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

December 18, 2017

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

FROM: Anthony W. Markley, Senior Project Manager ***/RA/***
Licensing Branch 1
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Office of New Reactors

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION STAFF REPORT FOR THE AUDIT OF REVISION 2 TO TOPICAL REPORT-0915-17565-P, "ACCIDENT SOURCE TERM METHODOLOGY" FOR NUSCALE POWER, LLC"

From October 10 through October 17, 2017, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit of Revision 2 to NuScale Power, LLC (NuScale) Topical Report (TR)-0915-17565-P, "Accident Source Term" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17254B067).

The purpose of this audit was to review NuScale's use of its NARCON atmospheric dispersion model as described in TR-0915-17565-P for the calculation of design-basis event offsite atmospheric dispersion factors. The audit focused on adherence to the χ/Q selection criteria provided in Revision 1 to Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants." The NRC staff conducted its audit at NuScale's offices in Rockville, Maryland and also reviewed documents in NuScale's electronic reading room.

The staff's audit plan, dated October 5, 2017, is available ADAMS under Accession No. ML17277A850. The NRC staff conducted the audit in accordance with the Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits."

Docket No.: PROJ0769

Enclosure:
As stated

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SUMMARY OF STAFF AUDIT OF REVISION 2 TO TOPICAL REPORT TR-0915-17565-P, "ACCIDENT SOURCE TERM METHODOLOGY" FOR NUSCALE POWER, LLC

NRC AUDIT TEAM:

- Brad Harvey (NRO, Audit Lead)
- Jason D. White, (NRO, Meteorologist)
- Anthony W. Markley (NRO, Senior Project Manager)

1. SUMMARY

From October 10 through October 17, 2017, the U.S. Nuclear Regulatory Commission (NRC) staff from the Meteorology and Oceanography Team conducted an audit of Revision 2 to the NuScale Power, LLC (NuScale) Topical Report (TR) "Accident Source Term Methodology," TR-0915-17565-P (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17254B067). The TR-0915-17565-P describes a generalized methodology for developing accident source terms and performing the corresponding radiological consequence analyses for design-basis accidents (DBAs).

This audit focused on reviewing NuScale's use of their NARCON atmospheric dispersion computer code for the calculation of design-basis event offsite atmospheric dispersion factors (χ/Q values) and the code's adherence to the χ/Q selection criteria provided in Revision 1 to Regulatory Guide (RG) 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants." The NRC staff's review of the NARCON computer code and related documentation concluded the code can be executed in adherence to the χ/Q selection criteria provided in RG 1.145.

2. BACKGROUND AND SCOPE

By letter dated September 11, 2017, NuScale submitted Revision 2 of the licensing TR "Accident Source Term Methodology," TR-0915-17565-P, to the NRC for review and approval (ADAMS Accession No. ML17254B067). Revision 2 to the TR incorporated responses to several Requests for Additional Information (ADAMS Accession Nos. ML17037D39, ML17081A561, ML17205A485, and ML17236A528) that were submitted to NuScale by the NRC staff.

The TR-0915-17565-P describes a generalized methodology for developing accident source terms and performing the corresponding radiological consequence analyses for DBAs. The TR includes specifying the methodology NuScale intends to use to derive the accident release atmospheric dispersion site parameters values at the owner controlled area security fence for the NuScale Design Certification (DC) application. NuScale plans to postulate in its DC application an exclusion area boundary (EAB) and outer boundary of the low population zone (LPZ) that are at the security owner controlled area fence. The TR methodology is also

intended to be used by subsequent combined license applicants that references the NuScale design to derive their corresponding site characteristic values.

This audit focused on evaluating NuScale's use of the ARCON96 computer code dispersion algorithms (NUREG/CR-6331, Revision 1, "Atmospheric Relative Concentrations in Building Wakes") for calculating offsite χ/Q values (position 1 in Section 1.2, Scope, of the TR) rather than the computer code PAVAN (NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations"). Both PAVAN and ARCON96 are NRC-sponsored codes approved for calculating relative concentration values (also known as atmospheric dispersion factors or χ/Q values). PAVAN implements the guidance provided in RG 1.145 for determining χ/Q values offsite at the EAB and outer boundary of the LPZ whereas ARCON96 implements the guidance provided in RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," for determining onsite χ/Q values for the control room (CR). In order to implement the TR-0915-17565 methodology, NuScale developed its own version of ARCON96, called NARCON.

The NRC staff concentrated its review on NARCON's adherence to the χ/Q selection criteria provided in Revision 1 to RG 1.145. The NRC staff conducted its review by performing the following:

- Reviewing documentation for Version 1.0.3 of the NARCON computer code
- Reviewing the calculation being used to update the NuScale DC Final Safety Analysis Report (FSAR) Tier 1, Table 5.0-1, and Tier 2, Table 2.0-1 accident release χ/Q site parameter values at the security owner controlled area fence using Version 1.0.3 of the NARCON computer code
- Executing its own test cases using Version 1.0.3 of the NARCON computer code (the intent of these tests cases was not to perform a rigorous verification of the model but rather review the resulting trends in χ/Q values for reasonableness)

3. REGULATORY REQUIREMENTS

For DC applicants, the regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) 52.47(a)(2)(iv) state that a DC application must contain an assessment of the plant design features intended to mitigate the radiological consequences of accidents, which includes consideration of postulated site meteorology, to evaluate the offsite radiological consequences at the EAB and LPZ. Regulation 10 CFR 52.47(a)(1) also requires a DC applicant to provide site parameters postulated for the design. Site parameters are the postulated physical, environmental and demographic features of an assumed site and are specified in a DC. A DC typically contains site parameters related to accident release χ/Q values at the EAB and LPZ.

