RAIO-0118-58281

February 01, 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. 312 (eRAI No. 9267) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 312 (eRAI No. 9267)," dated December 22, 2017

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 Questions from NRC eRAI No. 9267:

- 12.02-7
- 12.02-8

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
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9267

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NuScale Response to NRC Request for Additional Information eRAI No. 9267

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

eRAI No.: 9267
Date of RAI Issue: 12/22/2017

NRC Question No.: 12.02-7

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 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. The DSRS Acceptance Criteria section of NuScale DSRS 12.2, "Radiation Sources,' states that the applications should contain the methods, models and assumptions used as the bases for all sources described in DCD Section 12.2. The DSRS Acceptance Criteria section of DSRS 12.3-12.4, "Radiation Protection Design Features," states that the areas inside the plant structures, as well as in the general plant yard, should be subdivided into radiation zones, with maximum design dose rate zones and the criteria used in selecting maximum dose rates identified.

Background

NuScale DCD Tier 2, Revision 0 DCD Section 11.4.2.5.1, "Tanks," regarding "Spent Resin Storage Tanks," (SRST) states that there are two permanently installed SRSTs that are provided to receive spent resins from the chemical and volume control system (CVCS) and the Pool Clean Up System (PCUS) demineralizers.

DCD Tier 2, Revision 0 subsection 12.2.1.7, "Solid Radioactive Waste System," states that the assumed values used to develop the solid radioactive waste system (SRWS) source terms are listed in Table 12.2-18. NuScale DCD Tier 2, Revision 0 Table 12.2-18, "Solid Radioactive Waste System Component Source Term Inputs," list the dimensions of the SRST. DCD Table 12.2-19, "Solid Radioactive Waste System Component Source Terms – Radionuclide Content," lists the radionuclide inventory of the SRST. DCD Table 12.2-20: "Solid Radioactive Waste System Component Source Terms – Source Strengths," provides the Spent Resin Storage (SRST) gamma emission rate in photon/s.

Based on information made available to the staff during the RPAC Chapter 12 Audit, the model of the SRST contained in the analytical package reviewed by the staff appears to be

significantly different than the model described in DCD Table 12.2-18. For instance, the height of the SRST as described in DCD Table 12.2-18 is 24.56 feet, however, based on the parameters used in the analytical model, the tank height is 17.96 feet. Furthermore, the height of the resin comprising the actual source of radioactive material in the tank, is only 7.9 feet.

Key Issue 1:

The radionuclide concentrations listed in DCD subsection 12.2 are the basis of the information used to establish plant source terms. NuScale DSRS 12.2 Acceptance Criteria, states that all of the sources of radiation exposure to workers and members of the public (from contained sources) are to be identified, characterized, and considered in the design and operation of the facility. This section of the DSRS 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.

Question 1:

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to radiation exposures, the staff requests that the applicant:

- Describe the sources of radioactive material contained in the SRST, how many cubic feet from each source demineralizer and the decay period for assumed for each bed,
- As necessary, revise DCD Section 12.2 information needed to describe the source contained in the tank,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

As described in FSAR Section 11.4.2, the spent resin storage tank (SRST) is designed to receive Class B/C spent resins from the pool cleanup system (PCUS) demineralizers and the chemical and volume control system (CVCS) demineralizers (except the CVCS deborating demineralizers, which are expected to be Class A). The spent resins from PCUS and CVCS are collected in one SRST over an approximate two-year period.

Section 9.3.4 of the FSAR states that there are four CVCS demineralizers with 8.8 ft^3 of resin each (assumed to be 10 ft^3). The PCUS has three 100% capacity demineralizers, with 470 ft^3 of resin each. To ensure there is sufficient volume capacity in the design, the four CVCS demineralizers are conservatively assumed to be sluiced to the SRST at the end of each unit's operating cycle. For the PCUS demineralizers, one demineralizer is assumed to operate for two years and then to have the resin replaced, and one demineralizer has the resin replaced every five years. The assumed change-out frequency for each demineralizer is shown below.

Class B/C Spent Resin Source	Description	Demineralizer Resin Volume (ft^3)	Number of Replacements per year	Total Spent Resin Volume (ft^3/year)
CVCS	Mixed Bed	10	12	120
CVCS	Cation Bed	10	12	120
PCUS	PCU Demin	470	0.5	235
PCUS	PCU Demin	470	0.2	94
			TOTAL =	**569 (~600)**

FSAR Table 11.4-3 has been revised to reflect this total annual volume of 600 ft^3.

