RAIO-0918-61868

September 19, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 356 (eRAI No. 9253) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 356 (eRAI No. 9253)," dated January 29, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 356 (eRAI No.9253)," dated August 21, 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. 9253:

- 11.01-2

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
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9253

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9253

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

eRAI No.: 9253
Date of RAI Issue: 01/29/2018

NRC Question No.: 11.01-2

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 set forth in part 20 of this chapter. 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 all normal operation, anticipated operation occurrence, and design basis source terms, etc., will be considered. In addition, 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, these differences should be described with sufficient detail; and the basis of the alternate method and model parameters should be provided to allow the staff to evaluate this approach. 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.

NRC guidance in Branch Technical Position (BTP) 11-6, “Postulated Radioactive Releases due

to Liquid- Containing Tank Failures," identifies radionuclides (both parent and progeny) such as H-3, C-14, Sr-90, Tc-99, I-129, and Cs-137, etc., (and additionally for pressurized water power reactors, Br-84, Rb-88, Y- 91m, Te-129, Te-131, and Ce-143), that should be included, at a minimum, in an environmental transport analysis for assessment of an accidental liquid release due to their long half-lives and mobility. Conformance with BTP 11-6 is considered, in part, as an acceptable method for demonstrating compliance with the applicable regulations in 10 CFR Part 20, Appendix I to 10 CFR Part 50, and 40 CFR Part 190.

Key Issue 1: Realistic and design basis source terms in the NuScale design exclude Tc-99, a long-lived and environmentally mobile radionuclide produced in the fuel, which can escape as a fission product into the reactor coolant system for release into the environment. Tc-99 should be included in source terms, environmental transport analyses, and dose assessments, or its exclusion justified. (Question related to NRC eRAI 8750 and NuScale RAIO-0817-55643.)

Design Certification Application Content:

Based on information obtained during the NRC's regulatory audit of the NuScale Design Control Document (DCD) Rev. 0, Chapter 11, "Radioactive Waste Management," and Chapter 12, "Radiation Protection," and Environmental Qualification aspects of the NuScale design, the staff observed that Tc-99 activity in the fuel had been calculated (Tc-99 activity appears to be about three orders of magnitude greater than the I-129 activity in the fuel), but this information was excluded from DCD Chapter 11, Table 11.1-1: Maximum Core Isotopic Inventory and in NuScale Technical Report (TR) Effluent Release (GALE Replacement) Methodology and Results, TR-1116-25065-NP Rev. 0, Appendix A Summary Tables. Furthermore, this information was also not carried forward and tracked throughout the source term tables in DCD Chapter 11 for consideration in the calculation analyses and assessment of effluent releases and public doses. In addition, DCD Chapter 12, Table 12.2-10: "Reactor Pool Cooling, Spent Fuel Pool Cooling, Pool Cleanup and Pool Surge Control System Component Source Terms - Radionuclide Content," excludes Tc-99 activity in the liquid release source term that would be used by the COL applicant in its postulated accidental liquid-containing tank failure analysis and dose assessment to a member of the public for completion of COL Item 11.2-3.

Question 1

Therefore, the staff requests that NuScale:

a. Include Tc-99 activities in the fuel, primary and secondary coolant for realistic and design basis source terms in DCD Chapter 11 Tables 11.1-1, 11.1-4, 11.1-5, 11.1-6, and 11.1-7, and TR-1116-25065-NP, or justify its exclusion;

b. Include Tc-99 activity in the postulated accidental liquid release source term for the pool surge control system in DCD Chapter 12 Table 12.2-10, or justify its exclusion; and

c. Based on the above, provide a DCD and TR-1116-25065-NP markup to include these changes.

Key Issue 2: The proposed alternate methodology used to calculate the tritium (H-3) production rate in the reactor coolant system (RCS) is non-conservative and underestimates H-3 concentrations in liquid and gaseous effluent releases during normal operations because it does not account for the buildup of H- 3 due to recycling of previously used RCS. In the NuScale design, H-3 is the largest calculated water activation production reaction due to more water in the RCS per megawatt generated, higher capacity factor, and higher starting lithium concentration, which results in more H-3 production than a standard light water pressurized reactor. An increase in H-3 concentration results in a proportional increase to offsite public dose. (Question related to NRC eRAI 9270.)

Design Certification Application Content:

Based on information obtained during the NRC's regulatory audit of the NuScale Design Control Document (DCD) Rev. 0, Chapter 11, "Radioactive Waste Management" and Chapter 12, "Radiation Protection," and Environmental Qualification aspects of the NuScale design, the staff observed that the H- 3 concentration in the RCS, which moves readily throughout the plant system pathways for eventual release in liquid and gaseous effluents into the environment, assumes no recycling of the RCS; that is, all make up water supplied to the RCS during the operating cycle is assumed to contain zero radioactivity including H-3.

