RAIO-0818-61492

August 22, 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. 343 (eRAI No. 9298) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 343 (eRAI No. 9298)," dated January 26, 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. 9298:

- 12.03-17
- 12.03-18
- 12.03-19
- 12.03-20

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
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9298

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9298

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

eRAI No.: 9298
Date of RAI Issue: 01/26/2018

NRC Question No.: 12.03-17

Regulatory Basis

Appendix A to Part 50—General Design Criteria (GDC) for Nuclear Power Plants, Criterion 4 requires applicants to ensure that structures, systems, and components important to safety are designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation and postulated accidents.

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) 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," notes that 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,) the reviewer should ensure that methods are in place to ensure that ORE remains ALARA. The staff should review how the application identifies 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. The acceptance criteria of NuScale DSRS section 12.3-12.4 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.

Background

DCD Tier 2 Revision 0 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. The only location where the use of polyethylene is identified is in DCD Table 12.3-6: “Reactor Building Shield Wall Geometry.”

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,” list the shielded doors located in the RXB. DCD Table 12.3-9: “Radioactive Waste Building Radiation Shield Doors,” list the shielded doors located in the RWB. DCD Section 12.3 does not contain any information about the assumption for concrete density, other than the references to ANSI/ANS 6.4-2006 and PNNL- 25870.

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 noticed that the polyethylene shielding specified for the bioshield cover is high density polyethylene and includes 5% natural boron.

Based on information made available to the staff during the RPAC Chapter 12 a, the staff was able to review some of the assumptions used for the RXB shielding analysis. However, the RXB MCNP6 analysis package for the RXB was not available for staff review, so the staff was unable to assess what values were used in the actual RXB shielding calculations.

The acceptance criteria of NuScale DSRS section 12.3-12.4 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.

Key Issue 1

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 polyethylene density, or that the polyethylene is supposed to contain boron; nor the minimum weight percent of boron in the polyethylene documented.

Question 1

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to the neutron shielding materials incorporated into the

design, the staff requests that the applicant:

- Justify/explain the assumptions used to perform the neutron shielding analysis for the bioshield polyethylene shielding, including the associated methods, models and assumptions used to establish the identified values,
- As necessary, revise DCD Section 12.3.2, and Table 12.3-6 to describe the these assumptions

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale has revised the design of the bioshield and has removed the borated polyethylene layer and replaced it with concrete. The shielding analysis results, documented in FSAR Tier 2 Table 12.3-6, and Tier 1 Table 3.11-1 have been revised to reflect this change. For the shielding design, as described in the FSAR, the materials used include steel and concrete. FSAR Tier 2 Tables 12.3-6 and 12.3-7 (and Tier 1 Tables 3.11-1 and 3.12-1) identify the locations and materials that are provided as part of the shielding design. Other shielding materials may be employed by the licensee for temporary or compensatory shielding.

Impact on DCA:

FSAR Tier 1 Table 3.11-1 and Tier 2 Table 12.3-6 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 12.03-17, RAI 12.03-27

Table 3.11-1: Reactor Building Shield Wall Geometry

Elev.	Room Name	North Wall (Note 1)	East Wall (Note 1)	South Wall (Note 1)	West Wall (Note 1)	Floor (Note 2)	Ceiling (Note 2)
24′	Module 1 CVCS ion exchanger sluice room	20″ structural steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 2 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 3 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 4 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 5 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 6 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 7 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 8 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 9 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 10 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 11 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Module 12 CVCS ion exchanger sluice room	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	20" concrete/steel composite slab
24′	Degasifier room “A”	5′ concrete, RXB exterior wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	3′ concrete (floor of 50′ elevation)
24′	Degasifier room “B”	5′ concrete, RXB exterior wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	10′ concrete (ground floor)	3′ concrete (floor of 50′ elevation)
24′	Pool cleanup filter room “A”	5′ concrete, RXB wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	5′ concrete, RXB exterior wall	10′ concrete (ground floor)	3′ concrete (floor of 50′ elevation)
24′	Pool cleanup filter room “B”	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	5′ concrete, RXB exterior wall	10′ concrete (ground floor)	3′ concrete (floor of 50′ elevation)

