August 13, 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. 355 (eRAI No. 9258) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 355 (eRAI No. 9258)," 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 Questions from NRC eRAI No. 9258:

- 12.02-29
- 12.02-30

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-8G9A
Samuel Lee, NRC, OWFN-8G9A
Getachew Tesfaye, NRC, OWFN-8H12

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9258

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NuScale Response to NRC Request for Additional Information eRAI No. 9258

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

eRAI No.: 9258
Date of RAI Issue: 01/29/2018

NRC Question No.: 12.02-29
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 part 20 of this chapter. 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 Part 50 Appendix A, criterion 4 requires applicants to identify the environmental conditions, including radiation, associated with normal operation. The DSRS Acceptance Criteria section of NuScale DSRS section 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 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 Section 12.2.1.3, “Chemical and Volume Control System,” states that for the specific activity content of the resin transfer pipe, a lower density value for the resin than that stated in the spent resin storage tank (SRST) is assumed. DCD Section 12.2.1.13 further states that the theoretical maximum for randomly 'jammed' spherical matter is a packing density of 63.4%. At somewhere below this point, the resin beads would no longer flow through a pipe. The 'jammed' sphere packing with the lowest density is a diluted ('tunneled') packing density of 49.365%. Therefore, to prevent resin beads from clogging, a packing density of less than 49.365% is needed. A generic resin transfer line is modeled assuming it is 100% obstructed by spherical resin beads from the CVCS mixed bed demineralizer, which results in approximately 50% of the pipe's internal volume consisting of resin bead material and the other 50% consisting of water. The generic resin transfer line is modeled with the parameters listed in Table 12.2-6, “Chemical and Volume Control System Component Source Term Inputs and Assumptions.” The only additional information provided in DCD Table 12.2-6 are the dimensions of the resin transfer line. DCD Table 12.2-19, “Solid Radioactive Waste System Component Source Terms – Radionuclide Content,” lists the radionuclide content of the SRST. The parameters described above are used by the applicant to calculate the contents of the resin transfer pipe listed in Table 12.2-7, “Chemical and Volume Control System Component Source Terms - Radionuclide Content.” The staff also noticed that the column in DCD Table 12.2-7 listing the radionuclide content of the resin transfer line does not contain Ba-137m. Cs-137 decays, with a 30 year half-life, to Ba-137m, with a 2.5 minute half-life. Since Ba-137m is in secular equilibrium with the parent Cs-137 radionuclide, the specific activity of Ba-137m should be within 94 percent of the Cs-137 specific activity, within 20 minutes. The significant, 662 KeV photon, associated with the decay of Cs-137 is actually emitted from the decay of Ba-137m, so omitting Ba-137m results in a significant underestimation of the photon source strength and thus the resultant dose rate.

Key Issue 1:

Based on operating experience at commercial nuclear power plants (see DE2004826015 “Studsvik Processing Facility Update,” available from https://ntrl.ntis.gov/NTRL/), a relatively high ratio of water to resin is required to ensure unobstructed flow of resin slurries through the resin transfer pipes. However, based on that same operational experience, despite efforts by plant personnel, resin transfer lines do become clogged. When that happens the density of the resin in the transfer line becomes that of the water soaked resin in the SRST. As a result it is unclear why “A generic resin transfer line is modeled assuming it is 100% obstructed by spherical resin beads from the CVCS mixed bed demineralizer, which results in approximately 50% of the pipe's internal volume consisting of resin bead material and the other 50% consisting of water.” If the pipe contains more resin, this will result in higher exposures and would impact the designated radiation zones due to a higher maximum dose rate in the area, as stated in the Acceptance Criteria for DSRS 12.3-12.4.

Question 1

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

- Please explain/justify the basis for assuming a non-conservative source term for the “obstructed” pipe and the resulting exposure rates and radiation zone designation,
- Revise DCD Section 12.2.1.3 to remove the discussion related to crediting a lower resin density for the design of shielding,
- Revise DCD Table 12.2-7 to increase the specific activity of the resin in the resin transfer line to the specific activity of the resin in the SRST,
- As necessary, revise the DCD radiation zone maps in DCD Section 12.3 to reflect the increase in specific activity of the resin in the resin transfer line,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

The industry information referenced in the NRC question from Studsvik states:

> "Resin Transfer Lines - Efficient transfer of resins requires a substantial amount of water to prevent line plugging. When resins are transferred with a vacuum assist, the potential exists for significant line blockage. All resin transfer systems must be equipped with numerous backflush and blowdown connections at all points where line plugging can occur."

NuScale agrees that resin transfer lines can become clogged, even though NuScale does not use a vacuum assist transfer. NuScale performed an analysis of a clogged resin transfer pipe source term, and is appropriately conservative. This is explained in FSAR Section 12.2.1.3, that a tightly packed arrangement of resin beads, supported by industry experience, results in a clogged pipe consisting of 50% water and 50% resin beads. The theoretical maximum packing density for spherical matter is 63.4%, however spherical beads would no longer flow through a pipe at about 50%. Therefore, with conditions inside the resin transfer pipe having greater than 50% resin beads, the flow of the slurry will stop and the line is clogged. This is the expected condition if a resin transfer line becomes clogged, so the source term for the resin transfer line is based on this clogged condition. Although the SRST source term is modeled more conservatively by using an even higher (and, incidentally, theoretically impossible) resin bead packing fraction, the NuScale resin transfer line source term is still appropriately conservative for a clogged condition. The NRC states that when a resin transfer line becomes clogged, "the density of the resin in the transfer line becomes that of the water soaked resin in the SRST." While this is physically true, it does not mean that it is necessary to model a clogged line to the same degree of conservatism as was done in the SRST. NuScale modeled the SRST resin density more conservatively than a clogged resin transfer line, but both are modeled conservatively, albeit differently.

