

August 10, 2016

MEMORANDUM TO: Mark Tonacci, Chief
Licensing Branch 1
Division of New Reactor Licensing
Office of New Reactors

FROM: Prosanta Chowdhury, Project Manager **/RA/**
Licensing Branch 1
Division of New Reactor Licensing
Office of New Reactors

SUBJECT: U. S. NUCLEAR REGULATORY COMMISSION STAFF AUDIT
REPORT FOR NUSCALE POWER, LLC PRE-APPLICATION
ACTIVITIES ASSOCIATED WITH NUSCALE DOCUMENTS ON RISK
INSIGHTS DRAWN FROM THE PROBABILISTIC RISK ASSESSMENT
(PROJ0769)

As part of its pre-application activities pertaining to the anticipated design certification application from NuScale Power, LLC (NuScale), the U.S. Nuclear Regulatory Commission (NRC) staff performed an audit of the probabilistic risk assessment (PRA) being developed in support of the application. The audit was conducted on May 11, 2016 – May 12, 2016 (Agencywide Document Access and Management System (ADAMS) Accession No. ML16126A176). The pre-application audit was performed to gather information from NuScale's risk assessment of their integral pressurized water reactor (iPWR) design. Specifically, the NRC staff's objective in conducting this audit was to obtain risk insights regarding the NuScale design from the current design PRA so as to be able to provide appropriate guidance for NRC reviewers to plan an enhanced safety-focused review of the NuScale application for design certification.

The NRC staff conducted the audit at the NuScale offices located at 11333 Woodglen Drive, Suite 205, Rockville, Maryland, 20852. The audit was conducted in accordance with the Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits."

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The publicly available version of the audit report and the attendee list is attached to the report. The non-public (proprietary) version of the audit report is documented as an Enclosure (ADAMS Accession No. ML16221A383).

Project No.: PROJ0769

cc: NuScale DC ListServ

M. Tonacci

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Project No.: PROJ0769

cc: NuScale DC ListServ

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ADAMS Accession Nos.:

ML16221A296– Pkg

ML16221A123– Audit Summary Report (Public)

ML16221A383– Enclosure (Proprietary; Non-Public) *via email NRO-002

OFFICE	NRO/DNRL/LB1: PM	NRO/DNRL/LB1: LA*	NRO/DSRA/SPRA: BC*
NAME	PChowdhury	MBrown	LMrowca
DATE	8/10/2016	8/09/2016	8/08/2016

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NUSCALE POWER, LLC

SUMMARY REPORT OF AUDIT REGARDING

RISK INSIGHTS DRAWN FROM THE PROBABILISTIC RISK ASSESSMENT

NRC Audit Team:

Members of the audit team, listed below, were selected based on their detailed knowledge of probabilistic risk assessment (PRA), their experience in obtaining risk insights from PRAs supporting previous design certification reviews, and their knowledge regarding implementation of the NRC's risk-informed and integrated review framework for SMRs documented in NUREG-0800, Introduction-Part 2, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Integral Pressurized Water Reactor Edition":

- Lynn Mrowca, Branch Chief (NRO/DSRA/SPRA)
- Mark Caruso, Sr. Reliability and Risk Analyst (NRO/DSRA/SPRA)
- Tony Nakanishi, Reliability and Risk Analyst (NRO/DSRA/SPRA)

I. PURPOSE

The audit was conducted on May 11, 2016 - May 12, 2016. The pre-application audit was performed to gather information from NuScale Power, LLC's (NuScale) risk assessment of their integral pressurized water reactor (iPWR) design. Specifically, the NRC staff's objective in conducting this audit was to obtain risk insights regarding the NuScale design from the current design PRA so as to be able to provide appropriate guidance for NRC reviewers to plan an enhanced safety-focused review of the NuScale application for design certification.

The NRC staff conducted the audit at the NuScale offices located at 11333 Woodglen Drive, Suite 205, Rockville, Maryland, 20852. The NRC staff conducted the audit in accordance with the Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits." (Reference 1).

II. BACKGROUND AND AUDIT BASES

In 2010, the U.S. Nuclear Regulatory Commission (NRC or Commission) provided direction to the NRC staff on the preparation for, and review of, small modular reactor (SMR) applications, with a near-term focus on integral pressurized water reactor designs. The Commission directed the NRC staff to more fully integrate the use of risk insights into pre-application activities and the review of applications and, consistent with regulatory requirements and Commission policy statements, to align the review focus and resources to risk-significant structures, systems, and components (SSC) and other aspects of the design that contribute most to safety in order to enhance the effectiveness and efficiency of the review process. On May 11, 2011, the

Commission issued a Staff Requirements Memorandum approving the NRC staff's proposed risk-informed and integrated review framework (Agencywide Documents Access and Management System (ADAMS) Accession No. ML111320551). A detailed description of the NRC staff's framework is provided in NUREG-0800, Introduction-Part 2, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Small Modular Reactor Edition," January 2014 ("NUREG-0800, Introduction-Part 2").

As discussed in NUREG-0800, Introduction-Part 2, performance of the risk-informed categorization of SMR SSCs is a key framework activity. In order for the NRC staff to implement the categorization process, the applicant must first categorize SSCs as (1) either safety-related or non-safety-related using the criteria in Title 10 of the *Code of Federal Regulations*, Part 50.2, and (2) either risk significant or not risk significant using risk insights from the PRA and other deterministic factors. Insights from the preliminary NuScale Power, LLC (NuScale) PRA results assist the NRC staff in gaining an understanding of the applicant's risk categorization of SSCs.

