RAIO-0518-60189

May 24, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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11555 Rockville Pike
Rockville, MD 20852-2738

**SUBJECT:** NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 168 (eRAI No. 8977) on the NuScale Design Certification Application

**REFERENCES:**

1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 168 (eRAI No. 8977)," dated August 12, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 168 (eRAI No.8977)," dated October 11, 2017
3. NuScale Power, LLC Supplemental Response to NRC "Request for Additional Information No. 168 (eRAI No. 8977)," dated March 26, 2018

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) supplemental response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 8977:

- 19-27

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Paul Infanger at 541-452-7351 or at pinfanger@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8977

**Enclosure 1:**

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8977

NuScale Power

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 8977
**Date of RAI Issue:** 08/12/2017

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**NRC Question No.:** 19-27

**Regulatory Basis**
10 CFR 52.47(a)(27) states that a Design Certification (DC) application must contain a Final Safety Analysis Report (FSAR) that includes a description of the design-specific Probabilistic Risk Assessment (PRA) and its results. 10 CFR 52.47(a)(23) states that a DC application for light-water reactor (LWR) designs must contain an FSAR that includes a description and analysis of design features for the prevention and mitigation of severe accidents (e.g., challenges to containment integrity caused by core- concrete interaction, steam explosion, high-pressure melt ejection, hydrogen combustion, and containment bypass). For staff to make a finding that the applicant has performed an adequate evaluation of the risk from severe accidents in accordance with Standard Review Plan (SRP) 19.0, the applicant is requested to respond to the questions below.

**Request for additional information**

a. The applicant used a large release frequency metric of less than 10-6 large releases per year and defined a large release as an acute exposure of greater than 200 rem to an individual located at a distance of 0.167 miles from the reactor for 96 hours. SRP 19.0 directs the staff to determine whether the applicant has adequately demonstrated that the risk associated with the design compares favorably against the Commission's goals. In order to make this finding, the applicant is requested to add information to Chapter 19 of the NuScale FSAR to demonstrate its large release frequency metric, including its large release definition, is equivalent to or less than the Commission's Safety Goal Policy's quantitative health objective for prompt fatality risk.
b. The applicant is requested to clarify the text in Chapter 19 of the FSAR by adding the following:
    a. Identify the scenarios in which the applicant compared the predicted dose directly against the large release definition of 200 rem at 0.167 miles to classify whether the scenario results in a large release.
    b. Identify the scenarios in which the applicant compared the predicted radionuclide release against the MACCS back-calculated radionuclide release equivalent to the large release definition of 200 rem at 0.167 miles to classify whether the scenario results in a large release.

c. For at-power accidents, “Probabilistic Risk Assessment Large Release Frequency Definition,” ER- P000-7004-R0, and “Release Fraction Determination for PRA Large Release,” ER-P000-7005, describe (1) the use of MACCS to translate the large release definition of 200 rem over 96 hours into an equivalent environmental radionuclide release and (2) a hand calculation showing that releases from a leaking containment (as opposed to a failed containment) are smaller than this (i.e., less than a large release). In the FSAR, the applicant used the iodine release fraction as the metric for this comparison. The applicant is requested to add clarifying information to Chapter 19 of the FSAR describing how the following were addressed in this comparison: (1) other aspects of the environmental release such as release timing, release rate, other radionuclides (e.g., cesium) and (2) other potentially important phenomena such as changes in wind direction during the 96- hour exposure period.

d. “Code Manual for MACCS2,” NUREG/CR-6613, Vol. 1, states “The dispersion of a plume of material released in the wake of a building is subject to a large degree of uncertainty. For that reason, MACCS should not be used for estimating doses at distances of less than 0.5 km [0.31 miles] from laboratory or industrial-facilities.” The applicant’s discussion on page 10 of “Probabilistic Risk Assessment Large Release Frequency Definition,” ER-P000-7004-R0, indicates that the applicant recognized this uncertainty and attempted to address it by applying a building wake model to both the short and long faces of the reactor building and identifying the largest dose. The applicant is requested to add information to Chapter 19 of the FSAR describing its validation of the assumptions and input used in its MACCS predictions of plume concentration at 0.167 miles from the reactor for its large release assessment. The information should include a discussion of its parameterization of the spatially dependent dispersion parameters (sigma-y and sigma-z) in MACCS’s Gaussian plume model and its treatment of meteorological phenomena such as building wake, plume lift, and meander, as applicable.

