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

September 13, 2018

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

FROM: Rani Franovich, Project Manager ***/RA/***
Licensing Branch 1
Division of Licensing, Siting
and Environmental Analysis
Office of New Reactors

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION AUDIT OF THE PROBABILISTIC RISK ASSESSMENT AND SEVERE ACCIDENT EVALUATION OF THE NUSCALE POWER, LLC DESIGN

As part of its safety review of the design certification application from NuScale Power, LLC (NuScale), the U.S. Nuclear Regulatory Commission (NRC) staff performed an audit of information supporting Chapters 19 and 17.4 of the final safety analysis report (FSAR) submitted with the application. In particular, the purpose of the audit was for the NRC staff to examine and evaluate documents that support responses to the staff's requests for additional information (RAIs) in Table 1. This examination and evaluation was intended to inform the NRC staff's review of the responses to the RAIs.

The audit commenced on March 6, 2018, and was originally scheduled to end on April 3, 2018. Subsequently, the audit was extended to April 24, 2018, to provide additional time to complete the audit. The audit was conducted via the NuScale electronic reading room (ERR), in NuScale's Rockville office, and through periodic telephone conversations between appropriate NRC and NuScale staff. An exit meeting was conducted on April 24, 2018, where the overall results of the audit were reported, and the ERR stayed open through May 18, 2018.

The audit was conducted per the audit plan issued March 5, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18053A216).

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Members of the audit team included the following NRC staff:

- Mark Caruso (Office of New Reactors (NRO), Audit Lead)
- Rani Franovich (NRO, Project Manager)
- Michelle Hayes (NRO, Acting Chief of Probabilistic Risk Assessment and Severe Accidents Branch)
- Jason Schaperow (NRO, Severe Accident Phenomenology)
- Marie Pohida (NRO, Probabilistic Risk Analysis)
- Tony Nakanishi (NRO, Probabilistic Risk Analysis)
- Alissa Neuhausen (NRO, Seismic/Structural)
- Shawn Campbell (Office of Nuclear Regulatory Research (RES), Severe Accident Phenomenology)
- Hossein Esmaili (RES, Severe Accident Phenomenology)
- Brad Harvey (NRO, Meteorology)
- Keith Compton (RES, Accident Analysis)
- Greg Makar (NRO, Materials/Structural)
- Leslie Terry (NRO, Materials/Structural)
- Patrick Purtscher (RES, Materials/Structural)
- BP Jain (NRO, Seismic/Structural)

Audit Activities

In accordance with the audit plan, the NRC staff examined documents supporting the RAI responses in Table 1. The complete list of documents examined by the NRC during the audit is provided in Table 2. During the course of the audit staff reviewed documents and asked questions for purposes of clarifying the information being reviewed.

The staff interacted with the following NuScale staff during audit discussions:

- James Curry (Project Manager For Audit)
- William Galyean (Probabilistic Risk Analysis)
- Sarah Bristol (Probabilistic Risk Analysis)
- Etienne Mullin (Probabilistic Risk Analysis)
- Scott Weber (Probabilistic Risk Analysis)

- Luke Mcsweeney (Probabilistic Risk Analysis)
- Grant Buster (Probabilistic Risk Analysis)

Audit Results

For four of the RAIs, the document review and the dialogue between the staff and the applicant obviated the need for a formal supplemental RAI. For six of the RAIs, the applicant provided supplemental RAI responses to address the staff's outstanding information needs. For two of the RAIs, the staff is considering alternative approaches to resolve the issue. The audit results for each of the twelve RAIs included in the audit are provided in the last column of Table 1. These results were discussed with the applicant during the audit exit meeting on April 24, 2018.

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DATE	9/13/2018	9/13/2018

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Table 1: Summary of Audit Topics and Results