However, to have consistent modeling regarding resin bead source terms, NuScale has revised its calculations to model a clogged resin transfer line and a resin storage tank with the same resin bead density (0.76 g/ml) for bulk dry resin, instead of the swollen or water saturated densities ranging from 1.1 to 1.5 g/ml.

The most limiting case for the resin transfer line is modeled using CVCS mixed bed demineralizer resins decayed for 48 hours. The SRST spent resin specific activity is not as limiting as the CVCS mixed bed spent resins, therefore the SRST specific activity is not used.

NuScale has also revised FSAR Section 12.2.1.3, Table 12.2-6, Table 12.2-7 and Table 12.2-8 to reflect these modeling changes. For the changes to FSAR Tables 12.2-6, 12.2-7 and 12.2-8, see the NuScale response to RAI 9257 (Q12.02-14).

Impact on DCA:

FSAR Section 12.2.1.3 has been been revised as described in the response above and as shown in the markup provided in this response.

lithium removal. The decontamination factors assumed are listed in Table 12.2-6. ~~The cation beds are assumed not to be in operation during a crud burst cleanup period.~~

The CVCS demineralizer radionuclide inventories and source strengths are tabulated for zero decay and 3.65 day (0.01 year) decay to demonstrate that maintenance activities during outages can be managed to allow the short-lived isotopes to decay away.

The CVCS demineralizer beds are located in the Reactor Building (RXB) on the 24' elevation inside the CVCS cubicles. The mixed-bed source terms and source strengths are listed in Table 12.2-7 and Table 12.2-8, respectively.

Regenerative and Non-Regenerative Heat Exchangers

The regenerative heat exchanger is used to cool the primary coolant as it enters the CVCS using the CVCS water returning back to the RCS. The non-regenerative heat exchanger further cools the primary coolant, using reactor component cooling water, to protect the demineralizer resins. The heat exchangers are tube and shell type, as described in Section 9.3.4. To calculate the radiological source term, the heat exchangers are assumed to be completely filled with primary coolant. The major source term model assumptions are listed in Table 12.2-6. The source term for the RCS water is found in Table 11.1-4.

The heat exchangers are located in the RXB on the 50' elevation inside the heat exchanger rooms.

Module Heating System Heat Exchangers

The module heating system heat exchanger radiological source term is assumed to be the same as the CVCS regenerative and non-regenerative heat exchanger source term. This is conservative because a module heatup system heat exchanger contains about one-third the source term used to model the CVCS heat exchangers.

Resin Transfer Pipe

RAI 12.02-29

~~The theoretical maximum for randomly 'jammed' spherical matter is a packing density of 63.4% (Reference 12.2-4). At somewhere below this point, the resin beads would no longer flow through a pipe. The 'jammed' sphere packing with the lowest density is a diluted ('tunneled') packing density of 49.365% (Reference 12.2-5). Therefore, to prevent resin beads from clogging, a packing density of less than 49.365% is needed.~~ A generic resin transfer line is modeled assuming it is 100% obstructed by spherical resin beads from the CVCS mixed bed demineralizer, which has been modeled using a bulk dry resin density ~~results in approximately 50% of the pipe's internal volume consisting of resin bead material and the other 50% consisting of water~~. The generic resin transfer line is modeled with the parameters listed in Table 12.2-6. The source term used for the spent resin transfer line is the CVCS mixed bed demineralizer decayed for 48 hours, as provided in Table 12.2-7 and Table 12.2-8, with a spent resin volume of 8.8 ft^3.

Response to Request for Additional Information
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eRAI No.: 9258
Date of RAI Issue: 01/29/2018

NRC Question No.: 12.02-30
The regulatory basis and summary are in RAI-9258 Q-30982
Key Issue 2
The methodology used to develop the photon source strength from the post-accident fluid does not account for some principle photon radiation emitting isotopes in the fluid stream. For instance, Ba-137m is in secular equilibrium with the parent Cs-137 radionuclide, the specific activity of Ba-137m should be within 94 percent of the Cs-137 specific activity, within 20 minutes. However, since DCD Table 12.2-7 shows that there is no Ba-137m activity in the resin transfer line, the photon source strength used by the applicant to perform the analysis of dose resulting from the sample fluid, apparently did not properly account for Ba-137m, thus resulting in an underestimation of the dose rate from the sample fluid.

Question 2

- Describe and explain the results of accounting for the correct isotopic content of the resin transfer line that includes Ba-137m, and any other radiologically significant isotopes that should be present but are not,
- Revise DCD Table 12.2-7 to include Ba-137m, and confirm that all other radiologically significant isotopes, in the resin transfer line, are appropriately accounted for,
- As necessary, revise the DCD radiation zone maps in DCD Section 12.3 to reflect the increase in specific activity of the resin in the resin transfer line,
- As necessary, revise the thicknesses of shielding described in the DCD to reflect the increase in the photon strength of the resin in the resin transfer line,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale agrees and has included Ba-137m in secular equilibrium with Cs-137 in the resin transfer line source term and has revised FSAR Tables 12.2-7 and 12.2-8, accordingly.

The changes to FSAR Tables 12.2-7 and 12.2-8 were provided with the NuScale response to RAI 9257 (Q12.02-14).

Impact on DCA:

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