RAIO-0718-60836

July 11, 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. 311 (eRAI No. 9265) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 311 (eRAI No. 9265)," 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 Question from NRC eRAI No. 9265:

- 12.02-5

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
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9265

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9265

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

eRAI No.: 9265
Date of RAI Issue: 12/22/2017

NRC Question No.: 12.02-5

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 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents. The Acceptance Criteria of DSRS section 3.11, “Environmental Qualification of Mechanical and Electrical Equipment,” states that the radiation environment should be based on the integrated effects of the normally expected radiation environment over the equipment’s installed life, plus the effects associated with the design-basis event during or following which the equipment is required to remain functional.

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. NuScale DSRS section 12.2 “Radiation Source,” regarding the identification of isotopes and the methods, models and assumptions used to determine dose rates. NuScale DSRS section 12.3, “Radiation Protection Design Feature,” states in the specific acceptance criteria that areas inside the plant structures should be subdivided into radiation zones, with maximum design dose rate zones and the criteria used in selecting maximum dose rates identified.

Background

DCD Tier 2 Revision 0 DCD Table 11.1-2, “Parameters Used to Calculate Coolant Source Terms,” list the value of the reactor coolant system (RCS) mass as 117,400 lbm. DCD Section 12.2.1, “Contained Sources,” states that the contained radiation sources are developed for normal operation and shutdown conditions and are based on the design basis primary coolant activity concentrations from DCD Section 11.1. DCD 12.2.1.3, “Chemical and Volume Control System,” 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,” and DCD

Table 12.2-12, “Liquid Radioactive Waste System Component Source Term Inputs and Assumptions,” provide additional assumptions used for calculating source terms described in DCD Section 12.2, but do not provide alternate RCS masses.

Based on the review of material made available to the staff during the RPAC Chapter 12 Audit, the staff noticed that the different calculation packages reviewed by the staff often used different values for the amount of water in the RCS. In some cases, the changes appeared to be the result of several processes, including: rounding during conversion from volume to mass, incorrect application of temperature/density effects at the time and point of application, or assumptions related to the amount of water in the reactor vessel. The staff understands some of the changes, such as the use of a different mass to generate a more conservative value for the specific analysis being performed. However, in a number of cases observed by the staff, the changes made were not in a conservative direction for the particular analysis, and the application of the change was not identified in the DCD. For example, the value of the mass of RCS in the reactor vessel (RV) and containment vessel (CNV) was greater than the value specified in DCD Table 11.1-2. The increased mass added additional shielding material, and decreased the specific activity of the coolant. Both of these changes result in non-conservative changes in estimated dose rates. In another case, the density of the coolant at normal operating temperature and pressure (NOP/NOT) was used for a fluid at room temperature, resulting in underestimating the amount of radioactive material by about 25%.

Key Issue 1:

Based on the review of material made available to the staff during the RPAC Chapter 12 Audit, the staff determined that the applicant used different RCS mass values for different calculations performed to determine source terms applied to the review of radiation exposure to personnel and equipment, but the use of different RCS masses was not identified as part of the assumptions stated in DCD Section 12.2 and in some cases is non-conservative.

Question

- Explain/clarify the assumptions for RCS mass and ensure such assumptions are appropriate or conservative for the source terms for analysis results described or used in DCD Section 12.2 and DCD Section 3.11,
- As necessary, revise the assumptions documented in DCD Section 12.2 to reflect mass of RCS used for the specific analysis.

