring that the focused crack tip meshes are fine enough) – to help assess TR Tables 4-8 and 4-9;
4. K values extracted from the successive contours for the cracks analyzed in the TR, to ensure that the values finally used are accurate or conservative, and to understand the choice of contour used in TR Table 5-1;

5. Stress profiles extracted from the finite element models to calculate K at the crack tips; needed to ensure a 3<sup>rd</sup> order polynomial fit is an acceptable representation of the stress, particularly for the cracks located at geometric discontinuities.

### **SPECIAL REQUESTS**

The NRC staff asks that the requested documents be available to the NRC auditors in NuScale's eRR. Use of the eRR allows multiple auditors in different geographic locations to examine the same document at the same time which improves the efficiency and reduces the cost of the audit. Additional documents may be identified as the review progresses. When the staff's review of the documents associated with a specific issue is complete the staff will notify either Division of New Reactor Licensing or NuScale that these documents can be removed from eRR. The staff also requests that NuScale personnel knowledgeable in the audit topics be available to the NRC staff (with reasonable notification). Finally, the staff requests that a conference room with a speaker phone be available when auditing at the NuScale office.

### **AUDIT ACTIVITIES AND DELIVERABLES**

The NRC staff acknowledges that if the information requested is proprietary then it will be handled appropriately throughout the audit. While the NRC staff will take notes, they will not remove hard copy or electronic files from the audit site(s). Any NRC contractors participating in the audit will be evaluated and approved through standard NRC processes for handling sensitive material. No plans to include contractors in this audit exist at this time.

The NRC will hold a conference call or meeting to exit the audit. At the exit meeting NRC staff will identify issues that have been closed or will be resolved by another mechanism, such as requests for additional information (RAIs) or public meetings.

At the completion of the audit, the audit team will issue an audit summary within 90 days that will be declared and entered as an official agency record in the NRC's ADAMS records management system, in accordance with NRO-REG-108. The audit outcome may be used to assist the NRC staff in the issuance of RAIs (if necessary) for the licensing review of the NuScale DCD and to identify any additional information to be submitted on the docket in support of the NRC staff's preparation of their safety evaluation report.

If necessary, any circumstances related to the conduct of the audit will be communicated to the NRC project manager, Bruce Bavol at 301-415-6715 or bruce.bavol@nrc.gov.