

May 30, 2017

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

FROM: Rani Franovich, Senior 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 TOPICAL REPORT TR-0516-49416, "NON-LOSS-OF-
COOLANT ACCIDENT ANALYSIS METHODOLOGY," REVISION 0

By letter dated January 10, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17010A427), NuScale Power, LLC (NuScale) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review topical report TR-0516-49416, Rev. 0, "Non-Loss-of-Coolant Accident Analysis Methodology," in support of the NuScale design certification application, which the NRC accepted for review on March 23, 2017 (ADAMS Accession No. ML17074A087). On April 27, 2017, the NRC staff started its detailed technical review of TR-0516-49416-P, Rev. 0.

The purpose of the NRC's regulatory audit of NuScale's subject line chapters is to: (1) gain a better understanding of the NuScale design; (2) verify information; (3) identify information that will require docketing to support the basis of the licensing or regulatory decision; and, (4) review related documentation and non-docketed information to evaluate conformance with regulatory guidance.

The audit will take place at NuScale's offices in Rockville, Maryland. The audit entrance will be held on May 31, 2017. The contents of the audit plan are provided as an enclosure.

Docket No. 52-048

Enclosure:
Audit Plan

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

CONTACT: Rani Franovich, NRO/DNRL
301-415-7334

SUBJECT: AUDIT PLAN FOR THE REGULATORY AUDIT OF NUSCALE TOPICAL
REPORT TR-0516-49416, "NON-LOSS-OF-COOLANT ACCIDENT ANALYSIS
METHODOLOGY," REVISION 0

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ADAMS Accession No: ML17138A112

***via email**

NRO-002

OFFICE	NRO/DNRL/LB1: PM	NRO/DNRL/LB1: LA	NRO/DNRL/LB1
NAME	RFranovich (BBavol for)	MBrown	BBavol (sign)
DATE	5/30/17	5/25/17	5/30/2017

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**UNITED STATES NUCLEAR REGULATORY COMMISSION
AUDIT PLAN FOR THE REGULATORY AUDIT OF
OF NUSCALE TOPICAL REPORT
TR-0516-49416, “NON-LOSS-OF-COOLANT ACCIDENT ANALYSIS METHODOLOGY”
Project No. 0769
Docket No. 52-048**

AUDIT PLAN

APPLICANT: NuScale Power, LLC (NuScale)

APPLICANT CONTACTS: Marty Bryan
Darrell Gardner
Steven Mirsky
Jennie Wilke

DURATION: 180 days
Phase 1: May 31, 2017, through August 29, 2017
Phase 2: August 30, 2017, through November 17, 2017

LOCATION: **U.S. Nuclear Regulatory Commission (NRC) Headquarters
(via NuScale’s electronic reading room (eRR))**
Two White Flint North
11545 Rockville Pike
Rockville, Maryland 20852-2738

NuScale
11333 Woodglenn Drive, Suite 205
Rockville, Maryland 20852

AUDIT TEAM: Alexandra Burja, NRO, Audit Team Lead
Ray Skarda, NRO
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Rebecca Karas, NRO, SRSB Branch Chief
Matt Thomas, NRO
Andrew Proffitt, NRO
Andrew Bielen, RES
Ronald Harrington, RES
Peter Lien, RES
Shawn Marshall, RES
Peter Yarsky, RES
Erick Ball, Energy Research Incorporated (ERI)
Mohsen Khatib-Rahbar, ERI
Alfred Krall, ERI
Morgan Libby, ERI
Walter Tauche, ERI
Zhe Yuan, ERI
Michael Zavisca, ERI

I. BACKGROUND AND OBJECTIVES

By letter dated January 10, 2017 (ADAMS Accession No. ML17010A427), NuScale submitted for NRC staff review topical report TR-0516-49416, Rev. 0, "Non-Loss-of-Coolant Accident Analysis Methodology," in support of the NuScale design certification application, which the NRC accepted for review on March 23, 2017 (ADAMS Accession No. ML17074A087). On April 27, 2017, the NRC issued a letter accepting TR-0516-49416-P, Rev. 0 for review (ADAMS Accession No. ML17116A063). To facilitate the NRC staff's evaluation of information supporting the topical report, the staff is planning the following:

- An audit entrance meeting is scheduled for May 31, 2017, via conference call. The initial audit duration is 180 days, which includes audit phases 1 and 2 as noted above in the section titled, "DURATION." The audit is expected to primarily be performed via the NuScale eRR or, if necessary, at NuScale's Rockville office. During this audit, the NRC staff will examine the reference documents and analyses mentioned but not specifically cited to support their statements in TR-0516-49416-P and the FSAR.
- If necessary, this audit plan will be updated to support the remainder of the review.

