

## NuScaleDCRaisPEm Resource

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**Subject:** Request for Additional Information No. 345 RAI No. 9294 (12.3)  
**Attachments:** Request for Additional Information No. 345 (eRAI No. 9294).pdf

Attached please find NRC staff's request for additional information concerning review of the NuScale Design Certification Application.

Please submit your technically correct and complete response within 60 days of the date of this RAI to the NRC Document Control Desk. .

If you have any questions, please contact me.

Thank you.

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## Request for Additional Information No. 345 (eRAI No. 9294)

Issue Date: 01/26/2018

Application Title: NuScale Standard Design Certification - 52-048

Operating Company: NuScale Power, LLC

Docket No. 52-048

Review Section: 12.03-12.04 - Radiation Protection Design Features

Application Section: 12.3, Tier 13.11, Tier 13.12

### QUESTIONS

12.03-23

#### 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 10 CFR 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) 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 Acceptance Criteria of DSRS Section 12.3-12.4, "Radiation Protection Design Features," contains a number of criteria related to the design of the shielding, including:

- 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.
- That the composition of the shielding material should be selected to minimize, to the extent practicable, the potential for the shield itself to become a radiation source (either from activation of the shield material or production of secondary radiation resulting from interactions with the primary radiation).
- Where the applicant's shielding design incorporates material subject to degradation, such as through the effects of radiation (e.g., depletion of boron neutron absorbers,) temperature extremes (e.g., degradation of polymer based materials because of high temperature,) density changes (e.g., sagging or settling of shielding material with age,) methods are in place to ensure that ORE remains ALARA, and the equipment exposures are maintained in accordance with the provisions of 10 CFR 50.49 should be specified
- The application should identify the allowable constraints (e.g., minimum cooling air flow, maximum shielding material temperature, and maximum allowable neutron flux,) and how those parameters are measured and assessed over the design life of the facility.
- That accessible portions of the facility that are capable of having radiation levels greater than 1 gray (Gy) per hour (100 rads per hour) are shielded, and are clearly marked with a sign stating that potentially lethal radiation fields are possible. If removable shielding is used to reduce dose rates to less than 1 Gy per hour, it must also be explicitly marked as above.

#### Background

DCD Tier 2 Revision 0 Section 12.3.2, "Shielding," describes some of the design considerations for radiation shielding, such as stating that material used for a significant portion of plant shielding is concrete.

DCD Section 12.3.2.2, "Design Considerations," states that the selection of shielding materials considers the ambient environment and potential degradation mechanisms. The material used for a significant portion of plant shielding is concrete. In addition to concrete, other types of materials such as steel, water, tungsten, and polymer composites are considered for both permanent and temporary shielding. DCD Section 12.3.2.4.3, "Reactor Building," states that cubicle walls are concrete supported by carbon steel plates, called structural steel partition walls.

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 12.3-7, "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 identified that some shielding design calculations referenced the use of additional steel (i.e., in addition to the structural steel partition walls already noted,) shielding to limit dose rates in adjacent areas.

### Key Issue 1

DCD Tier 2 Revision 0 Section 12.3.2, "Shielding," does not identify the specific areas where additional shielding is required. DCD Table 12.3-6, "Reactor Building Shield Wall Geometry," and DCD Table 12.3-7, "Radioactive Waste Building Shield Wall Geometry," provide the nominal thickness of concrete for some of the walls in the RXB and RWB. However, neither table identifies the location of nor the minimum thickness of any additional steel shielding material.

### Question 1

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

- Describe the locations in the RXB and RWB where additional steel shielding is credited for the radiation shielding design,
- Justify/explain the assumptions used to perform the shielding analysis in the RXB and the RWB, supporting the amount of steel shielding identified, including the associated methods, models and assumptions used to establish the identified values,
- As necessary, revised section DCD Section 12.3.2, to describe the these steel thicknesses, and the associated assumptions,

OR

Provide the specific alternative approaches used and the associated justification.

