



August 23, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission  
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**SUBJECT:** NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 444 (eRAI No. 9295) on the NuScale Design Certification Application

**REFERENCES:** 1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 444 (eRAI No. 9295)," dated April 30, 2018  
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 444 (eRAI No.9295)," dated May 08, 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. 9295:

- 12.03-55

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](mailto:cfosaaen@nuscalepower.com).

Sincerely,

Zackary W. Rad  
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9295

**Enclosure 1:**

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9295

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

**eRAI No.:** 9295

**Date of RAI Issue:** 04/30/2018

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**NRC Question No.:** 12.03-55

### **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 of 10 CFR Part 20.

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."

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.

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**

The dose rates and radiation zones listed in DCD Subsection 12.3 are the bases of the information used to establish plant radiation protection design features, described in NuScale

DSRS 12.3 "Acceptance Criteria." The DSRS Acceptance Criteria are used by the staff to check that the applicant's method for performing shield design calculations, including shield and source geometries, are realistic and consistent with the assumed source term. This acceptance criteria is consistent with the requirements of 10 CFR Part 20 and 10 CFR Part 50 and 10 CFR Part 52.

Specifically, NuScale DCD Tier 2, Revision 0, Figure 12.3-1g "Reactor Building Radiation Zone Map - 100' Elevation," shows that the area between column lines RX4 and RX6 (east and west of the reactor pool), RXA and RXB (north of the reactor pool) and between column lines RXD and RXE (south of the reactor pool) as depicted on DCD Figure 1.2-216, "Reactor Building 100'-0" Elevation" as Steam Galleries, Rooms 010- 411 and 010-418 respectively, are labelled as a Radiation Zone 0. DCD Tier 2, Revision 0, Table 12.3-1 "Normal Operation Radiation Zone Designations," shows that areas designated as radiation Zone 0 have dose rates  $\leq 0.05$  mrem/hr.

However, the staff noted that DCD Tier 2 Revision 0, Figure 3.6-16 "Postulated High- Energy Main Steam System Pipe Routing Beyond the NuScale Power Module (COL Applicant Scope)," and Figure 3.6-17 "Postulated High-Energy Feedwater System Pipe Routing Beyond the NuScale Power Module (COL Applicant Scope)," show the main steam and main feedwater lines passing through the reactor building pool wall (RXD or RXB).

Specifically NuScale DCA Tier 2, Revision 0, Table 3C-6: "Normal Operating Environmental Conditions," states that the 60 Years Integrated N Dose (rads) for the area outside of the containment vessel and under the bioshield is  $1.85E6$  rads (3.7 rads/hour). Figure 12.3-1g depicts the areas under the bioshield as a radiation Zone VI (dose rates  $\geq 1$  rad/hr and  $\leq 500$  rad/hr from Table 12.3-1.) DCD Subsection 12.3.2 "Shielding," does not discuss any specific shielding features between the Nuclear Power Module (NPM) bay under the bioshield and the Steam Galleries to prevent neutron streaming into the Steam Galleries (Rooms 010-411 and 010-418). DCD Subsection 12.3.2.2 "Design Considerations," does not discuss any considerations of the types of shielding material, or the environmental controls provided to ensure shielding integrity, for shielding material that may be installed around the high temperature main steam and main feedwater lines. DCD Table 12.3-6, "Reactor Building Shield Wall Geometry," does not discuss the neutron fluence from under the bioshield area as a shielding consideration for the Steam Galleries. Therefore, the staff is unable to substantiate the applicant's designation of the Steam Galleries as a radiation Zone 0.

Key Issue: The bases for establishing claimed radiation zones are not readily discernable from the information provided. Based on information made available to the staff during the application review and the Chapter 12 audit, the staff was not able to characterize the neutron radiation fields in the aforementioned areas. The staff needs to understand the methods, models, and assumptions used by the applicant to calculate the radiation sources that were used to determine the radiation zones depicted in DCD Chapter 12.3.

**Question**

To facilitate staff understanding of the underlying methods, model and assumptions, in support of its reasonable assurance review regarding the designation of facility radiation zones, the staff requests that the applicant:

1. Explain/Justify the methods, models, and assumptions used by the applicant to calculate the radiation sources that were used to determine the radiation zones depicted in DCD Chapter 12.3.
2. Provide appropriate and sufficient information, including shielding, absorption, and attenuation effects, to justify significant decreases in dose in the adjacent radiation zones.
3. As necessary, revise and update Section 12.3 of the NuScale DCD as appropriate, with respect to plant radiation zones,

OR

Provide the specific alternative approaches used and the associated justification.

