NuScale Power

RAIO-0318- 59010

March 6, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 348 (eRAI No. 9300) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 348 (eRAI No. 9300)," 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. 9300:

- 12.03-28

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,

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9300

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NuScale Response to NRC Request for Additional Information eRAI No. 9300

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

eRAI No.: 9300
Date of RAI Issue: 01/29/2018

NRC Question No.: 12.03-28

Regulatory Basis

10 CFR 52.47(a)(5) requires applicants to identify the kinds and quantities of radioactive materials expected to be produced in the operation and the means for controlling and limiting radiation exposures within the limits of 10 CFR Part 20. 10 CFR Part 20 requires the use of engineering features to control and minimize the amount of radiation exposure to members of the public and occupational workers, from both internal and external sources. 10 CFR 50.49(e)(4) requires applicants to identify the type of radiation and the total dose expected during normal operation over the installed life of the equipment. GDC 4 requires applicants to ensure that structures, systems, and components important to safety are designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation. NuScale DSRS 12.2 DSRS Acceptance Criteria states that the applicant should describe the radiation fields in sufficient detail for evaluating the inputs to shielding codes and the establishment of facility design features. The characteristics of the radiation fields evaluated during the staff review under NuScale DSRS 12.2, are used as inputs for the evaluation performed by the staff for NuScale DSRS 12.3-12.4, related to the acceptability of the shielding design, the establishment of radiation zones, the impact on systems, structures and components, and the activation of material.

Background

NuScale DCD, Tier 2 Revision 0, subsection 12.2.1.1 “Reactor Core,” states that the fission neutron, n-gamma and fission gamma source strength and neutron energy spectrum information are provided in Table 12.2-1.DCD Table 12.2-1 states that the Fission gamma source strength is 1.81E+20 particles/sec. However, NuScale Technical Report TR-0116-20781-P Rev. 0 “Fluence Calculation Methodology and Results,” does not provide any information about photon/gamma strength nor spectrum information.

DCD Table 12.2-1 states that Fission neutron source strength is 2.37E+19 particles/sec, and later states that the Fission neutron n- gamma source strength is 2.37E+19 particles/sec. It is not discernible to the staff the intended difference between the two listed parameters, and how each value is expected to be used. In the case of the Fission neutron n-gamma source strength parameter, it is not evident if or how it is related to the Fission gamma source strength, which Table 12.2-1 shows as 1.81E+20 particles/sec.

TR-0116-20781-P section 3.5 Neutron Source, states that the calculated fission neutron intensity for the NPM is estimated as 1.24E+19 neutrons per second. However, DCD Table 12.2-1 states that Fission neutron source strength is 2.37E+19 particles/sec, because clarifying information (e.g., peaking factor, enrichment, etc.) was not provided, it is not apparent to the staff how the value in table 12.2-1 was calculated.

The neutron spectrum and flux information evaluated during the staff review under NuScale DSRS 12.2, are subsequently used as inputs for the evaluation performed by the staff for NuScale DSRS 12.3-12.4 and DSRS 3.11, related to the acceptability of the shielding design, the establishment of radiation zones, the impact on systems, structures and components, and the activation of material. NuScale DSRS 12.2 Acceptance Criteria, states that the source descriptions should include all pertinent information required for input to shielding codes used in the design process, establishment of related facility design features, and determination of radiation dose to electrical equipment important to safety as described in 10 CFR 50.49, and GDC 4, as well as the controlling radiation exposure to workers, consistent with 10 CFR 20 and GDC 61. DSRS 12.2 also states that unless described within other sections of the FSAR, source descriptions should include the methods, models, and assumptions used as the bases for all values provided in FSAR Section 12.2. These acceptance criteria are consistent with the relevant requirements of 10 CFR Part 50 and 10 CFR Part 52.

Key Issue: The neutron flux and energy spectrum listed in DCD Table 12.2-1 are not well-defined nor is the derivation of stated values explained in the DCD. Based on information made available to the staff during the RPAC Chapter 12 Audit, the staff was not able to characterize the neutron radiation fields in the aforementioned areas. The staff needs to know the neutron flux, energy spectrum and appropriate supporting information to evaluate and confirm activation products and resulting dose rates in the FSAR. The information provided in the DCD is insufficient to allow the staff to confirm that the methods, models and assumptions stated in the DCD support the derivation of other data evaluated by the staff to make their safety finding.

