

August 1, 2016

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

FROM: Omid Tabatabai, Senior Project Manager /RA/
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Office of New Reactors

SUBJECT: NRC STAFF AUDIT REPORT FOR THE REVIEW OF NUSCALE
POWER, LLC, DOCUMENTS RELATED TO HIGHLY INTEGRATED
PROTECTION SYSTEM PLATFORM (PROJ0769)

From July 6, 2016 to July 7, 2016, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit of NuScale Power, LLC, (NuScale) documents related to its highly integrated protection system (HIPS) platform. The purpose of this audit was: (1) to gain a more in-depth understanding of the HIPS platform and associated prototype design documents so that staff could complete a detailed review of the HIPS topical report; and (2) to review docketed and non-docketed information related to the HIPS platform to confirm that the HIPS platform meets fundamental instrumentation and control design principles and applicable regulatory requirements.

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."

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The publically available version of the audit report and the attendee list is documented as Enclosures 1 and 2 (Agencywide Document Access and Management System (ADAMS) Accession No. ML16208A260), and the non-public (proprietary) version of the audit report is documented in Enclosure 3 (ADAMS Accession No. ML16208A527).

Project No.: PROJ0769

Enclosures:
As stated

cc: NuScale DC ListServ

M. Tonacci

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cc: NuScale DC ListServ

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ADAMS Accession Nos.:

ML16208A427- Pkg

ML16208A260 - Audit Summary Report (Public)

ML16208A527- Audit Summary Report (Non-Public) *via email* NRO-002

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NUSCALE POWER, LLC
HIGHLY INTEGRATED PROTECTION SYSTEM PLATFORM
AUDIT SUMMARY REPORT

NRC Audit Team:

- Luis Betancourt, Electronics Engineer, Audit Lead (NRO/DEIA/ICE)
- Dinesh Taneja, Senior Electronics Engineer (NRO/DEIA/ICE)
- Joseph Ashcraft, Electronics Engineer (NRO/DEIA/ICE)
- Tung Truong, Electronics Engineer (NRO/DEIA/ICE)
- David Curtis, Chief (NRO/DEIA/ICE)
- Omid Tabatabai, Senior Project Manager (NRO/DNRL/LB1)

I. Purpose

From July 6, 2016 to July 7, 2016, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit of the Highly Integrated Protection System (HIPS) platform. The purpose of this audit was: (1) to gain a more in-depth understanding of the HIPS platform and associated prototype design documents so that the NRC staff could complete a detailed review of the HIPS topical report (TR); and (2) to review docketed and non-docketed information related to the HIPS platform to confirm that the HIPS platform meets fundamental instrumentation and control (I&C) design principles and applicable regulatory requirements.

The NRC staff conducted the audit at the NuScale Power, LLC offices located at 11333 Woodglen Drive, Suite 205, Rockville, MD, 20852. The 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 December 2015, NuScale submitted a TR titled, "Highly Integrated Protection System (HIPS) Platform," for the NRC staff's review and approval (Reference 2). NuScale requested that the NRC staff review the report and approve the assertion that generic key design concepts of the HIPS platform meet the applicable regulatory requirements. The NRC staff accepted the HIPS TR for review by letter dated February 19, 2016 (Reference 3). Since docketing the TR for a detailed review, the NRC staff has held several meetings with NuScale to discuss regulatory and technical matters related to the HIPS TR. However, the NRC staff determined that an audit of NuScale's supporting documentation, including NuScale's newly developed HIPS platform prototype, was necessary to complete their review of the TR. In addition, the audit assisted the NRC staff to review and assess the HIPS platform design documents against applicable regulations and standards such as Regulatory Guide (RG) 1.75, "Criteria for Independence of Electrical Systems," and Title 10 of the *Code of Federal Regulations* 50.55a(h)(3), which requires compliance with Institute of Electrical and Electronics Engineers Standard 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations."

III. Audit Objectives

The purpose of this audit was: (1) to gain a more in-depth understanding of HIPS platform and the associated prototype design documents so that NRC staff could complete a detailed review of the HIPS TR; and (2) to review docketed and non-docketed information related to the HIPS platform to confirm that the HIPS platform meets fundamental I&C design principles and applicable regulatory requirements.

