RAIO-0818-61473

August 21, 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. 479 (eRAI No. 9279) on the NuScale Design Certification Application

REFERENCES:

1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 479 (eRAI No. 9279)," dated May 14, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 479 (eRAI No.9279)," dated June 5, 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 Question from NRC eRAI No. 9279:

- 12.03-57

The response to RAI Questions 12.03-58 was previously provided in Reference 2. This completes all responses to eRAI 9279.

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. 9279

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9279

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

eRAI No.: 9279
Date of RAI Issue: 05/14/2018

NRC Question No.: 12.03-57
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.

Appendix A to Part 50—General Design Criteria for Nuclear Power Plants, Criterion 61—"Fuel storage and handling and radioactivity control," requires systems which may contain radioactivity to be designed with suitable shielding for radiation protection and with appropriate containment, confinement, and filtering systems.

10 CFR 20.1101(b) states that "the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)." 10 CFR 20.1003 states that ALARA "means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest."

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 of DSRS Section 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 acceptance criteria of NuScale DSRS Section 12.3-12.4, further states that the applicant's methods for performing shielding design calculations are acceptable if assumptions regarding source terms, cross sections, shield and source geometries, and transport methods are realistic; and if specified radiation zones are consistent with the assumed source term and

shielding specified in the design.

10 CFR 52.47(a)(22) requires applicants to provided information necessary to demonstrate how operating experience insights have been incorporated into the plant design.

Background

Small changes to the shielding design parameters have cumulative non-linear effects on the attenuating capability of the shielding and the resultant estimated dose rates. Due to the interrelated, non-linear and cumulative effects of the assumptions for shielding material composition, density and thicknesses, the staff relies on the consistent application of the criteria stated in the DCA when making their reasonable assurance finding.

DCD Tier 2 Revision 0, Section 12.3.2, "Shielding," describes some of the design considerations, such as stating that material used for a significant portion of plant shielding is concrete. For most applications, concrete shielding is designed in accordance with ANSI/ANS 6.4-2006, "Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants."

DCD Section 12.3.2.3, "Calculation Methods," states that source geometries, source term distributions and intensities are conservatively determined. Source terms associated with resin transfers and crud bursts are included. Shielding credit and material selections for modelled cells are conservatively applied. The material compositions for air, concrete, water, and stainless steel are taken from Pacific Northwest National Laboratory, "Compendium of Material Composition for Radiation Transport Modeling," PNNL-25870 Revision 1. DCD Section 12.3.2 0does not contain any information about the assumption for concrete density, other than the references to ANSI/ANS 6.4-2006 and PNNL-25870.

DCD Section 12.3.2.4.3, "Reactor Building," states that the major radiation sources in the RXB are associated with the Nuclear Power Module (NPM), chemical volume and control system (CVCS), Pool Clean Up System (PCUS), and spent fuel storage. The CVCS contains radioactive ion exchangers, filters, and heat exchangers. The CVCS is equipped with a resin transfer line used to transport resin slurry to the solid radioactive waste system (SRWS). The line is generically modeled in the RXB shielding model using the CVCS ion exchanger spectra. Major components associated with the radioactive waste processing system are discussed in DCD Section 12.3.2.4.4, "Radioactive Waste Building (RWB)."

DCD Table 12.3-6, "Reactor Building Shield Wall Geometry," provides the nominal thickness of concrete for some of the walls in the RXB. DCD Table 12.3-8, "Reactor Building Radiation Shield Doors," lists the shielded doors located in the RXB. DCD Table 12.3-9, "Radioactive Waste Building Radiation Shield Doors," lists the shielded doors located in the RWB.

DCD Section 12.3.2.4.4, "Radioactive Waste Building (RWB)," states that the RWB houses significant radiation sources that belong to the radioactive waste processing systems.

Significant components in the RWB containing radioactive material include: the Liquid Radioactive Waste System, the Gaseous Radioactive Waste System, and the Solid Radioactive Waste System.

DCD Table 12.3-7, "Radioactive Waste Building Shield Wall Geometry," provides the nominal thickness of concrete for some of the walls in the RWB. DCD Table 12.3-9, "Radioactive Waste Building Radiation Shield Doors," list the shielded doors located in the RWB.

Using information made available to the staff during the RPAC Chapter 12 Audit, the staff reviewed some of the shielding calculation information for the RXB and RWB. The staff identified that a number of differences existed between the shielding design information described in the RWB shielding calculation package and the relevant parameters specified in ANSI/ANS 6.4-2006 and PNNL-25870. The staff noted that the density assumed in documents related to the dose rate calculations for the radioactive waste building that were reviewed during the audit used a Granulated Activated Charcoal (GAC) filtration media density of 0.50 grams per cubic centimeter (g/cm3) instead of the density for charcoal of 0.32 g/cm3 listed in PNNL-25870. The staff noted that the density specified for resin contained in some sources appeared to be different than discussed in the DCD. The RWB shielding package referenced gamma photon strength values whose derivation was described in a different calculation package. Based on the staff review, the applicant used a standard method for grouping (aka binning) photon energies (i.e., the number of bins and the energy boundaries used are consistent with recognized standards). However, there appears to be some inconsistencies with the method used by the applicant for determining the quantity of photons used for some sources in the RWB. The shielding calculation package describing the methodology for the RWB shielding used concrete density and other density values that differed from those used in the actual shielding analysis performed for some of the RWB sources. However, the shielding analysis package for the RXB was not available for the staff review, so the staff was unable to assess what values were used in the actual RXB shielding calculations.