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**NuScale Response:**

A COL item has been added to Chapter 12 of the FSAR (COL Item 12.3-8) for the COL applicant to describe the radiation shielding design measures used to compensate for the main steam and main feedwater piping penetrations through the Reactor Building pool wall between the NuScale Power Module (NPM) bays and the Reactor Building steam galleries near the 100 ft elevation (Figures 3.6-16 and 3.6-17).

**Impact on DCA:**

FSAR Section 12.3.2.4.1 and Table 1.8-2 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 01-61, RAI 02.04.13-1, RAI 03.04.01-4, RAI 03.04.02-1, RAI 03.04.02-2, RAI 03.04.02-3, RAI 03.05.01.04-1, RAI 03.05.02-2, RAI 03.06.02-15, RAI 03.06.03-11, RAI 03.07.01-2, RAI 03.07.01-3, RAI 03.07.02-6S1, RAI 03.07.02-8, RAI 03.07.02-12, RAI 03.08.04-23S1, RAI 03.08.04-23S2, RAI 03.08.05-14S1, RAI 03.09.02-15, RAI 03.09.02-48, RAI 03.09.02-67, RAI 03.09.02-69, RAI 03.09.03-12, RAI 03.09.06-5, RAI 03.09.06-6, RAI 03.09.06-16, RAI 03.09.06-16S1, RAI 03.09.06-27, RAI 03.11-8, RAI 03.11-14, RAI 03.11-14S1, RAI 03.11-18, RAI 03.13-3, RAI 04.02-1S2, RAI 05.02.03-19, RAI 05.02.05-8, RAI 05.04.02.01-13, RAI 05.04.02.01-14, RAI 06.02.06-22, RAI 06.02.06-23, RAI 06.04-1, RAI 09.01.01-20, RAI 09.01.02-4, RAI 09.01.05-3, RAI 09.01.05-6, RAI 09.03.02-3, RAI 09.03.02-4, RAI 09.03.02-5, RAI 09.03.02-6, RAI 09.03.02-8, RAI 10.02-1, RAI 10.02-2, RAI 10.02-3, RAI 10.02.03-1, RAI 10.02.03-2, RAI 10.03.06-1, RAI 10.03.06-5, RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3, RAI 10.04.10-2, RAI 11.01-2, RAI 12.03-5S1, RAI 13.01.01-1, RAI 13.01.01-1S1, RAI 13.02.02-1, RAI 13.03-4, RAI 13.05.02.01-2, RAI 13.05.02.01-2S1, RAI 13.05.02.01-3, RAI 13.05.02.01-3S1, RAI 13.05.02.01-4, RAI 13.05.02.01-4S1, RAI 14.02-7, RAI 19-31, RAI 19-31S1, RAI 19-38, RAI 20.01-13

Table 1.8-2: Combined License Information Items

Item No.	Description of COL Information Item	Section
COL Item 1.1-1:	A COL applicant that references the NuScale Power Plant design certification will identify the site-specific plant location.	1.1
COL Item 1.1-2:	A COL applicant that references the NuScale Power Plant design certification will provide the schedules for completion of construction and commercial operation of each power module.	1.1
COL Item 1.4-1:	A COL applicant that references the NuScale Power Plant design certification will identify the prime agents or contractors for the construction and operation of the nuclear power plant.	1.4
COL Item 1.7-1:	A COL applicant that references the NuScale Power Plant design certification will provide site-specific diagrams and legends, as applicable.	1.7
COL Item 1.7-2:	A COL applicant that references the NuScale Power Plant design certification will list additional site-specific piping and instrumentation diagrams and legends as applicable.	1.7
COL Item 1.8-1:	A COL applicant that references the NuScale Power Plant design certification will provide a list of departures from the certified design.	1.8
COL Item 1.9-1:	A COL applicant that references the NuScale Power Plant design certification will review and address the conformance with regulatory criteria in effect six months before the docket date of the COL application for the site-specific portions and operational aspects of the facility design.	1.9
COL Item 1.10-1:	A COL applicant that references the NuScale Power Plant design certification will evaluate the potential hazards resulting from construction activities of the new NuScale facility to the safety-related and risk significant structures, systems, and components of existing operating unit(s) and newly constructed operating unit(s) at the co-located site per 10 CFR 52.79(a)(31). The evaluation will include identification of management and administrative controls necessary to eliminate or mitigate the consequences of potential hazards and demonstration that the limiting conditions for operation of an operating unit would not be exceeded. This COL item is not applicable for construction activities (build-out of the facility) at an individual NuScale Power Plant with operating NuScale Power Modules.	1.10
COL Item 2.0-1:	A COL applicant that references the NuScale Power Plant design certification will demonstrate that site-specific characteristics are bounded by the design parameters specified in Table 2.0-1. If site-specific values are not bounded by the values in Table 2.0-1, the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of its combined license application.	2.0
COL Item 2.1-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site geographic and demographic characteristics.	2.1
COL Item 2.2-1:	A COL applicant that references the NuScale Power Plant design certification will describe nearby industrial, transportation, and military facilities. The COL applicant will demonstrate that the design is acceptable for each potential accident, or provide site-specific design alternatives.	2.2
COL Item 2.3-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific meteorological characteristics for Section 2.3.1 through Section 2.3.5, as applicable.	2.3
COL Item 2.4-1:	A COL applicant that references the NuScale Power Plant design certification will investigate and describe the site-specific hydrologic characteristics for Section 2.4.1 through Section 2.4.14, <del>as applicable</del> except Section 2.4.8 and Section 2.4.10.	2.4
COL Item 2.5-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific geology, seismology, and geotechnical characteristics for Section 2.5.1 through Section 2.5.5, below.	2.5