IV. Scope of the Audit

The NRC performed the audit to review NuScale's specific design documents that would provide details of the HIPS platform. The NRC staff reviewed the following documents:

- NuScale, PL-0003-3975, Revision 2, "DSS Project Plan."
- NuScale, SD-E011-1995, Revision 2, "Module Protection System (MPS) SDD."
- NuScale, ER-E011-2477, Revision 0, "MPS Hazard Analysis."
- NuScale, NP12-00-E000-I-ED-2259-S01, Revision 1, "I&C System Interconnection Diagram."
- HIPS Platform Requirements Specification, EQ-E000-3699, Revision A.
- HIPS Platform Design Specification, EQ-E000-3968, Revision A.
- Safety Function Module (SFM) Requirements Specification, EQ-E000-3705, Revision A.
- SFM Design Specification, EQ-E000-3704, Revision A.
- Equipment Interface Module (EIM) Requirements Specification, EQ-E000-3695, Revision A.
- EIM Design Specification, EQ-E000-3694, Revision A.
- Communications Module (CM) Requirements Specification, EQ-E000-3693, Revision A.
- CM Design Specification, EQ-E000-3692, Revision A.

Audit Activities and Summary of Findings

The regulatory audit began with an entrance meeting at 8:30 a.m. on Wednesday, July 6, 2016. At the entrance meeting, the NRC staff discussed the schedule of activities for the audit and the agenda. On the first day of the audit, the NRC staff examined the design description, systems specifications, and functional block diagrams of the HIPS platform (see Section IV of this

report). The NRC staff focused the review of the audit documents on the fundamental design principles. Specifically, the review was focused on these four areas: (1) independence and redundancy design concepts, (2) capabilities of the HIPS platform to eliminate/mitigate software common cause failures (CCF), (3) calibration, testing, and diagnostics capabilities of the HIPS platform, and (4) failsafe state capabilities of the HIPS platform.

Throughout the audit, the NRC staff held question-and-answer sessions with NuScale to address NRC staff's questions while reviewing documents. In addition, the NRC staff communicated with NuScale where additional information were needed to be incorporated in the TR. The exit meeting was held at 2:00 p.m. on July 7, 2016. At the exit meeting, the NRC staff further communicated the results of their document reviews and discussed revisions to the topical report and the status of request for information (RAI) responses with NuScale.

Below is a summary of the audit activities, findings, and follow-up actions:

Independence and Redundancy

The NRC staff assessed the electrical, signal path, and functional independence features of the HIPS platform. Furthermore, the NRC staff assessed the communications independence interfaces inside and outside the HIPS platform.

As a result of this audit, the NRC staff requested NuScale to include additional information in the TR as described below:

- Isolation between safety-related and nonsafety-related signals: The NRC staff requested NuScale to add a discussion in the HIPS TR regarding the separation of cables for the connectors between safety-related and nonsafety-related signals in accordance with the electrical isolation requirements in RG 1.75, "Criteria for Independence of Electrical Systems," and the International Electrotechnical Commission 60950-1: 2005, "Information Technology Equipment – Safety – Part 1: General Requirements." NuScale agreed with the NRC staff's request and will include this discussion in their response to the staff's RAI No. 3, Question 07.01 Draft DSRS-2.
- Functional Independence: The NRC staff requested NuScale to add a discussion in the HIPS TR regarding the functional independence between the safety data buses and the monitoring and indication bus. NuScale agreed with the NRC staff's request and will include this discussion in their response to the NRC staff's RAI No. 3, Question 07.01 Draft DSRS-2.
- Enable nonsafety switch: The NRC staff gained a better understanding of the functionality and the intended use of the enable nonsafety switch and nonsafety-related discrete control signals in the hard-wired module.
- Actuation and Priority Logic: The NRC staff requested NuScale to add a discussion in the HIPS TR regarding the capability of the APL circuitry to accept automatic, manual, and nonsafety enable commands. Additionally, the NRC staff asked NuScale to discuss which of these signals has the highest priority command based on the inputs. NuScale

agreed with the NRC staff's request and will include this discussion in their response to the staff's RAI No. 3, Question 07.01 Draft DSRS-2.