Key Issue 1

Due to the interrelated, non-linear and cumulative effects of the assumptions for shielding material compositions, density and thicknesses, the staff needs to know the application of key parameters in the NuScale shielding calculations in each specific area. DCD Tier 2 Section 12.3.2, "Shielding," DCD Section 12.3.2.3, "Calculation Methods," and DCD Section 12.3.2.4.3, "Reactor Building," do not specify the values of key assumptions, such as minimum concrete density in the RXB. Small changes to the shielding design parameters have cumulative non-linear effects that may result in a lower attenuating capability of the shielding with the result that dose rates may be non-proportionally higher than the estimated dose rates. In addition to using reasonably conservative shielding parameters to obtain realistic and conservative dose rate estimates, the source strength used in the analysis must be equal to or greater than the source described in the DCD. The source strengths are used as energy binning inputs to the shielding analysis as well as inputs to part of the dose conversion factors used to calculate the dose rate.

Also, using information made available to the staff during the RPAC Chapter 12 Audit, the staff reviewed some of the shielding calculation information for the RXB and the RWB. The staff identified a number of differences between the shielding design information provided for the RXB and for the RWB.

These differences include the following:

- The assumed concrete density for the RWB shield walls appear to be inconsistent with stated standards, and non-conservative for radiation attenuation,
- The density specified for resin contained in some CVCS demineralizers appeared to be different than discussed in the DCD,
- The density stated for the Granulated Activated Charcoal (GAC) filtration media appeared to be non- conservative for radiation attenuation in the GAC.
- The RXB and RWB shielding calculation packages referenced gamma photon strength values whose derivation was described in a different calculation package. Based on the staff review, there appears to be some inconsistencies with the application of the photon source strength method used by the applicant for some sources in the RXB and the RWB.

Question 1

To facilitate staff understanding of the application information in support of its reasonable assurance review regarding the RXB and RWB shielding designs, the staff requests that the applicant provide the following:

- Justify/explain the assumptions used to perform the shielding analysis in the RXB and the RWB, including the associated methods, models and assumptions used to establish the identified values,
- Justify/explain the photon source strengths and the resultant tally multiplier factors, used in the RWB shielding analysis package,
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  DCD Section 12.3.2, as appropriate, to describe these assumptions,As necessary, revise

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale revised its shielding calculations to evaluate a number of concurrent changes related to source term assumptions. Modeling inconsistencies were reconciled, including:

- Concrete densities: As stated in FSAR Section 12.3.2.3, the Reactor Building (RXB) and Radioactive Waste Building (RWB) shielding calculations use a concrete density based on PNNL-25870, Rev. 1 (2.3g/ml - material 99 for regular concrete), and SCALE 6.1 manual regulatory concrete (developed for US NRC).
- GAC density: NuScale calculated the gaseous radioactive waste system (GRWS) decay bed vessel volumes based on a 0.5g/mL basis, in accordance with a vendor's technical specification sheet for a range of 0.5 to 0.6g/mL density of activated carbon for gas delay. The shielding calculation used the lower density as a design basis shelf-shield density for GRWS decay beds and for the liquid radioactive waste system (LRWS) granulated activated carbon beds, which will be filled with liquid.
- Ion exchanger resin density: NuScale shielding calculations for the RXB and RWB use a dry resin density of 760g/l. This density was applied to ion exchanger vessels, spent resin storage tanks, resin transfer lines, and high integrity containers. This density value is conservative, because it is for a dry resin condition. Shielding calculation resin densities for a wet resin (water saturated) condition is about 1000g/l, therefore an assumed resin density of 760g/l provides less self-shielding and is thus conservative.
- NuScale source strengths are generally calculated on a mass basis, as most sources are a liquid (contaminated water). The exceptions to the mass basis methodology are processing media such as filters and ion exchange resins, which are calculated on a component basis. The spent resin transfer line shielding calculation uses a volumetric basis for source strength using 100 percent resin loading in the pipe.

The photon source strengths used in shielding calculations are described in the tables of FSAR Section 12.2. These source strengths are generated using the industry standard code, SCALE. Tally multipliers are a shielding calculation variable that can be used to defined the total source strength, just as a weight card can be used to describe the total source strength. These values are developed within engineering calculations and, where necessary, reported in the FSAR. The NuScale quality assurance program and engineering procedures are implemented to ensure engineering products are checked and validated. Changes to the RXB and RWB radiation zone maps are included in NuScale responses to RAI 9281 (Q12.03-56) and RAI 9302 (Q12.03-15).

Impact on DCA:

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