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale has revised the pertinent calculations to be consistent or conservative related to the use of the RCS mass value. The RCS mass for primary coolant source term calculations was based on RCS regional coolant densities at 100% power. The RCS mass in a NuScale power module varies with operating power due to the inverse relationship of coolant density with temperature. Thus, at high temperatures (i.e. 100% power), the coolant mass is smaller due to lower density resulting in higher activity concentrations in the primary coolant. The application of primary coolant source term varies in radiological consequence calculations dependent on the intended use. These uses of the primary coolant source term is either on a total curie content, or mass based concentrations for shielding analysis where the coolant is at lower temperatures. As a result, the following FSAR tables have been revised:

- FSAR Table 11.1-2: Reactor coolant system mass = 1.03E+05 lb
- FSAR Table 11.1-3: Weight of water in reactor coolant system = 4.67E+04 kg

All source terms based on primary coolant use a total primary coolant mass of 1.03E+05 lb as applicable or a mass based concentration for conditions when primary coolant is at higher densities. When the primary coolant source term is not used with a mass of 1.03E+05 lb, it is applied on a mass basis that results in a conservative application.

Impact on DCA:

FSAR Tables 11.1-2 and 11.1-3 have been revised as described in the response above and as shown in the markup provided in this response.

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Table 11.1-2: Parameters Used to Calculate Coolant Source Terms

Parameter	Value
Reactor core thermal power (MWt)	160 + 3.2 = 163.2 MWt (102%)
Number of fuel assemblies in one core	37
Range of U-235 fuel enrichment (0.5% increments)	1.5% - 5.0%
UO_2 mass in one fuel assembly (with no gadolinium)	282.8 kg
Range of gadolinium within burnable poison rods (0, 4 or 8 rods per fuel assembly)	2% - 8%
U-235 enrichment cutback for gadolinium-containing rods	5% for each 1% Gd_2O_3 (minimum 15% cutback)
Maximum fuel assembly burnup	60,000 MWD/MTU
Failed fuel fractions: Realistic source term Design basis source term	 ~~0.0028~~0.0066% ~~0.028~~0.066%
Escape rate coefficients: Xe, Kr gases I, Br, Cs, Rb Mo, Tc, Ag Te Sr, Ba Others	 6.5E-08 s^{-1} 1.3E-08 s^{-1} 2.0E-09 s^{-1} 1.0E-09 s^{-1} 1.0E-11 s^{-1} 1.6E-12 s^{-1}
Average density of reactor coolant	~~0.7511~~0.724 gram/cm^3
Reactor coolant system mass	~~117,400~~1.03E+05 lb
Argon injection concentration: Design Basis Realistic	 0.15 µCi/cm^3 0.10 µCi/cm^3
CVCS flow rate (purification)	22 gpm (at 7.295 lb/gallon)
Secondary coolant mass	~~7.158E+04~~5.575E+04 lb
Secondary steam leak rate	80 lb/hr/unit x 12 units =960 lb/hr
Secondary coolant flow rate	~~5.36E+05~~5.32E+05 lb/hr
Decontamination factors for CVCS mixed bed demineralizers: Halogens Cs, Rb Other	 100 2 50
Decontamination factors for condensate demineralizers: Halogens Cs, Rb Other	 100 10 100
Primary-to-secondary leak rate: Design Basis Realistic	 75 lb/day/unit x 12 units = 900 lb/day 3.53 lb/day/unit x 12 units = 42.4 lb/day

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Table 11.1-3: Specific Parameters for Crud

Parameter	Symbol	Units	Value
Thermal power	P	MW_{th}	160
Steam flow rate	FS	kg/s	~~66.9~~6.70E+01
Weight of water in steam generators	WS	kg	~~1,350~~7.55E+02
Weight of water in reactor coolant system	WP	kg	4.67E+04
Letdown flow rate for purification	FD	kg/s	~~1.136~~1.30
Letdown flow rate for boron control	FB	kg/s	~~0.002~~2.64E-03
Flow through cation demineralizer	FA	kg/s	0
Ratio of condensate demineralizer flow to total steam flow	NC	---	1
Fraction of material removed by cation demineralizer	NA	---	0.9
Fraction of material removed by purification demineralizer	NB	---	0.98
Ratio of concentration in steam to that in steam generator (once-through steam generator)	NS	---	1
Fraction of activity removed by condensate demineralizers	NX	---	0.9