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

- gain a better understanding of the NuScale non-loss-of-coolant accident (non-LOCA) methodology and supporting calculations and documentation;
- better determine whether the methodology meets NRC regulations and conforms to regulatory guidance;
- develop requests for additional information (RAI) in areas not adequately covered in the topical report documentation; and
- identify supplemental information that should be added to the topical report to allow the staff to make its safety finding.

The NRC staff determined efficiency gains would be realized by auditing the documents which support the topical report to inform RAIs. If the staff determines during the audit and interactions with the applicant that additional information is needed to support a safety finding, a corresponding RAI will be issued at that time even if before the conclusion of the audit.

II. REGULATORY AUDIT BASIS

10 CFR 52.47(a)(4) states that a final safety analysis report (FSAR) submitted as part of a standard design certification must include:

[a]n analysis and evaluation of the design and performance of structures, systems, and components with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents.

An audit is needed to evaluate the non-LOCA analysis methodology, which is incorporated by reference into Chapter 15 of the NuScale FSAR and used to develop safety conclusions documented therein. The NRC staff must have sufficient information to ensure that acceptable risk and adequate assurance of safety can be documented in the NRC staff's safety evaluation reports for the non-LOCA TR and Chapter 15 of the FSAR.

The following general design criteria (GDC) from Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A are applicable to the non-LOCA analysis:

- GDC 5, "Sharing of structures, systems, and components"
- GDC 10, "Reactor design"
- GDC 13, "Instrumentation and control"
- GDC 15, "Reactor coolant system design"
- GDC 17, "Electric power systems"
- GDC 20, "Protection system functions"
- GDC 25, "Protection system requirements for reactivity control malfunctions"
- GDC 26, "Reactivity control system redundancy and capability"
- GDC 27, "Combined reactivity control systems capability"
- GDC 28, "Reactivity limits"
- GDC 31, "Fracture prevention of reactor coolant pressure boundary"
- GDC 34, "Residual heat removal"

In addition, relevant regulatory guidance includes:

- Regulatory Guide 1.203, "Transient and Accident Analysis Methods," December

2005.

- NuScale Design-Specific Review Standard (DSRS) 15.0, "Introduction – Transient and Accident Analyses," Revision 0, June 2016.
- Standard Review Plan (SRP) 15.0.2, "Review of Transient and Accident Analysis Method," Revision 0, March 2007.
- DSRS 15.1.1-15.1.4, "Decrease in Feedwater Temperature, Increase in Feedwater Flow, Increase in Steam Flow, and Inadvertent Opening of the Turbine Bypass System or Inadvertent Operation of the Decay Heat Removal System," Revision 0, June 2016.
- DSRS 15.1.5, "Steam System Piping Failures Inside and Outside of Containment," Revision 0, June 2016.
- DSRS 15.1.6, "Loss of Containment Vacuum," Revision 0, June 2016.
- DSRS 15.2.1-15.2.5, "Loss of External Load; Turbine Trip; Loss of Condenser Vacuum; Closure of Main Steam Isolation Valve; and Steam Pressure Regulator Failure (Closed)," Revision 0, June 2016.
- DSRS 15.2.6, "Loss of Nonemergency AC Power to the Station Auxiliaries," Revision 0, June 2016.
- DSRS 15.2.7, "Loss of Normal Feedwater Flow," Revision 0, June 2016.
- DSRS 15.2.8, "Feedwater System Pipe Break Inside and Outside Containment," Revision 0, June 2016.
- SRP 15.4.1, "Uncontrolled Control Rod Assembly Withdrawal from a Subcritical or Low Power Startup Condition," Revision 3, March 2007.
- SRP 15.4.2 Revision 3, "Uncontrolled Control Rod Assembly Withdrawal at Power," Revision 3, March 2007.
- SRP 15.4.3, "Control Rod Misoperation (System Malfunction or Operator Error)," Revision 3, March 2007.
- SRP 15.4.6, "Inadvertent Decrease in Boron Concentration in the Reactor Coolant System (PWR)," Revision 2, March 2007.
- SRP 15.4.7, "Inadvertent Loading and Operation of a Fuel Assembly in an Improper Position," Revision 2, March 2007.
- DSRS 15.5.1 – 15.5.2, "Chemical and Volume Control System Malfunction that Increases Reactor Coolant Inventory," Revision 0, June 2016.