The CVCS mixed bed and cation bed demineralizer radionuclide content are developed assuming the beds are in service for an entire fuel cycle (FSAR Table 12.2-7), and then sluiced to the SRST after two days of decay following reactor shutdown. Assuming there are 12 power modules, this sluicing operation from the CVCS to the SRST would occur six times per year for both the mixed and cation demineralizer beds. These sluicing operations are assumed to be evenly spaced out over time such that there are CVCS mixed bed and cation beds sluiced to the SRST every 59.3 days over a two year (711.6 days) period. It is assumed that the two-year accumulation of radionuclides from the design basis primary coolant source term is collected in one CVCS mixed bed and one CVCS cation bed. This results in the two-year accumulation of radionuclides residing in one half the volume of CVCS spent resin shown above (i.e., less self-shielding).

As described in FSAR Section 12.2.1.4, the PCUS demineralizers are used to clean up the reactor pool water, especially after each refueling outage. For the purposes of determining the PCUS resin radionuclide content, it is assumed that the entire reactor pool water activity inventory (as reflected in FSAR Table 12.2-10) is deposited in a PCUS demineralizer during each cleanup period between refueling outages. This same reactor pool water activity deposition is repeated 12 times over a two year period. At the end of this two year period, a 658 ft^3 volume of PCUS spent resin and its associated radionuclide activity is transferred to the SRST. FSAR Section 12.2.1.4 has been revised to more clearly describe these modeling assumptions.

The SRST source term in FSAR Table 12.2-19 reflects the activity in the SRST from both CVCS and PCUS spent resins at the end of this two year period, with no additional decay.

Impact on DCA:

Section 12.2.1.4 and Table 11.4-3 have been revised as described in the response above and as shown in the markup provided in this response.

Table 11.4-3: Estimated Annual Volumes of Wet Solid Waste

Waste Classification	Sources	Volume Generated (ft^3/yr)	Container Type	Container Volume (ft^3)	No. of Containers (rounded up)
Class B/C	CVCS and PCUS spent resins	~~450~~600	8-120 HIC	~~120~~112	~~4~~6 HICs
Class B/C	cartridge filters from CVCS and PCUS	52	8-120 HIC	~~120~~112	1 HIC
Class A	LRWS spent resins and CVCS deborating spent resins	~~200~~170	8-120 HIC	~~120~~112	2 HICs
	LRWS filter cartridges, TUF filter rejects, RO rejects, membranes, and misc.	20	55 gal drum	7.3	3 drums
Class A	oily waste	14	55 gal drum	7.3	2 drums
	mixed waste	14	55 gal drum	7.3	2 drums
	charcoal (from GAC) (replaced every 5 years)	~~10~~20 (avg)	8-120 HIC	~~120~~112	1 HIC every five years

12.2.1.4 Reactor Pool Cooling, Spent Fuel Pool Cooling and Pool Cleanup Systems

The reactor pool cooling system (RPCS) is a cooling-water system that removes heat from the reactor pool, while the spent fuel pool cooling system (SFPCS) removes heat by drawing water from the spent fuel pool. The pool cleanup system (PCUS) draws water from either the SFPCS or the RPCS and removes impurities to reduce radiation exposures and to maintain water chemistry and clarity. These systems are further described in Section 9.1.3.

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The RPCS and SFPCS heat exchangers are conservatively assumed to be filled with reactor pool water even though the shell side is normally filled with site cooling water. Because the majority of the radioactivity consists of tritium, these heat exchangers do not represent a significant radiation source that requires radiation shielding. The primary system components considered in designing shielding are the PCUS demineralizers and filters that accumulate activity from radioactive contamination in the reactor pool water. The PCUS demineralizers are assumed to collect the entire inventory of radioactivity ~~released to~~in the pool water ~~due to the NPM disassembly during a refueling outage~~as reflected in Table 12.2-10. It is also assumed that the PCUS demineralizers operate for two years, resulting in the collection of ~~12 refueling outage events~~the entire reactor pool water radionuclide inventory 12 times (assuming a plant with 12 NPMs on a 2 year refueling cycle).

The PCUS filters are not explicitly modeled, but are assumed to result in local radiation dose rates that are 10 percent of the PCUS demineralizer. It is also assumed that the PCUS filters do not contribute to the area dose rate outside their shielded cubicles.

The input assumptions used to develop these source terms are listed in Table 12.2-9. The radionuclide source terms and source strengths for this equipment are provided in Table 12.2-10 and Table 12.2-11, respectively.

12.2.1.5 Liquid Radioactive Waste System

The radionuclide inventory in the liquid radioactive waste system (LRWS) includes fission and activation products originating from the reactor core and the reactor coolant system (RCS). The radionuclide inventories are listed for the major LRWS components in Table 12.2-13a and Table 12.2-13b which are the basis for the liquid radioactive waste component shielding design.