4. RELEVANT GUIDANCE

- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," provides review guidance that the NRC staff finds acceptable in meeting the applicable regulatory requirements. In particular, Section 2.3.4, Revision 3, "Short-term Atmospheric Dispersion Estimates for Accident Releases," of NUREG-0800 contains guidance relevant to this review.

- RG 1.145 provides guidance on appropriate dispersion models for estimating offsite relative air concentrations (χ/Q values) as a function of downwind direction and distance (i.e., at the EAB and LPZ) for various short-term time periods (up to 30 days) after an accident.

- RG 1.194 discusses acceptable approaches for estimating short-term (i.e., 2 hours to 30 days post-accident) average χ/Q values in the vicinity of buildings at CR ventilation air intakes and at other locations of significant air in-leakage to the CR envelope due to postulated design-basis accidental radiological airborne releases.

- RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," Revision 1, includes guidance on the measurement and processing of onsite meteorological data for use as input to atmospheric dispersion models in support of plant licensing and operation.

- NUREG/CR-6331 is the user's manual for the NRC-sponsored ARCON96 dispersion model, which is referenced in RG 1.194.

- NUREG/CR-2858 is the user's manual for the NRC-sponsored PAVAN dispersion model, which implements the guidance provided in RG 1.145.

5. OBSERVATIONS AND EVALUATIONS

The NRC staff examined the following documents and performed the following activities at the NuScale Office in Rockville, Maryland.

a. Documentation for the NARCON Atmospheric Dispersion Code

The NRC staff reviewed the *NARCON Software Release Note* (Document No. SwRN-0304-14163, Revision 4) and the *NARCON Software User's Manual* (Document No. SwUM-0304-113018, Revision 2) for Version 1.0.3 of the NARCON computer code. Based on the information provided in these documents, the NRC staff concluded that NARCON can be executed in adherence to the χ/Q selection criteria discussed in RG 1.145.

b. Calculation Updating the NuScale DC FSAR Accident Release χ/Q Values at the Security Owner Controlled Area Fence

The NRC staff reviewed the *Offsite Atmospheric Dispersion Factors* document (EC-0000-1351, Revision 3), whose purpose is to provide the χ/Q values to be used in design-basis event offsite radiological consequence analyses for the EAB and the outer boundary of the LPZ using Version 1.0.3 of NARCON. This document lists inputs and assumptions used to derive the accident χ/Q values, which included:

- Defining the EAB and outer boundary LPZ distances as the security fence at the owner controlled area boundary. Between the reactor building and turbine building, the turbine building south wall was identified as closest to the site boundary at a distance of 400 feet (121.92 meters).

- Using meteorological data representative of an 80-90th percentile U.S. site (data from Sacramento, CA, for 1984-1986 were used for this purpose as determined by NuScale's

Determination of 80-90th Percentile Meteorological Data for U.S. Sites document No. EE-0000-3547, Revision A).

- Using other input assumptions such as a ground level release.

The NRC staff reviewed the input assumptions and found them to be either conservative and/or in compliance with guidance provided in RG 1.145 and RG 1.194.

A building area test case in document EC-0000-1351 demonstrated that smaller building areas result in slightly larger and more conservative concentrations.

The NRC staff reviewed the resulting χ/Q values from document EC-0000-1351 and found that there was little to no change in χ/Q values as a function of direction sector at 0.5 miles for the 0-2 hour, 2-8 hour, 8-24 hour, and 1-4 day χ/Q values. NuScale explained during the audit that this is a result of the confluence of three factors: (1) for downwind distances exceeding 600 meters, the largest χ/Q values occur during low wind speed conditions; (2) the Sacramento 1984-1986 meteorological data base contains a large percentage of calm winds; and (3) all receptors regardless of direction sector are considered to be downwind during calm conditions. The NRC found that this is a reasonable explanation as to why there was little to no change in sector χ/Q values at 0.5 miles (805 meters).

The NRC staff also reviewed the NuScale Determination of 80-90th Percentile Meteorological Data for U.S. Sites document (Document No. EE-0000-3547, Revision A). This study used NARCON to examine hourly surface meteorological data and twice daily mixing height data from National Weather Service (NWS) stations located throughout the U.S. to identify the 80-90th percent 0-2 hour χ/Q value. NuScale found that meteorological data from Sacramento, CA for 1984-1986 represented the 80-90th percentile U.S. site and used these data to calculate the χ/Q values presented in document EE-0000-3547.

The NRC staff used an excel spreadsheet to review the NWS 1984 Sacramento meteorological data set. The NRC staff found the stability class frequency distribution to be reasonable (e.g., a generally normal distribution centered on neutral (D) stability). The wind directions were somewhat bi-focal, with maximums occurring with wind directions from 40 degrees (6.6%) and 150 degrees (5.6%) and a minimum with wind directions from 220 degrees (0.4%). The wind speed distribution (which was reported to the nearest whole knot) was typical for a NWS site using wind sensors with a high starting threshold, with 13.7 percent recorded as calm (zero knots), no recordings for one knot, and 0.2 percent recordings at two knots. The most frequent wind speed was 13.6 percent at 5 knots.

c. NRC Staff NARCON Test Cases

The NRC staff executed Version 1.0.3 of the NARCON model using data from six nuclear power plant sites. These test cases provide some assurance that the NARCON code is operating as intended to implement the χ/Q selection criteria discussed in RG 1.145.

6. CONCLUSION

The NRC staff reviewed the documentation for the latest version of the NARCON computer code (Version 1.0.3) and executed several runs of the computer code. The staff found the code can be executed in adherence to the χ/Q selection criteria provided in RG 1.145.