III. REGULATORY AUDIT SCOPE

The scope of this audit includes information, documents, and supporting calculations related to the methodology described in TR-0516-49416-P. Additionally, due to the importance of steam generator heat transfer and the decay heat removal system (DHRS) in non-LOCA transients, the audit scope includes information, documents, and supporting calculations related to the assessment and modeling of the helical coil steam generators, including the heat transfer correlations, described in more detail in the LOCA topical report, TR-0516-49422-P.

In addition to the initial set of audit documents and information requested in Attachment A, the staff may request other information to be audited as identified during review of the TR, audit documents, or RAI responses. These documents will be added to the audit report prepared by the staff following the conclusion of the audit.

IV. SPECIAL REQUESTS

The NRC staff requests the documents listed in Attachment A 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 the NRC's Division of New Reactor Licensing (DNRL) or NuScale that these documents can be removed from eRR, thereby minimizing their residence time in eRR.

In addition, the NRC staff may request in-person audit meetings with NuScale personnel to facilitate the staff's understanding of material to be audited. Such meetings will be scheduled based on mutual availability. The staff requests that document titles identified by NRC staff that are germane to an in-person audit meeting be made available in the eRR prior to any scheduled in-person audit meeting.

V. AUDIT ACTIVITIES AND DELIVERABLES

The NRC audit team is expected to consist of aforementioned individuals reviewing the non-LOCA methodology. The NRC staff will conduct this audit in accordance with the guidance provided in NRO-REG-108, "Regulatory Audits" (Reference 4). The NRC staff acknowledges the proprietary nature of the information requested and will handle it appropriately throughout the audit. While the NRC staff will take notes, the NRC staff will not remove hard copies or electronic files from the audit site(s).

The audit will initiate on May 31, 2017. The audit is scheduled for a period of 180 days and will consist of two phases, each approximately 90 days. Phase 1 will consist mainly of the initial staff investigation of supporting documentation for the non-LOCA methodology. The review of the majority of the documents identified in Attachment A is expected to complete by the end of Phase 1. The documents needed for Phase 2 will be identified at the end of Phase 1.

Phase 2 is expected to result in the closure of the remaining audit items and may include additional items related to RAI responses, as necessary. If additional items are identified late in Phase 2, which could include items related to RAI responses or design changes, the audit plan may be revised to include additional phases to address these specific identified items, or

a new audit plan may be generated. Audit reports will be generated upon completion of each phase and will be published in the NRC's ADAMS.

During each phase, the NRC will hold monthly audit calls and/or meetings with NuScale to identify issues that have been closed or will be resolved by another mechanism, such as RAIs or public meetings. In the monthly meetings, NRC will also identify any new emerging information needs as well as documents that can be removed from eRR.

The audit will assist the NRC staff in the issuance of RAIs (if necessary) for the licensing review of the Non-Loss-of-Coolant Accident Analysis Methodology topical report in preparation of the NRC staff's safety evaluation.

If necessary, any circumstances related to the conductance of the audit will be communicated to Rani Franovich (NRC) at 301-415-7334 or Rani.Franovich@nrc.gov.

VI. REFERENCES

1. Letter from NuScale Power, LLC, "NuScale Power, LLC Submittal of "Non-Loss-of-Coolant Accident Analysis Methodology," TR-0516-49416 (NRC Project No. 0769)," January 10, 2017, ADAMS Accession Number ML17010A427.
2. Letter to NuScale Power, LLC, "NuScale Power, LLC. – Acceptance of an Application for Standard Design Certification of a Small Modular Reactor," March 23, 2017, ADAMS Accession No. ML17074A087.
3. Letter to NuScale Power, LLC, "Acceptance Letter for the Review Of NuScale Power, LLC Topical Reports TR-0516-49422, "Loss-Of-Coolant Accident Evaluation Model," Revision 0, And TR-0516-49416, "Non-Loss-Of-Coolant Accident Analysis," Revision 0 (CAC RN6303, RN6305)," April 27, 2017, ADAMS Accession Number ML17116A063.
4. NRO-REG-108, "Regulatory Audits," April 2, 2009, ADAMS Accession Number ML081910260.