The NRC staff states in NUREG-0800, Introduction-Part 2: (1) They expect to receive preliminary results of the categorization activities as they become available from the applicant in the pre-application phase of the NRC staff's review; and (2) The NRC staff will conduct pre-application meetings or audits as necessary to obtain and review the information. The quality and timeliness of applicant's inputs are key to the effectiveness of the staff's pre-application activities. Conducting this pre-application audit is consistent with the NRC's risk-informed and integrated review framework discussed above.

III. AUDIT OBJECTIVES

The NRC staff's objective in conducting this audit was to obtain risk insights regarding the NuScale design from the current design PRA so as to be able to provide appropriate guidance for NRC reviewers to plan a safety-focused review of the NuScale application for design certification.

IV. SCOPE OF THE AUDIT AND AUDIT ACTIVITIES

The scope of the audit included sampling of documents provided by NuScale that document insights drawn from the PRA. Current documentation for the NuScale PRA includes 125 separate documents. The NRC staff focused on reviewing a subset of these documents as listed below.

On May 11, 2016, in the morning, a short entrance meeting was held with the prospective applicant to review key elements of the audit plan (ADAMS Accession No. ML16126A176). The NRC staff audited the prospective applicant's PRA documentation and related procedures from the morning of May 11, 2016, through the afternoon of May 12, 2016. The documents reviewed by the NRC staff during the audit are listed below:

<u>ID</u>	<u>Title</u>
17	Probabilistic Analysis of Emergency Core Cooling Valve Reliability
27	Passive Safety System Reliability Study
32	Decay Heat Removal System Notebook
35	Emergency Core Cooling System Notebook
53	Success Criteria for In-Vessel Retention in Reactor Pressure Vessel
54	Success Criteria for In-Vessel Retention in Containment Vessel
66	Low Power and Shutdown Probabilistic Risk Assessment Notebook
67	Probabilistic Risk Assessment for Reactor Building Crane
78	LCC-07T: Charging Line Break Inside Containment with ECCS
88	LCU-03T: Unisolated Charging Line LOCA Outside Containment with No Mitigation
90	LEC-05T: ECCS Valve LOCA with No Mitigation
126	Multi-Module Probabilistic Risk Assessment Notebook
127	Shared System Hazards Analysis

Throughout the audit, the NRC staff held question-and-answer sessions with NuScale to address NRC staff's questions while reviewing documents. A public meeting was held on May 24, 2016, to discuss feedback from the NuScale staff and the NRC staff (ADAMS Accession No. ML16222A360), including where additional information might be needed in the design certification application.

The enclosure (proprietary; non-public) to this report, "Results of the NuScale PRA and Risk Insights Observed during the May 11 and 12, 2016, Audit," summarizes the technical information audited by staff and provides the staff's conclusions and observations. The information in the enclosure is based on the notes taken by the NRC staff during the audit. The NRC staff did not acquire any documents during the audit.

Below is a summary of the findings and conclusion.

V. SUMMARY OF FINDINGS AND CONCLUSION

Based on the NRC staff's audit of the prospective applicant's PRA documentation and related procedures, the staff drew the following conclusions:

1. The prospective applicant has developed a Level 1 and 2 PRA for internal events at power, and for low power and shutdown conditions. Based on the audit of this PRA and the responses to a number of questions from the NRC staff, it appears that the prospective applicant is on a success path to meet the NRC expectations for the development of PRA to support certification of a new reactor design. The NRC staff noted that additional work remains to complete the PRA and severe accident analyses required for design certification (e.g., analysis of internal fires and floods).
2. The PRA notebooks examined were well organized, comprehensive in scope, and contain a level of detail comparable with PRA documentation that the NRC staff has reviewed as part of recent large light-water reactor design certification reviews. The information in the notebooks appears to be consistent with the NuScale design as it is currently understood.
3. The prospective applicant appears to be building a generally clear and easily understood PRA infrastructure for further development of the PRA and use of the PRA in the design process. This provides confidence that this PRA infrastructure will be consistent with NRC expectations for the development and use of PRA to support certification of a new reactor design.
4. The shutdown PRA model structure has not changed significantly since the NRC staff's previous audit in 2011. The NRC staff did observe that time estimates for plant operating states (POS) have increased significantly which reflects a more complete understanding of the activities that will take place during each POS. The team observed that significant progress has been made in analyzing scenario(s) involving the dropping or tipping of a module during refueling operations. The possibility of such scenarios was acknowledged during the 2011 audit, but no analysis had been performed at that time.
5. A number of important PRA results and associated risk insights were established to support use by the NRC staff in planning its enhanced safety focused review of a future design certification application. This included results from a shared system assessment that described how shared systems contribute to events that may occur simultaneously on multiple modules.

VI. REFERENCES

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

LIST OF ATTENDEES

U.S. Nuclear Regulatory Commission Audit of NuScale Power, LLC Pre-Application Activities Associated with NuScale Documents on Risk Insights Drawn from the Probabilistic Risk Assessment

May 11 – 12, 2016

Gregory Cranston, U.S. Nuclear Regulatory Commission (NRC)
Lynn Mrowca, NRC
Mark Caruso, NRC
Tony Nakanishi, NRC
Gregg Clarkson, NuScale Power, LLC (NuScale)
Etienne Mullin, NuScale
Steven Pope, NuScale
Sarah Bristol, NuScale
Steven Unikewicz, NuScale
Bill Galyean, NuScale (via videoconference)
Guy Martin, NuScale (via videoconference)
Cindy Williams, NuScale (via videoconference)