The estimated input flows from various sources to the high-conductivity waste (HCW) collection tanks, the low-conductivity waste (LCW) collection tanks, and the detergent collection tank are listed in Table 11.2-3. These inputs are processed in batches by the liquid radioactive waste processing skids and sent to the HCW and LCW sample tanks for final disposition. The assumed values for the LRW processing equipment radionuclide collection efficiencies are listed in Table 12.2-12. The LRWS component source terms are provided in Table 12.2-13a and Table 12.2-13b, and source strengths are provided in Table 12.2-14a and Table 12.2-14b.

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eRAI No.: 9267
Date of RAI Issue: 12/22/2017

NRC Question No.: 12.02-8

The Regulatory Basis and Background are in RAI-9267 Question 30994

Key Issue 2:

The DSRS Acceptance Criteria 12.3-12.4, “Radiation Protection Design Features,” states that the areas inside the plant structures, as well as in the general plant yard, should be subdivided into radiation zones, with maximum design dose rate zones and the criteria used in selecting maximum dose rates identified. The source size, magnitude and configuration are elements of the model used to establish the effects of the contained sources on areas adjacent to the contained source. Because the geometry of the source described in the DCD does not appear to model the analytical method used to evaluate the radiation effects, the staff is unable to assess the validity of the radiation zone designations.

Question 2:

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to radiation exposures, the staff requests that the applicant:

- Explain/justify the parameters of the dose rate calculation model used to describe the SRST,
- As necessary, revise DCD Section Table 12.2-18 to include this information,
- As necessary, revise DCD Section 12.3-12.4 radiation zone figures,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

The height and diameter dimensions of the spent resin storage tanks (SRST) that are presented in FSAR Table 12.2-18 of 24.56 ft and 10.53 ft, respectively, have been corrected to be 7.94 ft and 12.0 ft, respectively. Similarly, the height and diameter dimensions of the phase separator tanks (PST) presented in FSAR Table 12.2-18 as 16.46 ft and 8.81 ft, respectively, have been

corrected to be 1.36 ft and 10.0 ft, respectively. The radionuclide content of the PST in FSAR Table 12.2-19 has also been revised. The other FSAR information related to these source terms and their associated dose rates is unchanged.

Impact on DCA:

Table 12.2-18 and Table 12.2-19 been revised as described in the response above and as shown in the markup provided in this response.

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Table 12.2-18: Solid Radioactive Waste System Component Source Term Inputs

Model Parameter	Value
Spent resin storage tank	
Contents	Spent resins from CVCS and PCUS
Geometry	vertical cylinder
Source dimensions of vessel	diameter=~~10.53~~12.0'; height=~~24.56~~7.94'
Shield thickness of steel shell	0.25"
Phase separator tank	
Inputs	Spent resins from LRWS
Geometry	vertical cylinder
Source dimensions of vessel	diameter=~~8.81~~10.0'; height=~~16.46~~1.36'
Shield thickness of steel shell	0.25"
High Integrity Container (HIC):	
Inputs	Spent resins from SRST
Geometry	Vertical cylinder
Source dimensions of container	Diameter=4.92' Height=5.83'
Array of HICs	One layer of five Class B/C HICs

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Table 12.2-19: Solid Radioactive Waste System Component Source Terms - Radionuclide Content