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**NuScale Response:**

NuScale is supplementing its response to RAI 8877 (Question 19-27) originally provided in letter RAIO-1017-56550 (dated October 11, 2017) and supplemented in letter RAIO-0318-59269 (dated March 26, 2018). This supplemental response is provided as a result of discussions with the NRC during the PRA audit that began on March 06, 2018 (ML18053A216).

<u>Letter RAIO-1017-56550: The first paragraph of the response to Item d) provided in letter RAIO-1017-56550 is replaced with:</u>

Validation of plume modeling within 0.31 miles of the release was accomplished through a comparison of MACCS plume dispersion results with an independent atmospheric transport and dispersion code previously accepted by the NRC for use in the presence of building wakes at distances near the site boundary (i.e., ARCON96). The results were compared for an identical ground level release from the short face of the reactor building using meteorological data from five different sites across the U.S. The results show that the mean of the MACCS calculated relative plume radiocuclide concentrations at and beyond the site boundary distance are equal to or greater than the mean of the ARCON96 calculated relative plume radionuclide concentrations for the same weather data.

FSAR Section 19.1.4.2.1.4 has been modified to reflect this response

Letter RAIO-0318-59269: The following paragraph of the response to Item c) provided in letter RAIO-0318-59269:

> The SAND2011-0128 release fractions are comparable to the NuScale design-specific release fractions from the design basis source term (FSAR Table 12.2-29). Additionally, following the methodology outlined in Steps 1 through 5, and replacing the SAND2011-0128 source term with the NuScale design basis source term release, results in a similar iodine large release fraction. Therefore, the SAND2011-0128 source term is judged to be applicable to the NuScale design for the purpose of determining the large release fraction threshold to the environment.

Is replaced with:

> The SAND2011-0128 release fractions are comparable to the NuScale design-specific release fractions from the design basis source term (DBST); the DBST is referenced in FSAR Section 15.0.3.3.4. Additionally, following the methodology outlined in Steps 1 through 5, and replacing the SAND2011-0128 source term with the NuScale design basis source term, results in a similar iodine large release fraction. Therefore, the SAND2011-0128 source term is judged to be applicable to the NuScale design for the purpose of determining the large release fraction threshold to the environment.

**Impact on DCA:**

FSAR Section 19.1.4.2.1.4 has been revised as described in the response above and as shown in the markup provided in this response.

Because the CNV is maintained at a vacuum, so that CNV leaks or isolation failures can be readily detected and addressed, small penetration failures or leaks are not considered as contributors to containment isolation failure.

Table 19.1-24 summarizes containment penetrations, the isolation method and treatment in the PRA.

#### 19.1.4.2.1.4 Release Categories

The Level 2 event tree, provided as Figure 19.1-15, is completed by defining the end state of each sequence. The figure provides three end states, "CD", "NR" and "LR." The end state "CD" allows quantification of the CDF as it summarizes the sequences transferred from the Level 1 event trees. The end state "NR" represents a core damage sequence with intact containment; for this end state, the potential radionuclide release is due to allowable leakage as defined by the Technical Specifications. The "LR" end state represents a large release. Due to the small core used in the design, additional release categories to reflect a range of release possibilities were judged to be unnecessary. The release categories are:

- RC1 is core damage with successful containment isolation.
- RC2 is core damage with containment bypass or failure of containment isolation.

RAI 19-27S1

The large release frequency (LRF) is the quantified result of the Level 2 PRA, and is used to demonstrate conformance with the safety goal promulgated in NRC policy statement (Reference 19.1-36). While various definitions of “large release” have been considered, there is not an established consensus definition. The definition used in the NuScale PRA is based on a threshold radionuclide dose that could result in early injuries.

RAI 19-27S1

Specifically, NUREG-0396 (Reference 19.1-9) specifies 200 rem whole body dose as the dose at which significant early injuries start to occur. This dose was used as the basis for defining a “large release” in terms of a hypothetical individual located at the site boundary; in the NuScale PRA, the “site boundary” is a best-estimate distance and is defined as one-half of the shortest site dimension, which is approximately 884 feet (0.167 miles).

RAI 19-27S1, RAI 19-27S2

Based on simulation results using the MACCS code (Reference 19.1-10), and following Steps 1 through 5 below, a release fraction of 2.9 percent of the iodine core inventory results in an acute 200 rem whole body (red marrow) mean dose over all weather trials at the site boundary. The mean MACCS plume dispersion relative radionuclide concentration results are equal to or greater than those provided by the ARCON96 code (described in Section 15.0.2) at and beyond the site boundary.