RAIO-0918-61870

September 19, 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 Supplemental Response to NRC Request for Additional Information No. 309 (eRAI No. 9263) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 309 (eRAI No. 9263)," dated December 22, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 309 (eRAI No.9263)," dated January 22, 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. 9263:

- 12.02-6

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 Supplemental Response to NRC Request for Additional Information eRAI No. 9263

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9263

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

eRAI No.: 9263
Date of RAI Issue: 12/22/2017

NRC Question No.: 12.02-6

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. 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

DCD Section 12.2.3, “References,” references Electric Power Research Institute (EPRI), "Pressurized Water Reactor Primary Water Chemistry Guidelines," Volumes 1 and 2, EPRI 3002000505 (TR-3002000505), Palo Alto, CA, Revision 7, April 2014. TR- 3002000505 Volume 2 states that deposition of particulates released during the shutdown evolution can lead to increased shutdown dose rates, elevated smearable activity levels in low flow regions, and increases in personnel contamination risks. It further notes that that without operating reactor coolant pumps, the flow forces will be reduced. Some outcomes of reduced flow forces include increased deposition of suspended material, less solubilization of system deposits, and an increased rate of deposition in low flow rate areas.

NuScale DCD Tier 2, Revision 0 Section 12.2.1.3, “Chemical and Volume Control System,” states that at the end of the fuel cycle, a crud burst is assumed, with the mixed-bed demineralizers being loaded with the entire radionuclide inventory increased due to the crud burst. This increase in radionuclide concentration in the primary coolant is determined by a review of industry data of increased radionuclide concentrations during crud bursts. The resulting crud burst peaking factors are listed in Table 12.2-6. DCD Table 12.2- 6, “Chemical and Volume Control System Component Source Term Inputs and Assumptions.” This table lists the peaking factors to be applied to the normal reactor coolant system (RCS) activity expected to be contained in Chemical and Volume Control System (CVCS) liquid following a crud burst during an outage.

DCD 12.2.1.8 “Reactor Pool Water,” states that the primary source of radionuclides in the reactor pool comes from the primary coolant system when a nuclear power module (NPM) is disassembled in the reactor pool during outages. During refueling outages, after the primary coolant crud burst is cleaned by the CVCS, the small remaining quantities of radionuclides are released into the pool water during NPM disassembly. DCD Table 12.2-6: “Chemical and Volume Control System Component Source Term Inputs and Assumptions,” list the assumptions used for assessing the ability of plant systems to clean up crud bursts. DCD Table 12.2-9: “Reactor Pool Cooling, Spent Fuel Pool Cooling, Pool Cleanup, and Pool Surge Control Systems Component Source Term Inputs and Assumptions,” discusses the assumptions used for cleaning up the pool, and DCD Table 12.2-10: “Reactor Pool Cooling, Spent Fuel Pool Cooling, Pool Cleanup and Pool Surge Control System Component Source Terms - Radionuclide Content,” provides the resultant pool radionuclide concentrations. Since the lower RCS flowrate may result in less cleanup through the CVCS components, there may be a larger release of radionuclides to the pool water during refueling evolutions.

DCD Tier 2 Revision 0 Section 9.3.4 “Chemical and Volume Control System,” (CVCS) notes that portions of the CVCS are used for crud burst clean up. DCD Figure 9.3.4-1: “Chemical and Volume Control System Diagram,” shows the location of the Chemical and volume control system (CVCS) reactor coolant system (RCS) injection line and the RCS discharge lines.

During normal operation, the RCS system flow is driven by the temperature gradients within the RCS. As noted in DCD Table 5.1-2: “Primary System Temperatures and Flow Rates,” the RCS primary flow rate at 100% reactor power is 587.0 Kg/s. As noted in DCD Table 5.1-2, following plant shutdown the RCS flowrate decreases to 68.5 Kg/s or less at 0% power. Based on DCD Table 11.1-2: “Parameters Used to Calculate Coolant Source Terms,” the CVCS purification system flow rate corresponds to approximately 1.4 Kg/s, while the RCS mass corresponds to about 5.3E4 Kg.

The radioactive material contained in the RCS as a result of crud burst challenges the ability of plant systems to control airborne radioactive material, minimize surface contamination, reduce effluent releases, and to control occupational radiation exposure.

Key Issue:

Using the information provided in the application, and information made available to the staff as part of the RPAC Chapter 12 Audit, the staff was unable to determine how the application factored these aspects of the design into the estimated amounts of radioactive material projected to be initially present in the RCS following shutdown, the estimation of the effectiveness of the processes used to clean up the RCS, the amount of radioactive material that may be present inside of NPM components at the time of disassembly, the subsequent amount of radioactive material added to the ultimate heat sink pool water and ultimately, the impact on radiological conditions (i.e., dose rates, airborne activity etc.) in the area of refueling activities.

Question

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions, with respect to the descriptions of the sources of radiation present in the facility, the staff requests that the applicant:

- Justify/explain how the applications assesses the impact of low RCS flow rates on the crud burst clean up capabilities of the NPM.
- As necessary revise DCD Section 12.2 to include adjustment factors for lack of forced flow RCS mixing,
- As necessary revise the radiation zone maps to account for any increased dose rates due to increased radionuclide contribution to the pool water,
- As necessary revise Table 12.2-33: “Reactor Building Airborne Concentrations,” to account for any increased dose rates due to increased radionuclide contribution to the pool water,
- As necessary revise Table 12.2-9, 12.2-10 and 12.2-11 to account for any increased radionuclide contribution to the pool water,
- Provide information on design features meant to reduce radionuclide buildup in the pool,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

During a public phone call with the NRC on 8/23/2018, NuScale agreed to revise FSAR Section 12.2.1.8. This revision includes a statement that the post-crud burst cleanup using the chemical and volume control system will operate until the projected dose rate from the pool water (after NuScale Power Module disassembly) to an operator on the refueling bridge is less than 2.5 mR/hr.

