RAIO-0319-64956

March 25, 2019

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 Supplemental Response to NRC Request for Additional Information No. 256 (eRAI No. 9161) on the NuScale Design Certification Application

REFERENCES:

1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 256 (eRAI No. 9161)," dated October 13, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 256 (eRAI No.9161)," dated August 30, 2018
3. NuScale Power, LLC Supplemental Response to "NRC Request for Additional Information No. 256 (eRAI No. 9161)" dated November 19, 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. 9161:

- 11.01-1

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 Carrie Fosaaen at 541-452-7126 or at cfosaaen@nuscalepower.com.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8H12
Samuel Lee, NRC, OWFN-8H12
Getachew Tesfaye, NRC, OWFN-8H12

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9161

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9161

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

eRAI No.: 9161
Date of RAI Issue: 10/13/2017

NRC Question No.: 11.01-1

Regulatory Requirements/Guidance

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. Radioactive materials are released as liquid and gaseous effluents and are generated in plant systems during normal reactor operations resulting in doses to workers and members of the public. 10 CFR Part 20, Appendix I to 10 CFR Part 50, and 40 CFR Part 190 specify the annual dose limits to workers and members of the public, and the As Low As is Reasonably Achievable numerical objectives in the design of radwaste systems for controlling and limiting liquid and gaseous effluent releases.

The Design Specific Review Standard (DSRS) Acceptance Criteria section for NuScale, DSRS Section 11.1, “Coolant Source Terms,” states when the applicant’s calculation technique or any source term parameters differ from that given in NUREG-0017 or ANSI/ANS 18.1-1999, they should be described with sufficient detail, and the basis of the alternate method and model parameters should be provided to allow the staff to conduct an independent evaluation. DSRS Sections 11.2, “Liquid Waste Management System,” and 11.3, “Gaseous Waste Management System,” describe that the calculated annual total quantity of radioactive materials released from each reactor will not result in exceeding the annual exposure pathway doses from liquid and gaseous effluents in Appendix I to 10 CFR Part 50; annual dose limits in 10 CFR 20.1301; and annual liquid and gaseous effluent concentration limits in Table 2, Columns 1 and 2 of Appendix B to 10 CFR Part 20. Further, DSRS Section 12.2, “Radiation Sources,” states that applications should contain the methods, models, and assumptions used as the bases for all sources described.

Key Issue: NuScale is pursuing an alternate approach for developing realistic liquid and gaseous effluent release source terms during normal operations from that endorsed by NRC in its current guidance. Any differences from the endorsed approach must be identified and justified.

Design certification application content:

NuScale Technical Report TR-1116-52065-NP Rev. 0, “Effluent Release (GALE Replacement) Methodology and Results,” provides a proposed alternative methodology for determining the realistic fuel failure fraction of 0.000028 (0.0028 percent (%) or 28 parts per million (ppm)) applied in fundamental first principle calculations of liquid and gaseous effluent source terms expected from normal operating conditions for the NuScale design. This realistic fuel failure fraction is based on a literature search as there is no operating experience or data available for performance of the shorter-in-length AREVA M5 fuel in a first-of-a-kind small modular reactor design. From the staff’s review of the literature referenced in TR-1116-52065-NP Rev. 0; Chapter 11, “Radioactive Waste Management” of the Design Control Document (DCD); and information obtained independently by the staff, there is an insufficient technical bases and justification to support the realistic failed fuel fraction in TR-1116-52065-NP Rev. 0.

The staff requests that NuScale provide the following information for its review of the realistic failed fuel fraction to evaluate compliance with the applicable NRC requirements:

1. NuScale needs to provide a technical basis that clearly identifies and describes the fuel failure methodology (e.g., how fuel failure rate is evaluated using an approach such as the outage method). As part of its evaluation of the technical bases, the staff needs to review and confirm key parameters, values and assumptions used in calculating a conservative realistic failed fuel fraction appropriate for determining reactor coolant system (RCS) activity concentrations. Examples of parameters and values include the number of U.S. PWRs determined to be representative, core/assembly size, number of failed pins/rods, number of pins/rods and assemblies in refueling cycle, and total number of rods in the entire core that have been refueled in that year for the range of years considered. Examples of assumptions used in calculating a conservative realistic failed fuel fraction may include a maximum value or average value plus two sigma that bounds the realistic failed fuel fraction. The staff also needs to be provided for its review and evaluation the Electric Power Research Institute (EPRI) source data, other associated information, and quality documentation supporting the calculation of the realistic failed fuel fraction basis.