12.03-24

The Regulatory Basis and Background are in RAI-9294 Question 31054

### Key Issue 2

DCD Section 12.3.2.2, "Design Considerations," states that radiation shield doors are designed to have a radiation attenuation capability that meets or exceeds that of the wall within which they are installed. DCD Tier 2 Revision 0 Section 12.3.2, "Shielding," does not identify the specific areas where additional shielding is required. DCD Table 12.3-8, "Reactor Building Radiation Shield Doors," and DCD Table 12.3-9, "Radioactive Waste Building Radiation Shield Doors," provide a listing of the radiation shield doors located in the RXB and RWB. However, neither table identifies the location of nor the minimum thickness of any additional steel shielding material that is used in the rooms the doors are shielding, so it is not clear to the staff which "shielding thickness" applies to the radiation shielding doors, (i.e., just the concrete shielding, or the concrete shielding plus any other shielding enhancements.)

### Question 2

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

- Describe the locations in the RXB and RWB where additional steel shielding is credited for the radiation shielding design and should also be considered for the radiation shield doors minimum thickness,
- Justify/explain the assumptions used to perform the shielding analysis of the radiation shield doors located in the RXB and the RWB, ,
- As necessary, revised section DCD Section 12.3.2, to describe the these steel thicknesses, and the associated assumptions and any changes to the descriptions of the radiation shield doors,

OR

Provide the specific alternative approaches used and the associated justification.

12.03-25

The Regulatory Basis and Background are in RAI-9294 Question 31054

### Key Issue 3

The acceptance criteria of NuScale DSRS section 12.3-12.4, states that accessible portions of the facility that are capable of having radiation levels greater than 1 gray (Gy) per hour (100 rads per hour rads/hr) should be shielded. All accessible portions of the facility capable of having radiation levels greater than 1 Gy per hour (100 rads per hour) are to be clearly marked with a sign stating that potentially lethal radiation fields are possible. If removable shielding is used to reduce dose rates to less than 1 Gy per hour, it must also be explicitly marked as above. DCD Tier 2 Revision 0 Section 12.3.2.4.3, "Reactor Building," and DCD Section

12.3.2.4.4, "Radioactive Waste Building," identify a number of areas, such as resin demineralizers, filters, spent resin storage tanks etc., which may contain quantities of radioactive material resulting in radiation dose rates exceeding 100 rads/hr.

However, DCD Tier 2 Revision 0 Section 12.3.2, "Shielding," does not identify the specific areas where removable shielding is used. DCD Table 12.3-6, "Reactor Building Shield Wall Geometry," and DCD Table 12.3-8, "Reactor Building Radiation Shield Doors and DCD Table 12.3-7, "Radioactive Waste Building Shield Wall Geometry," provide the nominal thickness of concrete for some of the walls in the RXB and RWB. However, neither table identifies the location of removable shielding material. DCD Tier 2 Revision 0 Section 12.3.2, "Shielding," does not specify that those portions of the facility capable of having radiation levels greater than 1 Gy per hour (100 rads per hour) where removable shielding is used, are clearly marked with a sign stating that potentially lethal radiation fields are possible.

### Question 3

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

- Describe the locations in the RXB and RWB where removable shielding is credited for the radiation shielding design,
  - For those portions of the facility exceeding 100 rads/hr where removable shielding is used describe how the areas are marked,
  - As necessary, revised section DCD Section 12.3.2, to include these descriptions of removable shielding and markings,
- OR

Provide the specific alternative approaches used and the associated justification.

12.03-26

The Regulatory Basis and Background are in RAI-9294 Question 31054

### Key Issue 4

The acceptance criteria of NuScale DSRS section 12.3-12.4, states that the acceptability of the facility design features will include an assessment of design features provided to protect shielding material subject to degradation, such as through the effects of radiation (e.g., depletion of boron neutron absorbers,) temperature extremes (e.g., degradation of polymer based materials because of high temperature,) density changes (e.g., sagging or settling of shielding material with age). The guidance contained in Regulatory Guide (RG) 1.69, "Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants," discusses the use of American Concrete Institute (ACI) 349-06, "Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary," and ACI 349.1R-07, "Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures," and the associated environmental constraints on shielding material.