Isotope	SRST (Ci)	PST (Ci)	HIC (Ci)
Kr83m	4.12E-06	~~1.42E-09~~1.66E-09	1.69E-09
Kr85	-	~~2.09E-12~~7.93E-12	-
Xe131m	1.50E-02	~~7.18E-06~~1.55E-05	1.87E-21
Xe133m	2.00E-10	~~4.75E-07~~1.75E-06	-
Xe133	1.21E-04	~~3.10E-05~~1.11E-04	-
Xe135m	-	~~7.17E-14~~5.09E-13	-
Xe135	-	~~2.71E-10~~1.57E-09	-
Br82	4.54E-15	~~2.18E-08~~8.92E-08	-
I129	1.64E-03	~~2.04E-09~~7.65E-09	2.06E-04
I130	-	~~1.81E-10~~9.31E-10	-
I131	1.52E-01	~~4.76E-04~~1.04E-03	-
I132	1.36E-06	~~7.37E-06~~1.97E-05	-
I133	-	~~5.57E-07~~2.30E-06	-
I135	-	~~4.17E-13~~2.96E-12	-
Rb86	3.25E-02	~~1.35E-04~~1.58E-04	1.29E-14
Cs132	2.70E-06	~~6.64E-07~~7.76E-07	-
Cs134	6.53E+03	~~5.39E-01~~6.28E-01	4.24E+02
Cs136	3.03E-01	~~3.28E-03~~3.83E-03	2.00E-18
Cs137	6.98E+03	~~4.45E-01~~5.19E-01	8.34E+02
P32	2.19E-07	~~8.32E-11~~2.16E-10	2.62E-23
Co57	2.46E-06	~~1.21E-11~~3.13E-11	5.01E-08
Ni63	8.82E+01	~~1.39E-03~~1.73E-03	1.09E+01
Sr89	8.12E-02	~~2.96E-06~~6.92E-06	5.85E-07
Sr90	2.56E+00	~~5.67E-06~~1.47E-05	3.06E-01
Sr91	-	~~2.14E-13~~7.21E-13	-
Y90	2.56E+00	~~5.67E-06~~1.47E-05	3.06E-01
Y91m	-	~~1.38E-13~~4.64E-13	-
Y91	1.68E-02	~~4.24E-07~~1.10E-06	4.58E-07
Y93	-	~~8.79E-14~~3.19E-13	-
Zr95	6.03E+00	~~2.45E-04~~3.06E-04	3.40E-04
Zr97	-	~~1.82E-11~~5.68E-11	-
Nb95	8.33E+00	~~2.55E-04~~3.18E-04	7.50E-04
Mo99	3.15E-07	~~1.28E-05~~3.43E-05	-
Tc99m	3.04E-07	~~1.23E-05~~3.31E-05	-
Ru103	1.17E-02	~~5.22E-07~~1.35E-06	5.08E-09
Ru105	-	~~1.75E-19~~1.09E-18	-
Ru106	6.28E-01	~~2.54E-06~~6.59E-06	2.08E-02
Rh103m	1.15E-02	~~5.16E-07~~1.34E-06	5.03E-09
Rh105	9.87E-16	~~8.14E-09~~2.27E-08	-
Rh106	6.28E-01	~~2.54E-06~~6.59E-06	2.08E-02
Ag110m	1.24E+02	~~9.00E-07~~1.13E-06	2.15E+00
Sb124	5.05E-05	~~1.71E-10~~4.41E-10	1.75E-09
Sb125	2.67E-02	~~1.04E-08~~2.70E-08	2.04E-03
Sb127	1.98E-09	~~1.95E-10~~5.17E-10	-

Table 12.2-19: Solid Radioactive Waste System Component Source Terms - Radionuclide Content (Continued)

Isotope	SRST (Ci)	PST (Ci)	HIC (Ci)
Te125m	6.41E-02	~~1.50E-06~~3.86E-06	5.02E-04
Te127m	8.05E-01	~~9.22E-06~~2.39E-05	1.09E-03
Te127	7.89E-01	~~9.03E-06~~2.34E-05	1.07E-03
Te129m	1.35E-01	~~7.76E-06~~2.01E-05	7.11E-09
Te129	8.52E-02	~~4.90E-06~~1.27E-05	4.49E-09
Te131m	1.72E-15	~~8.68E-08~~2.44E-07	-
Te131	4.51E-16	~~2.28E-08~~6.40E-08	-
Te132	1.32E-06	~~7.15E-06~~1.91E-05	-
Ba137m	6.61E+03	~~4.21E-01~~4.91E-01	7.90E+02
Ba140	1.49E-03	~~7.99E-07~~2.07E-06	2.96E-21
La140	1.71E-03	~~9.05E-07~~2.35E-06	3.41E-21
Ce141	5.59E-03	~~3.39E-07~~8.79E-07	1.80E-10
Ce143	1.83E-17	~~8.96E-10~~2.52E-09	-
Ce144	4.69E-01	~~2.23E-06~~5.78E-06	1.04E-02
Pr143	2.74E-04	~~1.21E-07~~3.15E-07	5.62E-21
Pr144	4.69E-01	~~2.23E-06~~5.78E-06	1.04E-02
Np239	2.49E-10	~~1.06E-07~~2.88E-07	-
Na24	-	~~8.86E-08~~2.32E-07	-
Cr51	1.12E+01	~~3.00E-06~~3.75E-06	2.60E-08
Mn54	1.81E+02	~~3.86E-05~~4.79E-05	4.66E+00
Fe55	2.74E+02	~~4.95E-03~~6.14E-03	2.09E+01
Fe59	2.59E+00	~~1.27E-04~~1.58E-04	4.96E-06
Co58	7.03E+02	~~2.25E-03~~2.56E-03	8.33E-02
Co60	1.46E+02	~~3.67E-04~~4.57E-04	1.41E+01
W187	1.21E-17	~~1.74E-07~~3.29E-07	-
Zn65	4.54E+01	~~1.12E-03~~1.39E-03	7.52E-01
C14	4.68E+02	~~1.01E-03~~2.62E-03	5.85E+01

Note: Assumes the plant consists of 12 NPMs operating on a two-year refueling cycle.