Question

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions, with respect to the kinds and quantities of radioactive materials and radiation fields within the facility, the staff requests that the applicant:

- Identify and describe the methods, models and assumptions used to calculate the values listed in Table 12.2-1.
- Revise and update DCD section 12.2, to add clarification and provide information not currently included in DCD section 12.2, which is needed to evaluate the neutron flux and spectra used to assess activation products and dose rates. As appropriate, provide corrected information and pointers or references to applicable sections of the DCD or supporting technical report,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale modeled the core neutron source term (as provided in FSAR Table 12.2-1) using a U-235 Watt fission spectrum with a NuScale specific neutron source strength intensity. The maximum neutron release rate for the modeled core design configurations (U-235 enrichment and Gd_2O_3 loading) and burnup was used to conservatively adjust the neutron source term, thus creating a bounding neutron source term. In addition, this conservative neutron source term is multiplied by an assembly peaking factor of 1.461. The MCNP6 code is then used to transport the core neutron source term through the modeled NPM to determine the exposure rates and neutron flux intensity in the various parts of the module. The activation products calculations were performed using SCALE, with region specific neutron source intensity with NuScale specific core cross section libraries. The neutron source term used in TR-0116-20781, Rev. 0 is a best estimate source term used for vessel embrittlement calculations.

As shown in FSAR Table 12.2-1, the fission source strength (or intensity) has a value of 2.37E+19 particles per second. The n-gamma source strength is generated internally by MCNP6 using this same neutron source strength. To avoid confusion, this row of the table will be removed, but a description of the n-gamma source term will be added to FSAR Section 12.2.1.1.

Impact on DCA:

Section 12.2.1.1 and Table 12.2-1 have been revised as described in the response above and as shown in the markup provided in this response.

12.2 Radiation Sources

This section describes the sources of both contained and airborne radiation that provide input to:

- radiation shielding design calculations
- ventilation systems design
- radwaste systems design, including the classification of structures, systems, and components per Regulatory Guide 1.143
- radiation protection assessment, including personnel protection and operator dose estimates

12.2.1 Contained Sources

The contained radiation sources are developed for normal operation and shutdown conditions and are based on the design basis primary coolant activity concentrations from Section 11.1. They are determined by propagating this radionuclide activity through various plant systems using the parameters and assumptions provided in this section. In order for the radiological source terms to be used in shielding calculations, the isotopic inventory is used to calculate the intensity and energy spectrum of the total emitted radiation. The ORIGEN code is used to bin the particle emissions into default energy bins based on the activity of each individual isotope. The radiation sources described in this section provide part of the basis for the design of radiation shielding features. Personnel dose assessment considers both direct radiation exposure from contained sources and airborne contributions (Section 12.2.2). Plan scale drawings showing locations of contained sources are included in the radiation zone maps (Section 12.3).

12.2.1.1 Reactor Core

RAI 12.03-28

During normal reactor operations, neutron and gamma radiation are released from the reactor core and from the primary coolant. This radiation is attenuated by the reactor internals, the reactor vessel, the containment vessel, the water surrounding the NuScale Power Module (NPM), the reactor pool concrete walls, and by the bioshield. The fission neutron~~, n-gamma~~ and fission gamma source strength and neutron energy spectrum information are provided in Table 12.2-1. The n-gamma source strength is internally generated by MCNP6 using the neutron source strength as an input. The fission gamma energy probability density function is provided in Table 12.2-2. The fission neutron source utilizes the Watt spectrum for U-235.

12.2.1.2 Reactor Coolant System

Radionuclides present in the reactor coolant system (RCS) are generated from the release of radioactive materials from postulated fuel clad defects and neutron activation of the primary coolant and impurities in the primary coolant. The design basis source terms are described in Section 11.1.

RAI 12.03-28

Table 12.2-1: Core and Coolant Source Information

Parameter	Value
Fission neutron source strength	2.37E+19 particles/sec
Fission neutron energy spectrum	Watt spectrum for U-235
~~Fission neutron n-gamma source strength~~	~~2.37E+19 particles/sec~~
Fission gamma source strength	1.81E+20 particles/sec
Near Core Primary coolant (including short-lived isotopes: <10 sec)	1.169E+13 particles/sec
Primary coolant (longer-lived isotopes: >10 sec)	3.79E+12 particles/sec