DCD Tier 2 Section 12.3.1.2.3, "Penetrations," states that if penetrations through shield walls are necessary, the penetrations are designed to minimize streaming (e.g., with an offset) from a radiation source to accessible areas. If penetration offsets are not practical, then penetrations are either shielded or elevated above floor level. DCD Section 12.3.2.2, "Design Considerations," states that in addition to concrete, other types of materials such as steel, water, tungsten, and polymer composites are considered for both permanent and temporary shielding. However, DCD Tier 2 Revision 0 Section 12.3.2, "Shielding," does not identify any areas of the plant shielding (e.g., penetration shielding around hot pipes,) that have limitations associated with the shielding material or for which specific design criteria (e.g., maximum temperature, radiation resistance etc.) are required for the integrity of the shielding to be maintained.

### Question 4

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

- Describe the locations in the RXB and RWB where the integrity of radiation shielding may be adversely affected by the local environmental conditions,
  - Describe the design features provided to protect the integrity of the radiation shielding at those locations,
  - Describe the locations in the RXB and RWB, where materials other than steel or concrete are credited for the shielding design, (e.g., the use of polymeric shielding material, or the use of tungsten,)
  - Describe the locations in the RXB and RWB where potentially degradable shielding material is credited for the radiation shielding design, and the associated critical criteria for maintaining integrity of the shielding material,
  - If the COL applicant is expected to provide programmatic controls to protect the integrity of the radiation shielding, describe the COL Item that provides that requirement to the COL Applicant,
  - As necessary, revised section DCD Section 12.3.2, to include the aforementioned information related to maintaining the integrity of the radiation shielding,
- OR

Provide the specific alternative approaches used and the associated justification.

## 12.03-27

The Regulatory Basis and Background are in RAI-9294 Question 31054

### Key Issue 5

DCD Tier 1 Revision 0 Section 3.11, "Reactor Building," and DCD Tier 1 Section 3.12, "Radioactive Waste Building," contain the Inspections, Tests, Analyses, & Acceptance Criteria (ITAAC,) related to the radiation shielding.

DCD Tier 1 Section 3.11, "Reactor Building," states that the RXB includes radiation shielding barriers for normal operation and post-accident radiation shielding. It further states that DCD Tier 1 Table 3.11-2, "Reactor Building Inspections, Tests, Analyses, and Acceptance Criteria," contains the inspections, tests, and analyses for the RXB. DCD Tier 1 Table 3.11-1 item 4 Acceptance Criteria states that the thickness of RXB radiation shielding barriers is greater than or equal to the required thickness specified in DCD Tier 1 Table 3.11-1. DCD Tier 1 Section 3.11 further states that the RXB includes radiation attenuating doors for normal operation and post-accident radiation shielding. These doors have a radiation attenuation capability that meets or exceeds that of the wall within which they are installed.

DCD Tier 1 Section 3.12, "Radioactive Waste Building," states that the RWB includes radiation shielding barriers for normal operation and post-accident radiation shielding. Also, the RWB includes radiation attenuating doors for normal operation and for post-accident radiation shielding. These doors have a radiation attenuation capability that meets or exceeds that of the wall within which they are installed. DCD Tier 1 Section 3.12 further states that DCD Tier 1 Table 3.12-2: "Radioactive Waste Building ITAAC" contains the inspections, tests, and analyses for the RWB. DCD Tier 1 Table 3.12-2 item 1 Acceptance Criteria states that the thickness of RWB radiation shielding barriers is greater than or equal to the required thickness specified in DCD Tier 1 Table 3.12-1, "Radioactive Waste Building Shield Wall Geometry."

DCD Tier 2 Section 12.3.2.2, "Design Considerations," states that DCD Tier 2 Table 12.3-6 and DCD Tier 2 Table 12.3-7, show the nominal shielding thicknesses for rooms in the RXB and the RWB, respectively. DCD Tier 2 Table 12.3-6, "Reactor Building Shield Wall Geometry," provides the nominal thickness of concrete for some of the walls in the RXB. DCD Tier 2 Table 12.3-7, "Radioactive Waste Building Shield Wall Geometry," provides the nominal thickness of concrete for some of the walls in the RWB.

### Question 5

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions regarding the adequacy of the radiation shielding and the associated ITAAC, the staff requests that the applicant:

- As necessary, revise DCD Tier 1 Section 3.11 and DCD Tier 1 Section 3.12, and the associated tables, to reflect type and the minimum thicknesses of radiation shielding material, in addition to concrete, used in the RXB and RWB,  
OR  
Provide the specific alternative approaches used and the associated justification.