2. In NuScale Technical Report TR-1116-52065-NP Rev. 0, “International Atomic Energy Agency, “Review of Fuel Failures in Water Cooled Reactors,” IAEA Nuclear Energy Series No. NF-T-2.1,” June 2010 (Reference 7.2.9) states that there are “different methods of fuel failure rate evaluation used by different utilities, fuel vendors and organizations make fuel failure analysis and identification of general tendencies in fuel performance evaluation difficult.” It further describes that EPRI uses the fuel assembly failure rate method which may underestimate the defect rate by a factor of about three to five. For example, Table 3.3 in IAEA NF-T-2.1 shows that for U.S. PWRs from 1994 through 2006 there is a factor of 5 underestimation (non-conservativism) in comparing “old” (core) method of 25.8 parts per million (ppm) and “new” (reload) method of 131.6 ppm for fuel failure rates.

   Provide sufficient detail to identify and justify the failed fuel methodology (i.e., fuel failure rate evaluation) applied in determining the RCS activity concentrations for the NuScale design.

3. NuScale Technical Report TR-1116-52065-NP Rev. 0, Section 5.2, “US Pressurized Water Reactor Fuel Failure History” discusses fuel failure fractions and suggests a correlation to ANSI/ANS-18.1- 1999, NUREG-0017 Rev. 1, PWR-GALE08, and PWR-GALE09.

   The ANSI/ANS-18.1-1999 voluntary standard (Reference 7.2.2) and NUREG-0017 Rev. 1 guidance (Reference 7.2.1) do not specify any failed fuel fraction, fuel failure methodology, or discuss the representativeness and quality of these data. Moreover, interim versions of PWR-GALE08 and PWR- GALE09 in Geelhood, K.J. and J.P. Rishel, “Applicability of GALE-86 Codes to Integral Pressurized Water Reactor Designs,” PNNL-21386, May 2012 (Reference 7.2.3), and Geelhood, K.J., “Benchmarking of GALE-09 Release Predictions Using Site Specific Data from 2005 to 2010,” PNNL- 22076, November 2012 (Reference 7.2.19) are not endorsed by the NRC.

   Given that ANSI/ANS-18.1-1999 and NUREG-0017 Rev. 1 do not provide sufficient information to support a realistic failed fuel fraction basis, and that PWR-GALE08 and PWR-GALE09 are not endorsed by the NRC, provide sufficient detail and justification of how fuel failure rates can be correlated to ANSI/ANS-18.1-1999, NUREG-0017 Rev. 1, PWR-GALE08 and PWR-GALE09, and are appropriate for determining RCS activity concentrations for the NuScale design.

4. NuScale Technical Report TR-1116-52065-NP Rev. 0, Appendix A, Table A-6, “Fuel failure data for U.S. PWRs with zirconium-alloy cladding” provides failed fuel fractions for Sources

and References from the early 1970s through 2010. Figure 5-2, “Fuel failure data for zirconium-alloy clad U.S. pressurized water reactors” plots fuel failure fractions for zirconium-alloy clad U.S. PWRs from 1975 through 2010 from various sources. Table 5-1, “Fuel failure values” shows Minimum (Rods/Million), Maximum (Rods/Million), and Average (Rods/Million) values for three Date Ranges (1996-2000, 2001-2005, 2006-2010), in which the realistic fuel failure fraction of 0.000028 (0.0028% or 28 ppm) is shown as the maximum value for date ranges 2001-2005.