ATTACHMENT A – DOCUMENT LIST AND INFORMATION NEEDED

1. Information confirming the applicability of the SIET evaluation model, specifically:
 - helix radius, helix height, total height, total tube length, number of turns, and axial pitch for each of the coil rows (Coil Rows 1 through 5)
 - total height of the annular region where heat transfer can occur between primary fluid and secondary fluid
 - volume of the primary side annular region available for heat transfer
 - axial hydraulic diameter of annular primary region where heat transfer occurs
 - length of feed and steam headers
 - height and volume of containment vessel
2. Calculations and documentation related to SIET, including “SIET Helical Coil Steam Generator Test Program – Fluid heated Facility Test Section Installation and As-Built Report.”
3. Current version of EC-T050-3638, “Assessment of NRELAP5 Using SIET Fluid Heated Test Facility (TF-2) Data.”
4. Calculations and documentation related to KAIST, including detailed facility description and test reports.
5. Current version of EE-T080-13757, “NuScale Integral System Test (NIST-1) Facility Scaling Analysis.”
6. Current version of EC-0000-3853, “Calculations to Support NIST-1 Distortion Analysis and Modeling of Containment and Pool Heat Transfer.”
7. Current version of SDR-0615-15509, “NIST-1 Facility Description Report.”
8. NIST-1 test reports, including post-test assessments.
9. Current version of engineering drawing(s), “Steam Generator,” ED-A011-2689.
10. Current version of engineering drawings(s), “DHRs Passive Condenser,” ED-B030-2770.
11. Current version of engineering drawings(s), “Reactor Vessel Internals,” ED-A023-1958.
12. Current version of engineering drawings(s), “Reactor Vessel Internals - Lower Riser,” ED-A023-2304.
13. Current version of engineering drawings(s), “Reactor Vessel Internals – Upper Riser,” ED-A023-2303.

14. Current version of engineering drawing(s), "Main Steam Piping Layout," ED-C010-2375.
15. Current version of engineering drawing(s), "Feedwater Piping Layout," ED-C020-2355.
16. Non-LOCA PIRT development documentation, including the full PIRT (i.e., low- and medium-ranked phenomena in addition to the high-ranked phenomena), details of the PIRT development process such as PIRT panel discussions and findings, and the bases for the rankings.
17. Current version of SwUM-0304-15495, "NRELAP5 Version 1.3 Input Data Requirements"
18. NuScale-specific modeling guidelines that supplement the NRELAP5 code manual user guidelines, as mentioned in Section 6 of TR-0516-49416-P, but not listed as a reference. If these are part of SwUM-0304-15495, "NRELAP5 Version 1.3 Input Data Requirements," please state such.
19. Current version of SwUM-0304-17111, "NRELAP5 Version 1.3 Developer's Manual."
20. For sections 7.2.1.1, 7.2.2.1, and 7.2.4.1 of TR-0516-49416-P, the staff needs additional information supporting the basis for the high power analytical limit.
21. "Pressurizer Modeling: Using Different Thermodynamic Models and Comparing Results with RELAP Code Results," Applied Mechanics and Materials (Volumes 423-426), pp. 1444-1448, 2013.
22. "Heat transfer in tube coils with laminar and turbulent flow," by Seban, R.A., and E.F. McLaughlin, *International Journal of Heat and Mass Transfer*, vol. 6, pp. 387-395, 1963 (Ref. 34 of "Loss-of-Coolant Accident Evaluation Model," TR-0516-49422-P, Revision 0).
23. "Pressure drop, heat transfer and performance of a helically coiled tubular exchanger," by Prasad, B.V.S.S.S, D.H. Das, and A.K. Prabhakar, *Heat Recovery Systems and CHP*, 9: pp. 249-256, 1989 (Ref. 35 of TR-0516-49422-P, Revision 0).
24. "Turbulent film condensation of high pressure steam in a vertical tube of passive secondary condensation system," Korea Advanced Institute of Science and Technology, PhD thesis, 2000 (Ref. 24 of TR-0516-49416-P, Revision 0).
25. "Evaluation of Helical Geometry Effects for SG Heat Transfer and Pressure Drop," by H. Noyes, ER-A014-2268 (Ref. 2.4-61 of NRELAP5 Version 1.3 Theory Manual, SwUM-0304-17023, Revision 4).