NRC RAI Number	NuScale RAI Response Number	FSAR Section	Audit topic	Results
8882	RAIO-0817-55372 (ML17222A683)	19.2	Scrubbing of fission product aerosols by the reactor pool for a module drop accident.	NuScale issued supplemental RAI response RAIO-0618 (ML18165A438) to resolve outstanding issues.
8903	RAIO-0917-55876 (ML17251B163)	19.2	Bi-directional flow through reactor recirculation valves arresting core damage.	No outstanding issues.
8977	RAIO-1017-56550 (ML17284A652)	19.2	Large release definitions for at-power and shutdown (module drop) accidents.	NuScale issued supplemental RAI responses RAIO-0318-59269 (ML18085A516) and RAIO-0518-60189 (ML18145A136) to resolve outstanding issues.
9043	RAIO-1017-56516 (ML17283A413)	19.2	Corium retention in the reactor pressure vessel (RPV) lower plenum and the containment lower plenum by external cooling by water in the containment and in the reactor pool.	Due to phenomenological uncertainties, the staff continues to evaluate NuScale's conclusion that core debris retention is assured.
8889	RAIO-0118-58186 (ML18016A240)	19.1	The probability of severe accident induced steam generator tube failure.	No outstanding issues.
9112[1]	RAIO-1017-56897 (ML17303A578)	19.2	The potential for high pressure melt ejection of corium from the RPV to the containment to cause direct containment heating.	Due to phenomenological uncertainties, the staff is continues to evaluate this topic for resolution.
9367[2]	Not applicable	19.2	The NRC staff's independent MELCOR confirmatory analysis.	No outstanding issues.

NRC RAI Number	NuScale RAI Response Number	FSAR Section	Audit topic	Results
8899	RAIO-0118-58237 (ML18018B375)	19.1.5	Fragility calculations for reactor bay wall, reactor building (RBX) exterior wall, and RXB roof. Bases for screening structures, systems, and components with fragilities below the plant-level high confidence of low probability of failure.	NuScale issued a supplemental RAI response to resolve outstanding issues.
8840	RAIO-0717-55003 (ML17262B215)	19.1.4	Containment isolation for loss of coolant accidents inside containment.	NuScale issued supplemental RAI responses RAIO-0518-59975 (ML18135A269) and RAIO-0718-60731 (ML18183A554) to resolve outstanding issues.
8926	RAIO-0917-56321 (ML17272B031)	19.1.6	Dropped module consequence analysis.	NuScale issued supplemental RAI response RAIO-0518-60115 (ML18141A882) to resolve outstanding issues.
9128[1]	RAIO-0218-58534 (ML18036B203)	19.1	Module drop accident.	NuScale issued supplemental RAI response RAIO-0618-60457 (ML18165A431) to resolve outstanding issues.
8879	RAIO-0817-55698 (ML17241A139)	17.4	Expert panel decision-making process.	No outstanding issues.

Footnotes to Table 1:
[1]The applicant's responses to RAIs 9128 and 9112 were added to the audit subsequent to issuing the audit plan.
[2]The issues identified in draft RAI 9112 were resolved as a result of the audit, so the RAI was not issued as final.

Table 2: Documents in the Applicant's Electronic Reading Room

CFD SSC Classification Report – Rev2.pdf
CFDS (B191) Data Sheet – Expert Panel Approved 10-27-16 Revised 12-8-16.pdf
COR Energy Balance.pdf
CVC (B010) 2019 Data Sheet – EP Approved 9-7-17 Revised 2-8-18.pdf
CVCS SSC Classification Report Rev4.pdf
Documents Supporting PRA Audit 2_042518.pdf
ECN-P000-6271_R0_Evaluation of Additional MACCS Sensitivity Cases.pdf
ER-P010-5689_R0.pdf
ER-P020-3536_R0 with ECN.pdf
ER-P020-4450_R0 with ECN.pdf
ER-P060-5441_Rev_0.pdf
ER-P060-5441_Rev_1.pdf
ER-P060-7035 Rev 0.pdf
ER-P060-7048 Rev 0.pdf
ER-P060-7082_Rev_1_NRELAP5 Base Model.pdf
ER-P060-7085 Revision 1, Dropped Module Consequence Analysis
ECN P060-6053 Air as Fill Gas during Module Drop, Revision 0
ER_P030_5150_R0.pdf
ER_P040_5858_R0.pdf
List of Design Data Requested – Modified 3-27-2018.pdf
NuScale IVR Discussion Slides.pdf
PRA Audit 2_Question 0309-1.pdf
PRA Audit 2_Question 0315-1.pdf
PRA Audit 2_Question 0424-1 re. RAI 8977.pdf
RAI_8840_CI_Fail_Audit_Slides 2018-04-19.pdf
RBC (F011) 2109 datasheet - Expert Panel Approved 9-21-2017.pdf
RBC SSC Classification Report Rev 2- Signed.pdf
Slides - SMA_042418.pdf
TI-SGTF discussion slides Ver 3.pdf
PRA_Audit_UHS_Modeling_8840.pdf
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RAI 8926 Air as Fill Gas Slides.pdf
ECN-P060-6411, "Aerosol Contribution to Dropped Module Dose Consequence"