February 14, 2018

Docket No. 52-048

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

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 351 (eRAI No. 9259) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 351 (eRAI No. 9259)," dated January 29, 2018

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

The Enclosure to this letter contains NuScale's response to the following RAI Question from NRC eRAI No. 9259:

- 12.02-26

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 Steven Mirsky at 240-833-3001 or at smirsky@nuscalepower.com.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Anthony Markley, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9259

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NuScale Response to NRC Request for Additional Information eRAI No. 9259

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

eRAI No.: 9259
Date of RAI Issue: 01/29/2018

NRC Question No.: 12.02-26

Regulatory Basis

10 CFR 52.47(a)(5) requires applicants to identify the kinds and quantities of radioactive materials expected to be produced during operation and the means for controlling and limiting radiation exposures within the limits set forth in 10 CFR Part 20.

10 CFR 20.1101(b) and 10 CFR 20.1003 require the use of engineering controls to maintain exposures to radiation as far below the dose limits in 10 CFR Part 20 as is practical. 10 CFR 20.1204, “Determination of Internal Exposure”; 10 CFR 20.1701, “Use of Process or Other Engineering Controls”; and 10 CFR 20.1702, “Use of Other Controls,” as they relate to design features, ventilation, monitoring, and dose assessment for controlling the intake of radioactive materials. NuScale DSRS section 12.2, “Radiation Source,” regarding the identification of isotopes and the methods, models and assumptions used to determine dose rates.
The Acceptance Criteria provided in NuScale DSRS section 12.3, “Radiation Protection Design Feature,” provides guidance to the staff for evaluating the potential for airborne radioactivity areas within the facility.

Background

NuScale Design Control Document (DCD) Tier 2 Revision 0, subsection 12.2.1, “Contained Sources,” states that the contained radiation sources are developed for normal operation and shutdown conditions and are based on the design basis primary coolant activity concentrations from DCD Tier 2, Section 11.1.

DCD Section 12.2.1.8, “Reactor Pool Water,” states that the radionuclide contribution resulting from neutron activation of the reactor pool water contents is not significant due to the reduced neutron flux in the reactor pool water. DCD Section 12.2.1.8 further states that the neutron flux at the outside edge of the containment vessel was calculated to be approximately six orders of magnitude less than the average neutron flux in the core, and continues to quickly decrease in the reactor pool’s borated water. The small amount of neutron activation products in the reactor pool water was calculated to be insignificant compared to the amount of primary coolant radionuclides released to the reactor pool water during refueling outages.

While DCD Table 12.2-1, “Core and Coolant Source Information,” provides some information

about neutron production rates in the core, insufficient information is available to support the statement regarding the quantity of neutrons making it to the pool water that was made by the applicant in DCD Section 12.2.1.8.

The impact of tritium production is presented through a number of tables contained in the application including:

- DCD Table 12.2-10, “Reactor Pool Cooling, Spent Fuel Pool Cooling, Pool Cleanup and Pool Surge Control System Component Source Terms - Radionuclide Content,” which lists the tritium concentration values for the reactor pool water and the pool surge control system (PSC) Surge Tank.
- DCD Tier 2 Revision 0, Table 12.2-32, “Input Parameters for Determining Facility Airborne Concentrations,” which provides the parameters for determining facility airborne activity concentrations, including tritium,
- DCD Table 12.2-33, “Reactor Building Airborne Concentrations,” which lists the tritium airborne concentration in the reactor building (RXB).

The staff acknowledges that there is some validity to the statement by the applicant that the small amount of neutron activation products in the reactor pool water may be insignificant when compared to the amount of primary coolant radionuclides released to the reactor pool water during refueling outages.

The staff expects that all the neutrons exiting the Nuclear Power Modules (NPM) will be absorbed in one or more of the materials in the pool water. Based on the review of information made available to the staff during the RPAC Chapter 12 Audit, the staff determined that the applicant did not consider how the production of deuterium through the adsorption of a neutron by mono- nucleon Hydrogen would increase the atomic abundance of deuterium in the UHS pool water over time. The increase in the atomic abundance of deuterium results in a change in the macroscopic cross section of deuterium used to determine the amount of tritium produced by activation of water. The macroscopic cross section of deuterium is based on the microscopic cross section of deuterium (which does not change) and the relative atomic abundance of deuterium. Based on the staff review of information made available to the staff during the RPAC Chapter 12 Audit, the staff determined that the applicant used a fixed macroscopic cross section of deuterium for the production of tritium in the pool water.

Key Issue 1:

Because the methodology used by the applicant to calculate the tritium production rate in the UHS pool water does not account for the change in atomic abundance of deuterium in the UHS pool water over time, it underestimates the total production of tritium due to neutron activation of water. Since airborne tritium concentrations in the RXB are directly dependent on the UHS pool tritium concentration, the airborne tritium activity concentrations in the RXB may be underestimated.

Question 1:

To facilitate staff understanding of the application information sufficient to make appropriate

regulatory conclusions, the staff requests that the applicant:

- Please explain how tritium production due to neutron activation will be addressed to account for the change in atomic abundance of deuterium as described above,
- As necessary, revise DCD Section 12.2.1.8 to include a description of the revised methodology, that reflect the assumptions related to the buildup of deuterium and resultant increase over time,
- As necessary, revise DCD Section 12.2.2, “Airborne Radioactive Material Sources,” to reflect the changes to RCS tritium concentration and the associated bases,
- As necessary, revise DCD Table 12.2-10, DCD Table 12.2-32 and DCD Table 12.2-33 to reflect the changes in UHS pool and RXB airborne tritium concentrations resulting from accounting for the buildup of deuterium,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

A study of the consequence of deuterium buildup in the ultimate heat sink (UHS) over the life of the plant due to neutron activation in the pool water due to reactor operations was performed. Specifically, this study evaluated the consequence of increased tritium production in the pool water from reactor operations due to a conservatively modeled buildup of deuterium. The study calculated the maximum theoretical deuterium abundance in the pool from the activation of hydrogen. The study calculated the total production rate of deuterium in the reactor coolant system (RCS) and ultimate heat sink pool (UHS) and then balanced it with the removal rate from pool evaporation, to determine an equilibrium concentration of deuterium. The equilibrium deuterium concentrations were used in the tritium production calculation from the activation of deuterium in the RCS and the pool.

The resultant increase of tritium production in the pool water due to deuterium activation following 60 years of operation was 0.4%, from 5.53E-8 μCi/s to 5.55E-8 μCi/s. This production rate, when added to the production rates of tritium from other reactions, does not result in a reportable change; the total production rate of tritium from activation of the UHS is 4.37E-05 μCi/s, almost three orders of magnitude larger than the tritium production from deuterium activation in the pool water.

As there is essentially no change to the total production rate of tritium in the UHS from deuterium production, there is no need to change the FSAR to address changes in method, or the results of tritium activity in sources described in FSAR 12.2.

Changes to the RCS concentration of tritium from the buildup of deuterium and the consequence of these changes to the airborne radioactive material source are addressed in the response to eRAI #9270.

Impact on DCA:

There are no impacts to the DCA as a result of this response.