The NuScale realistic fuel failure fraction of 0.000028 (0.0028% or 28 ppm) is determined from EPRI source data in 2001 and “Executive Summary - The Path to Zero Defects: EPRI Fuel Reliability Guidelines,” 2008 (Reference 7.2.13). This two page Executive Summary contains a figure (bar graph) showing EOC (end of cycle) from 1980 through 2007 on the x-axis, but there is no unit label on the y-axis to identity what the values ranging from 0 to 300 represent.

a. Provide the y-axis unit label (e.g., number of failed pins/rods identified in refueling cycle for that year;

b. Identify the fuel failure methodology (e.g., core, outage, or reload) applied for each year from 1980 through 2007;

c. Provide the EPRI source data, associated information, and quality documentation used to extrapolate the maximum value (around 95 with no expressed unit label) in 2001 for U.S. PWRs in calculating the realistic fuel failure fraction; and

d. Provide sufficient detail and justification of how the tables, figures, and fuel failure methodology applied establishes an appropriate basis for determining RCS activity concentrations for the NuScale design.

5. In NuScale Technical Report TR-1116-52065-NP Rev. 0, the staff notes that conference presentations such as the International Atomic Energy Agency, “Results of the IAEA Study of Fuel Failures in Water Cooled Reactors in 2006-2010,” Presentation at Technical Working Group on Fuel Performance and Technology (TWGFPT) Meeting, April 24, 2012 (Reference 7.2.14); and U.S. Nuclear Regulatory Commission, “Nuclear Fuel Performance,” Office of

Nuclear Regulatory Research and Office of Nuclear Reactor Regulation Presentation, February 24, 2005 (Reference 7.2.18) are intended for information purposes only.

Provide sufficient detail and justification of how this information (conference presentations) can be used as the basis for licensing and for determining RCS activity concentrations for the NuScale design.

6. NuScale needs to revise the relevant sections, tables, and figures in DCD Chapters 11 and 12 and NuScale Technical Report TR-1116-52065-NP Rev. 0 related to the realistic failed fuel fraction discussions, and provide markups to include this revised information.

NuScale Response:

This supplemental response to RAI 9161 is provided to document the changes to FSAR Table 11.1-1 "Maximum Core Isotopic Inventory." These changes were incorporated into revision 2 of the DCA to reflect the actual core isotopic inventory that was utilized in the development of the Chapter 11 and 12 analyses.The previous version of Table 11.1-1 did not reflect the actual inventory used for these analyses.

Impact on DCA:

FSAR Table 11.1-1 has been revised as described in the response above and as shown in the markup provided in this response.

Table 11.1-1: Maximum Core Isotopic Inventory

Nuclide	Core Inventory (Ci)	Nuclide	Core Inventory (Ci)
Noble Gases		Other Fission Products	
Kr83m	4.7E+05	Y92	4.9E+06
Kr85m	9.7E+05	Y93	5.8E+06
Kr85	1.3E+05	Zr97	7.2E+06
Kr87	1.9E+06	Nb95	6.8E+06
Kr88	2.4E+06	Mo99	8.1E+06
Kr89	3.0E+06	Mo101	7.9E+06
Xe131m	6.0E+04	Tc99m	7.2E+06
Xe133m	2.9E+05	Tc99	2.1E+02
Xe133	9.0E+06	Ru103	8.9E+06
Xe135m	2.1E+06	Ru105	7.2E+06
Xe135	3.5E+06	Ru106	5.7E+06
Xe137	7.9E+06	Rh103m	8.8E+06
Xe138	7.4E+06	Rh105	6.8E+06
Halogens		Rh106	6.1E+06
Br82	2.6E+04	Ag110	2.3E+06
Br83	4.6E+05	Sb124	1.3E+04
Br84	7.7E+05	Sb125	1.1E+05
Br85	9.6E+05	Sb127	5.3E+05
I129	5.4E-01	Sb129	1.5E+06
I130	2.7E+05	Te125m	2.7E+04
I131	4.6E+06	Te127m	8.7E+04
I132	6.6E+06	Te127	5.3E+05
I133	8.9E+06	Te129m	2.5E+05
I134	9.9E+06	Te129	1.5E+06
I135	8.5E+06	Te131m	9.9E+05
Rubidium, Cesium		Te131	3.9E+06
Rb86m	2.0E+03	Te132	6.4E+06
Rb86	1.6E+04	Te133m	4.1E+06
Rb88	2.5E+06	Te134	7.6E+06
Rb89	3.3E+06	Ba137m	1.6E+06
Cs132	3.2E+02	Ba139	7.7E+06
Cs134	2.7E+06	Ba140	7.4E+06
Cs135m	3.2E+04	La140	7.8E+06
Cs136	5.9E+05	La141	7.0E+06
Cs137	1.6E+06	La142	6.6E+06
Cs138	8.1E+06	Ce141	7.0E+06
Other Fission Products		Ce143	6.4E+06
P32	7.2E+02	Ce144	5.9E+06
Co57	5.3E+00	Pr143	6.2E+06
Sr89	3.4E+06	Pr144	5.9E+06
Sr90	1.1E+06	Np239	1.2E+08
Sr91	4.4E+06	C14	2.1E+01
Sr92	4.9E+06	H3	2.0E+04
Y90	1.2E+06		
Y91m	2.6E+06		
Y91	4.5E+06		