This response supplements the original response for RAI 9263 submitted on January 22, 2018 (ML17356A003).

Impact on DCA:

FSAR Section 12.2.1.8 has been revised as described in the response above and as shown in the markup provided in this response.

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 12.2-16. The LRWS component source terms are provided in Table 12.2-17a and Table 12.2-17b, and source strengths are provided in Table 12.2-18a and Table 12.2-18b. To establish the shielding design downstream of the GAC filter, the radionuclide concentration in the outlet stream from the GAC filter is assumed to not be reduced by the GAC filter.

12.2.1.6 Gaseous Radioactive Waste System

Radioactive fission gases are produced in the reactor core and assumed to be released to the primary coolant, as discussed in Section 11.1. The radionuclide input to the gaseous radioactive waste system (GRWS) comes primarily from the LRWS degasifier, which strips the dissolved gases from the primary coolant that enters the degasifier from the CVCS. The gases from the degasifier are sent to the GRWS for conditioning and processing. Table 12.2-19 lists the assumed values pertaining to the GRWS source geometries and Table 11.3-1 describes the GRWS processing parameters. The GRWS component source terms are provided in Table 12.2-20 and the source strengths are provided in Table 12.2-22.

12.2.1.7 Solid Radioactive Waste System

RAI 12.02-2, RAI 12.03-4

The solid radioactive waste system (SRWS) handles solid radioactive waste from various waste streams, as described in Section 11.4. The waste inputs to the SRWS components are collected, resulting in a radionuclide source term for the SRWS components. The assumed values used to develop the SRWS component source terms are listed in Table 12.2-24. Table 12.2-26 lists the radionuclide inventory of the major SRWS components and Table 12.2-28 lists the SRWS component source strengths. As described in Section 11.4, there is storage space provided in the Radioactive Waste Building for processed waste packages that contain spent filters, dewatered resins, and other solid wastes. For shielding design purposes, it is assumed that the Class A/B/C high integrity container storage area contains five high integrity containers loaded with Class B/C dewatered spent resins from the spent resin storage tank, which has been decayed for approximately two years (one fuel cycle), and one 55-gallon drum filled with waste from the LRWS drum dryer. Table 12.2-17b provides the radionuclide inventory of the drum dryer and Table 12.2-18b provides the drum dryer source strength. Storage areas are shielded to limit the radiation level to be compliant with the designated radiation zone.

12.2.1.8 Reactor Pool Water

RAI 12.02-6, RAI 12.02-6S1, RAI 12.02-14

The reactor pool is housed within the RXB and contains up to 12 NPMs, which are partially immersed in the reactor pool water. Because the spent fuel pool communicates with the reactor pool through the weir wall, radionuclides are mixed with the spent fuel pool water volume. There are two sources of radioactive material considered for the reactor pool water: primary coolant released during refueling outages and direct neutron activation. Because of the low power and low temperatures in the spent fuel pool, the radionuclide contribution to the pool water from defective fuel assemblies in the storage racks is considered negligible. The primary source of radionuclides in the reactor pool comes from the primary coolant system when an NPM is disassembled in the reactor pool during outages. During refueling outages, after the primary coolant ~~crud burst~~ is cleaned by the CVCS, the small remaining quantities of radionuclides are released into the pool water during NPM disassembly. The post-crud burst cleanup of the primary coolant in the NPM by CVCS will operate until the projected dose rate (after NPM disassembly) ~~at one meter above the ultimate heat sink water is less than 5 mR/hr, consistent with Reference 12.2-3~~to an operator on the refueling bridge is less than 2.5 mR/hr. The other major input assumptions for the pool water source term are provided in Table 12.2-11.

RAI 12.02-23

The radionuclide contribution resulting from neutron activation of the reactor pool water contents is not significant due to the reduced neutron flux in the reactor pool water. The neutron flux at the outside edge of the containment vessel ~~was calculated~~is many ~~to be approximately six~~ orders of magnitude less than the average neutron flux in the core, and continues to quickly decrease in the reactor pool's borated water. The small amount of neutron activation products in the reactor pool water was calculated to be insignificant compared to the amount of primary coolant radionuclides released to the reactor pool water during refueling outages. The reactor pool and RCS water chemistry limits (when the temperature of the RCS is less than 250 degrees F) are in conformance with the Electric Power Research Institute primary water chemistry guidelines (Reference 12.2-3). The reactor pool water volume dilutes inadvertently introduced impurities that could result from component failures and, because the chemistry limits in both the reactor pool and each NPM are monitored, impurities in either of the two water sources are minimized.

Between refueling outages, the radionuclides in the reactor pool water are treated by the PCUS demineralizers and filters to reduce the radionuclide content. The pool water has a negligible neutron activation source term. The major input assumptions are listed in Table 12.2-11.

The pool surge control system (PSCS) storage tank is designed to temporarily store pool water that is displaced during drydock operations. The PSCS storage tank is modeled as a vertical cylindrical tank with the characteristics listed in Table 12.2-11.

The source terms and the source strengths for the pool water and the PSCS storage tank are provided in Table 12.2-12 and Table 12.2-15, respectively.

12.2.1.9 Spent Fuel

Spent fuel stored in the spent fuel racks presents a radiation source that is shielded by the water in the spent fuel pool as well as by the pool's concrete walls. The same methodology used to determine the maximum core isotopic source term in Section