



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

March 16, 2020

MEMORANDUM TO: Michael I. Dudek, Chief
New Reactor Licensing Branch
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulation

FROM: Omid Tabatabai, Senior Project Manager **/RA/**
New Reactor Licensing Branch
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulation

SUBJECT: AUDIT SUMMARY REPORT FOR THE REGULATORY AUDIT
OF NUSCALE POWER, LLC DESIGN CERTIFICATION
APPLICATION, CHAPTER 20, "MITIGATION OF BEYOND-
DESIGN-BASIS EVENTS"

By letter dated December 31, 2016, NuScale Power, LLC (NuScale) submitted to the U.S. Nuclear Regulatory Commission (NRC) a Final Safety Analysis Report (FSAR) for its Design Certification Application (DCA) of the NuScale design (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17013A229).

This audit was conducted to facilitate the NRC staff's safety evaluation of DCA Chapter 20, "Mitigation of Beyond-Design-Basis Events," and Technical Report 0816-50797, "Mitigation Strategies for Extended Loss of AC Power Event;" pertaining to the station blackout transient analysis, as well as NuScale's response to Request for Additional Information 9486, Question 20.01-17. The audit entrance meeting was held on December 17, 2018, at NuScale's Rockville, Maryland office.

The audit was conducted from the NRC headquarters via NuScale's electronic reading room, the NuScale office, and via telephone conferences. The audit plan is available in ADAMS with Accession No. ML18348B076.

Docket No. 52-048

Enclosure:
As stated

cc w/encl.: DC NuScale Power LLC Listserv

CONTACT: Omid Tabatabai, NRR/DNRL
301-415-6616

SUBJECT: AUDIT SUMMARY REPORT FOR THE REGULATORY AUDIT OF NUSCALE POWER, LLC DESIGN CERTIFICATION APPLICATION, CHAPTER 20, "MITIGATION OF BEYOND-DESIGN-BASIS EVENTS"
DATED: March 16, 2020

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ADAMS Accession No.: ML20076D885 ***via email** **NRR-106**

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**AUDIT REPORT FOR THE REGULATORY AUDIT OF NUSCALE POWER, LLC
FSAR NON-DOCKETED INFORMATION IN SUPPORT OF THE U.S. NUCLEAR
REGULATORY COMMISSION STAFF'S REVIEW OF NUSCALE DESIGN
CERTIFICATION APPLICATION, PART 2, CHAPTER 20, "MITIGATION OF
BEYOND-DESIGN-BASIS EVENTS"**

DOCKET NO. 52-048

I. INTRODUCTION AND BACKGROUND

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

To facilitate the NRC staff's evaluation of information supporting the FSAR, and to complete its safety review of portions of FSAR Chapter 20, "Mitigation of Beyond-Design-Basis Events," and Technical Report 0816-50797, "Mitigation Strategies for Extended Loss of AC Power Event;" pertaining to the station blackout (SBO) transient analysis, the NRC staff performed this audit to further evaluate NuScale's response to RAI 9486, Question 20.01-17.

II. REGULATORY AUDIT BASES

Under Title 10 of the *Code of Federal Regulations* Section 52.47(a)(2) states that a DCA must contain an FSAR that includes:

A description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," states:

Section 3.2.1.7 of Nuclear Energy Institute (NEI) 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, specifies that strategies "that have a time constraint to be successful should be identified and a basis provided that the time can reasonably be met."

Also, NEI 12-06, Section 3.2.1, "General Criteria and Baseline Assumptions," provides the general criteria and assumptions to be used in establishing the baseline coping strategy. Past regulatory precedence have included the need for reactor designs, including other passive

designs, to demonstrate the success of the strategies or include the ability to indicate core conditions.

III. AUDIT PURPOSE

The purpose of the audit was to confirm the basis for the safety conclusions made in the applicant's DCA Tier 2, Chapter 20 mitigation strategies for extended loss of alternating current (AC) power transient analyses. This includes an evaluation of the methodology of supporting calculations related to the FSAR Chapter 20 transient analyses for the mitigation strategies for extended loss of AC power and referenced SBO transient analyses.