RAI 11.01-2

Table 11.1-2: Maximum Core Isotopic Inventory

Nuclide	Core Inventory (Ci)	Nuclide	Core Inventory (Ci)
Noble Gases		Other Fission Products	
Kr83m	7.289E+05	Y92	8.103E+06
Kr85m	1.698E+06	Y93	8.584E+06
Kr85	1.339E+05	Zr95	8.547E+06
Kr87	3.478E+06	Zr97	8.288E+06
Kr88	4.662E+06	Nb95	8.510E+06
Kr89	5.994E+06	Mo99	8.658E+06
Xe131m	5.994E+04	Mo101	7.881E+06
Xe133m	2.871E+05	Tc99m	7.622E+06
Xe133	9.509E+06	Ru103	8.843E+06
Xe135m	2.098E+06	Ru105	7.215E+06
Xe135	4.958E+06	Ru106	5.698E+06
Xe137	8.547E+06	Rh103m	8.769E+06
Xe138	8.621E+06	Rh105	6.771E+06
Halogens		Rh106	6.142E+06
Br82	2.568E+04	Ag110m	6.475E+04
Br83	7.289E+05	Sb124	1.302E+04
Br84	1.310E+06	Sb125	1.143E+05
Br85	1.691E+06	Sb127	5.328E+05
I129	5.365E-01	Sb129	1.532E+06
I130	2.683E+05	Te125m	2.697E+04
I131	4.662E+06	Te127m	8.658E+04
I132	6.660E+06	Te127	5.254E+05
I133	9.546E+06	Te129m	2.498E+05
I134	1.092E+07	Te129	1.462E+06
I135	8.991E+06	Te131m	9.916E+05
Rubidium, Cesium		Te131	3.922E+06
Rb86m	2.013E+03	Te132	6.438E+06
Rb86	1.595E+04	Te133m	4.625E+06
Rb88	4.699E+06	Te134	9.546E+06
Rb89	6.253E+06	Ba137m	1.558E+06
Cs132	3.230E+02	Ba139	8.806E+05
Cs134	2.671E+06	Ba140	8.510E+06
Cs135m	3.193E+04	La140	8.547E+06
Cs136	5.883E+05	La141	8.066E+06
Cs137	1.635E+06	La142	7.955E+06
Cs138	9.213E+06	Ce141	7.955E+06
Other Fission Products		Ce143	8.103E+06
P32	7.622E+02	Ce144	6.586E+06
Co57	5.254E+00	Pr143	7.844E+06
Ni63	4.144E+01	Pr144	6.623E+06
Sr89	5.957E+06	Np239	1.288E+08
Sr90	1.129E+06		
Sr91	7.770E+06		
Sr92	7.992E+06		
Y90	1.158E+06		
Y91m	4.588E+06		
Y91	7.363E+06		