Table 3.11-1: Reactor Building Shield Wall Geometry (Continued)

Elev.	Room Name	North Wall (Note 1)	East Wall (Note 1)	South Wall (Note 1)	West Wall (Note 1)	Floor (Note 2)	Ceiling (Note 2)
100′	Modules 1-6 CVCS vertical pipe chases	20″ concrete/steel partition wall	20″ concrete/steel partition wall	5′ concrete (reactor pool wall)	20″ concrete/steel partition wall	N/A	N/A
100′	Modules 7-12 CVCS vertical pipe chases	5′ concrete (reactor pool wall)	20″ concrete/steel partition wall	20″ concrete/steel partition wall	20″ concrete/steel partition wall	N/A	N/A
126′	Reactor pool area	5′ concrete wall	5′ concrete wall	5′ concrete wall	5′ concrete wall	~~21.5~~23.5″ concrete, ~~2″ high-density polyethylene, 0.25~~0.5″ steel (Bioshield)	4′ concrete roof

Note 1: A 20″ concrete/steel partition wall consists of two one-half inch steel plates with 19″ of concrete in between.
Note 2: A 20″ concrete/steel composite slab consists of two one-half inch steel plates with 19″ of concrete in between.

RAI 12.03-17, RAI 12.03-23

Table 12.3-6: Reactor Building Shield Wall Geometry

Elev.	Room # (~~see~~ Note 1)	Room Name	North Wall (Note 2)	East Wall (Note 2)	South Wall (Note 2)	West Wall (Note 2)	Floor (Note 3)	Ceiling (Note 3)	Source Term
24′	010-040	Module 1 CVCS ion exchanger sluice room	20″ Structural steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-041	Module 2 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-042	Module 3 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-043	Module 4 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-044	Module 5 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-045	Module 6 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-051	Module 7 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-050	Module 8 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-049	Module 9 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-048	Module 10 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed
24′	010-047	Module 11 CVCS ion exchanger sluice room	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	10′ Concrete (ground floor)	20″ Concrete/steel composite slab	CVCS mixed bed and CVCS cation bed

Table 12.3-6: Reactor Building Shield Wall Geometry (Continued)

Elev.	Room # (~~see~~ Note 1)	Room Name	North Wall (Note 2)	East Wall (Note 2)	South Wall (Note 2)	West Wall (Note 2)	Floor (Note 3)	Ceiling (Note 3)	Source Term
75′	N/A	Modules 1-6 CVCS vertical pipe chases	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	5′ Concrete (reactor pool wall)	20″ Concrete/steel partition wall	N/A	N/A	CVCS pipe
75′	N/A	Modules 7-12 CVCS vertical pipe chases	5′ Concrete (reactor pool wall)	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	N/A	N/A	CVCS pipe
86′	N/A	Modules 1-6 CVCS vertical pipe chases	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	5′ Concrete (reactor pool wall)	20″ Concrete/steel partition wall	N/A	N/A	CVCS pipe
86′	N/A	Modules 7-12 CVCS vertical pipe chases	5′ Concrete (reactor pool wall)	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	N/A	N/A	CVCS pipe
100′	N/A	Modules 1-6 CVCS vertical pipe chases	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	5′ Concrete (reactor pool wall)	20″Concrete/steel partition wall	N/A	N/A	CVCS pipe
100′	N/A	Modules 7-12 CVCS vertical pipe chases	5′ Concrete (reactor pool wall)	20″ Concrete/steel partition wall	20″ Concrete/steel partition wall	20″Concrete/steel partition wall	N/A	N/A	CVCS pipe
126	010-022	Reactor pool area	5' Concrete wall	5' Concrete wall	5' Concrete wall	5' Concrete wall	~~21.5"~~23.5" Concrete ~~2" High-density polyethylene~~ ~~0.25~~0.5" Steel (Bioshield)	4' Concrete roof	NPM

Note 1: Refer to Figure 1.2-10 through Figure 1.2-18 for room locations.