IV. AUDIT LOCATION AND DATES

The audit was conducted from the NRC headquarters via NuScale's Electronic Reading Room (eRR).

Date: December 17, 2018 through January 11, 2019

Locations: NRC Headquarters
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738
NuScale eRR

V. AUDIT TEAM MEMBERS

John Budzynski (NRR, Audit Lead)
Jeffrey Schmidt (NRR)
Rebecca Patton (NRR, Branch Chief)
Donald Palmrose (NRR)
Timothy Drzewiecki (NRR)
Carl Thurston (NRR)
Ryan Nolan (NRR)
Omid Tabatabai (NRR, Senior Project Manager)

VI. APPLICANT AND INDUSTRY STAFF PARTICIPANTS

Carrie Fosaaen
Chris Maxwell
Nadja Joergensen

VII. DOCUMENTS AUDITED

1. EC-0000-3070, "Station Blackout Analysis"

2. ER_0000_00003573_00, "Extended Loss of Alternating Current Power Assessment"

VIII. DESCRIPTION OF AUDIT ACTIVITIES AND SUMMARY OF OBSERVATIONS

EC-0000-3070, "Station Blackout Analysis"

The NRC staff re-examined engineering calculation EC-0000-3070, "Station Blackout Analysis." The staff reviewed emergency core cooling system (ECCS) valve inputs and agreed use of nominal averaged area and flow coefficient were acceptable for beyond-design-basis calculations. The staff also reviewed oscillatory behavior and determined that the overall effects, typical for NRELAP5 calculation due to manometric responses, were not of significance.

ER 0000 00003573 00, "Extended Loss of Alternating Current Power Assessment"

The NRC staff examined ER-0000-00003573 to better understanding the methodology and analysis supporting NuScale's position that during equilibrium ECCS operation, the water levels in the riser, downcomer, and containment vessel are all closely coupled with oscillations in the downcomer level to cause corresponding oscillations in the reactor recirculation valve liquid flow rate with flow reversal. The staff notes that the analysis demonstrates that the mechanism for transferring decay heat to the decay heat removal system (DHRS) during riser uncover is self-balancing. If internal recirculation and riser heat transfer are insufficient to remove decay heat, coolant in the riser will remain sufficiently heated to sustain some normal circulation in addition to some internal circulation. In the long term, quasi-equilibrium conditions will be established at the coolant level, temperature, and flow necessary to remove decay heat through the DHRS. The staff also notes that while oscillations can occur, core critical heat flux and fuel cladding temperatures have significant margin to the safety limits.

IX. EXIT BRIEFING

The NRC staff conducted an audit closeout meeting on January 11, 2019. At the exit briefing the NRC staff reiterated the purpose of the audit and discussed their activities. The staff also informed NuScale that the staff would not be able to complete and exit its audit due to ongoing and evolving design issues associated with Chapter 15 review.

X. REQUESTS FOR ADDITIONAL INFORMATION RESULTING FROM AUDIT

As a result of the audit, the staff requested NuScale to docket supporting documentation regarding the riser uncover phenomena. Subsequently, NuScale supplemented the responses to Request for Additional Information (RAI) 9486, Question 20.01-17, and a related RAI 9508, Question 15-7.

XI. OPEN ITEMS AND PROPOSED CLOSURE PATHS

None. NuScale submitted its supplemental response to RAI 9486, Question 20.01-17, on March 28, 2019 (ADAMS Accession No. ML19087A325) and a supplemental response to 9508, Question 15-7 on March 14, 2019 (ADAMS Accession No. ML19073A284).

XII. DEVIATIONS FROM THE AUDIT PLAN

None

XIII. REFERENCES

1. Letter from NuScale Power, LLC, "NuScale Power, LLC Submittal of the NuScale Standard Plant Design Certification Application," December 31, 2016 (ADAMS Accession No. ML17013A229).
2. NRO-REG-108, "Regulatory Audits," April 2, 2009 (ADAMS Accession No. ML081910260).
3. Audit Plan for Regulatory Audit of NuScale Power, LLC, Final Safety Analysis Report – Chapter 20, "Mitigation of Beyond Design-Basis Events," ADAMS Accession No. M17356A120, December 27, 2017.
4. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, December 2015.