NuScale TR-1116-52065 Section 4.1.1, "Water Activation Products," describes cumulative water injection (i.e. RCS makeup water) and bleed out of the RCS over the two year operating cycle, Figure 4-2, "Tritium reactor coolant system balance" shows a peak H-3 activity of 74 Ci, and Figure 4-3, "Tritium concentration and time weighted average" shows a H-3 concentration of 0.97 uCi/ml. NuScale TR-1116-52065 Figure 4-3, "Tritium concentration and time weighted average" shows the "Tritium Concentration in RCS - No Recycle (uCi/g)" versus "Time (years)" for the operating cycle.

DCD Section 9.3.4.2.1, “General Description,” states that recycled, degassed reactor coolant from the Liquid Radioactive Waste System (LRWS) can also be added back to the Chemical and Volume Control System (CVCS) by a supply line upstream of the makeup pumps. DCD Chapter 9 Figure 9.3.4-1: Chemical and Volume Control System Diagram shows a return from the LRWS. DCD Section 11.2 describes that liquids may be recycled for use in the RCS. DCD Chapter 11, Tables 11.1-4: Primary Coolant Design Basis Source Term and 11.1-6: Primary Coolant Realistic Source Term provide H-3 concentrations of 9.7000E-01 uCi/g in the RCS. DCD Chapter 11 Tables 11.2-5: Estimated Annual Releases to Liquid Radioactive Waste System Discharge Header and 11.3-5: Gaseous Estimated Discharge for Normal Effluents show total plant release rates of 1.55E+03 Ci/y for liquid effluent releases and 7.37E+02 Ci/y for gaseous effluent releases, respectively.

Question 2

Therefore, the staff requests that NuScale:

a. Provide the method, model, and assumptions used to calculate the H-3 production rate in the RCS to account for H-3 buildup due to recycling of previously used RCS, or justify the current H-3 activity, concentration, and liquid and gaseous effluent release rates are conservative and bounding.

b. Based on the above, provide a DCD and TR-1116-25065-NP markup to include these changes.

NuScale Response:

NuScale Response (1):

Consistent with NRC Branch Technical Position (BTP) 11-6, the NuScale source terms in FSAR Chapters 11 and 12, and in TR-1116-52065, have been revised to include the radioisotope Tc-99. The revised FSAR Table 11.1-1, which now includes Tc-99, is attached to this response. The revised FSAR Tables 11.1-4, 11.1-5, 11.1-6 and 11.1-7 are included with the response to RAI 9270 (Q12.02-20). The revised technical report (TR-1116-52065, Rev. 1) is included with the response to RAI 9161 (Q11.01-1).

The following FSAR Tables have been updated to include Tc-99, as follows:

- FSAR Table 11.1-1 Maximum Core Isotopic Inventory - attached to this RAI response.

- FSAR Tables 11.1-4, 11.1-5, 11.1-6 & 11.1-7 for the primary and secondary coolant activities are shown in the NuScale response to RAI 9270 (12.02-20).
- FSAR Table 11.2-5 Estimated Annual Releases to LRWS Discharge Header - RAI 9264 (12.02-4)
- FSAR Table 11.2-8 Liquid Release Concentration Compared to Part 20 limits - RAI 9264 (12.02-4)
- FSAR Table 11.3-5 Gaseous Estimated Discharge for Normal Effluents - RAI 9264 (12.02-4)
- FSAR Table 12.2-7 CVCS Source Terms - RAI 9257 (12.02-14)
- FSAR Table 12.2-10 RPC, SFPC, PCU & PSCS Component Source Terms is shown in the NuScale response to RAI 9270 (12.02-20)
- FSAR Table 12.2-13a & 13b LRWS Component Source Terms - RAI 9256 (12.02-10)
- FSAR Table 12.2-16 GRWS Component Source Terms - RAI 9161
- FSAR Table 12.2-19 SRWS Component Source Terms - RAI 9264 (12.02-4)
- The revised FSAR Table 12.2-33 RXB Airborne Concentrations is shown in the NuScale response to RAI 12.02-20 - RAI 9270 (12.02-20)
- Tech Report TR-1116-52065, Rev. 1 (RAI 9161).

NuScale Response (2):

NuScale has evaluated the tritium concentration in various process streams based on three recycling modes: 1) no recycling of the primary coolant; 2) recycling of primary coolant to the reactor pool; and 3) recycling of primary coolant back to the chemical and volume control system (CVCS) makeup. The first mode (no recycling) maximizes the tritium concentration in the normal liquid discharge effluent stream; therefore, this tritium concentration is used for liquid effluent in FSAR Section 11.2 and TR-1116-52065. The second mode (recycling to the reactor pool) maximizes the tritium concentration in the reactor pool, in the airborne concentration in the airspace above the reactor pool, and in the normal gaseous effluent, and thus is used for the reactor pool water source term in FSAR Section 12.2 and normal gaseous effluent in FSAR Section 11.3 and TR-1116-52065. The third mode (recycling back to CVCS makeup) maximizes the tritium concentration in the primary coolant and is used in determining the airborne concentration due to primary coolant leakage, as shown in FSAR Table 12.2-33.

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.

RAI 11.01-2

Table 11.1-1: 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	Tc99	2.105E+02
Sr91	7.770E+06		
Sr92	7.992E+06		
Y90	1.158E+06		
Y91m	4.588E+06		
Y91	7.363E+06		