- Figure 3-3 of the HIPS TR: The NRC staff requested NuScale to include a legend for Figure 3-3, "Representative PS communications architecture (separation Group-A and Division I RTS and ESFAS)" of the HIPS TR. The NRC staff also asked NuScale to add a discussion in the HIPS TR regarding the dash line between safety function modules (SFMs) and the monitoring and indication bus communication module. NuScale agreed with the NRC staff's request and will add these discussions in the TR.

Software Common Cause Failures

This audit activity covered the capabilities of the HIPS platform to eliminate/mitigate software CCF. The NRC staff examined the diversity attributes within the HIPS platform design to eliminate consideration of software CCF. During these discussions, the NRC staff confirmed the primary focus of the review will be on equipment diversity.

The NRC staff made one observation during this audit activity:

- The NRC staff requested NuScale to provide a diagram in the HIPS TR to clarify and illustrate how the two different field-programmable gate array architectures mitigate and/or eliminate software common cause failures. NuScale agreed with the NRC staff's request and will include this discussion in their response to the staff's RAI No. 3, Question 07.01 Draft DSRS-4.

Calibration and Self-Testing Features and Safe State Modes

This audit activity covered how the safe states concepts as well as calibration, testing, and diagnostics features were applied to the HIPS platform. These design features include continuous self-tests, diagnostics, redundancy, and fail-safe configurability of the platform.

The NRC staff noted several observations during this audit activity:

- Technical Specifications and surveillance testing capabilities: The NRC staff requested NuScale to add a new section in the HIPS TR to discuss the capabilities of the HIPS platform to support the implementation of TS and surveillance testing. NuScale agreed and will include a new section in the TR to discuss this issue.
- Input Submodule: The NRC staff requested NuScale to add a discussion in the HIPS TR regarding the capabilities of the input submodule to send the raw input values to the monitoring and indication bus CM. In addition, discuss the use of these values to support surveillance testing. NuScale agreed and will include this discussion in their response to the NRC staff's RAI No. 3, Question 07.01 Draft DSRS-6.
- Safety Functions Module: The NRC staff requested NuScale to add a discussion in the HIPS TR regarding the SFM built-in self-testing features.

NuScale agreed and will include this discussion in their response to the NRC staff's RAI No. 3, Question 07.01 Draft DSRS-6.

- Self-Test Features: The NRC staff requested NuScale to add a discussion in the HIPS TR on how the self-testing features does not have an adverse impact on the safety functions. NuScale agreed and will include this discussion in their response to the NRC staff's RAI No. 3, Question 07.01 Draft DSRS-6.

V. CONCLUSION

Based on the documentation that the NRC staff reviewed during the regulatory audit, the staff has gained a greater understanding of the design details of the HIPS platform. The NRC staff will use the results of this audit to support staff's efforts to complete their safety evaluation report for the HIPS TR.

During the audit, the NRC staff provided feedback to NuScale personnel on topics that should be clarified in the HIPS topical report and NuScale's RAI responses. There were no open items or new RAIs identified during this audit.

VI. REFERENCES

1. NRO Office Instruction, NRO-REG-108, "Regulatory Audits," Revision 0, April 2009.
2. NuScale Power, LLC, Ltd., Topical Report 1015-18653, "Highly Integrated Protection System Platform," December 2015 (ADAMS Accession No. ML15363A114).
3. NRC letter to NuScale, "Acceptance Letter for the Review of Topical Report 1015-18653, "Highly Integrated Protection System Platform" Revision 0, (PROJ. 0769)," February 19, 2016 (ADAMS Accession No. ML16048A135).
4. NRC letter to NuScale, "Request for Additional Information Letter No. 3 -- Highly Integrated Protection System (HIPS) Platform Topical Report (TAC No. RN6110)," June 22, 2016 (ADAMS Accession No. ML16197A255).

LIST OF ATTENDEES

U.S. Nuclear Regulatory Commission Audit of NuScale Power, LLC Documents Related to HIPS Platform

July 6 - 7, 2016

Omid Tabatabai, U.S. Nuclear Regulatory Commission (NRC)
Joseph Ashcraft, NRC
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Steve Mirsky, NuScale
Brian Arnholt, NuScale
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Ryan McGee, NuScale
Carl Markert, NuScale
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Robert Temple, NuScale
Robert Gamble, NuScale
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