Note 2: A 20" concrete/steel partition wall consists of two one-half inch steel plates with 19" of concrete in between.

Note 3: A 20" concrete/steel composite slab consists of two one-half inch steel plates with 19" of concrete in between.

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

eRAI No.: 9298
Date of RAI Issue: 01/26/2018

NRC Question No.: 12.03-18

The Regulatory Basis and Background are in RAI-9298 Q-31062

Key Issue 2

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. However, there is no specification for the boron content of the polyethylene listed in DCD Tier1 Table 3.11, and there is no description of the minimum polyethylene density.

DCD Tier 2 Section 12.3.2.2, “Design Considerations,” states that DCD Tier 2 Table 12.3-6 shows the nominal shielding thicknesses for rooms in plant buildings. 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. However, there is no specification for the boron content of the polyethylene listed in DCD Tier 2 Table 12.3-6.

Question 2

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to the neutron shielding materials incorporated into the design, the staff requests that the applicant:

- As necessary, revise DCD Tier 1 Section 3.11 and DCD Tier 1 Table 3.11-1, to include the description of boron in the polyethylene shielding material and the density of the polyethylene material,
- As necessary, revise DCD Tier 2 Section 12.3.2.2 and DCD Table 12.3-6, to include the description of boron in the polyethylene shielding material and the density of the polyethylene material,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

See the NuScale response to RAI 12.03-17 (9298).

Impact on DCA:

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

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

eRAI No.: 9298
Date of RAI Issue: 01/26/2018

NRC Question No.: 12.03-19

The Regulatory Basis and Background are in RAI-9298 Q-31062

Key Issue 3

The Acceptance Criteria of DSRS Section 12.3-12.4, “Radiation Protection Design Features,” notes that 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,) methods are in place to ensure the integrity of the shielding, and how the application identifies the constraints (e.g., minimum cooling air flow, maximum shielding material temperature, and maximum allowable neutron flux,) and how those parameters are measured, assessed over the design life of the facility.

Question 3

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to the neutron shielding materials incorporated into the design, the staff requests that the applicant:
Justify/explain the design features and required constraints needed to ensure the integrity of the shielding over the design life of the plant,

- Explain/Justify the control mechanisms proposed to ensure that the constraints needed to ensure the integrity of the radiation shielding over the design life of the plant,
- As necessary, revise DCD Section 12.3.2, to describe these parameters, and the associated controls (e.g., COL Item,)

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

See the NuScale response to RAI 12.03-17 (9298).

Impact on DCA:

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

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

eRAI No.: 9298
Date of RAI Issue: 01/26/2018

NRC Question No.: 12.03-20

The Regulatory Basis and Background are in RAI-9298 Q-31062

Key Issue 4

DCD Tier 2 Revision 0 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, the only location where the use of shielding material other than concrete is identified, is the polyethylene identified in DCD Table 12.3-6: “Reactor Building Shield Wall Geometry.” Based on information made available to the staff during the RPAC Chapter 12 Audit, it appears that the shielding design also credits a number of steel/iron plates that are provided for other than structural support.

Question 4

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to the neutron shielding materials incorporated into the design, the staff requests that the applicant:

- Identity those areas, outside of the Containment Vessel, where steel/iron material is specifically credited for shielding,
- Identify other areas of the plant where shielding material other than concrete, steel/iron are used,
- As necessary, revise DCD Section 12.3.2, and to describe this shielding material,
- Justify/explain the design features and required operational constraints to ensure the integrity of the shielding over the design life of the plant,
- As necessary, revised section DCD Section 12.3.2, and to describe these parameters,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

See the NuScale response to RAI 12.03-17 (9298).

Impact on DCA:

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