**Table 1.8-2: Combined License Information Items (Continued)**

Item No.	Description of COL Information Item	Section
COL Item 12.2-1:	A COL applicant that references the NuScale Power Plant design certification will describe additional site-specific contained radiation sources that exceed 100 millicuries (including sources for instrumentation and radiography) not identified in Section 12.2.1.	12.2
COL Item 12.3-1:	A COL applicant that references the NuScale Power Plant design certification will develop the administrative controls regarding access to high radiation areas per the guidance of Regulatory Guide 8.38.	12.3
COL Item 12.3-2:	A COL applicant that references the NuScale Power Plant design certification will develop the administrative controls regarding access to very high radiation areas per the guidance of Regulatory Guide 8.38.	12.3
COL Item 12.3-3:	A COL applicant that references the NuScale Power Plant design certification will specify personnel exposure monitoring hardware, specify contamination identification and removal hardware, and establish administrative controls and procedures to control access into and exiting the radiologically controlled area.	12.3
COL Item 12.3-4:	A COL applicant that references the NuScale Power Plant design certification will develop the processes and programs necessary for the implementation of 10 CFR 20.1501 related to conducting radiological surveys, maintaining proper records, calibration of equipment, and personnel dosimetry.	12.3
COL Item 12.3-5:	A COL applicant that references the NuScale Power Plant design certification will describe design criteria for locating additional area radiation monitors.	12.3
COL Item 12.3-6:	A COL applicant that references the NuScale Power Plant design certification will develop the processes and programs necessary for the use of portable airborne monitoring instrumentation, including accurately determining the airborne iodine concentration in areas within the facility where plant personnel may be present during an accident.	12.3
COL Item 12.3-7:	A COL applicant that references the NuScale Power Plant design certification will develop the processes and programs associated with Objectives 5 and 6, to work in conjunction with design features, necessary to demonstrate compliance with 10 CFR 20.1406, and the guidance of Regulatory Guide 4.21.	12.3
<u>COL Item 12.3-8:</u>	<u>A COL applicant that references the NuScale Power Plant design certification will describe the radiation shielding design measures used to compensate for the main steam and main feedwater piping penetrations through the Reactor Building pool wall between the NuScale Power Module bays and the Reactor Building steam galleries near the 100 ft elevation (Shown on Figure 3.6-16 and Figure 3.6-17).</u>	
COL Item 12.4-1:	A COL applicant that references the NuScale Power Plant design certification will estimate doses to construction personnel from a co-located existing operating nuclear power plant that is not a NuScale Power Plant.	12.4
COL Item 12.5-1:	A COL applicant that references the NuScale Power Plant design certification will describe elements of the operational radiation protection program to ensure that occupational and public radiation exposures are as low as reasonably achievable in accordance with 10 CFR 20.1101.	12.5
COL Item 13.1-1:	A COL applicant that references the NuScale Power Plant design certification will provide a description of the corporate or home office management and technical support organization, including a description of the qualification requirements for (1) each identified position or class of positions that provide technical support to the onsite operating organization, and (2) individuals holding management and supervisory positions in organizational units providing technical support to the onsite operating organization.	13.1
COL Item 13.1-2:	A COL applicant that references the NuScale Power Plant design certification will provide a description of the proposed structure, functions, and responsibilities of the onsite organization necessary to operate and maintain the plant. The proposed operating staff shall be consistent with the minimum licensed operator staffing requirements in Section 18.5.	13.1
COL Item 13.1-3:	A COL applicant that references the NuScale Power Plant design certification will provide a description of the qualification requirements for each management, operating, technical, and maintenance position described in the operating organization.	13.1

The operating NuScale Power Module (NPM) dose rate at full power is also calculated using MCNP6. The reactor shielding calculations consider dose rates from fission neutrons, fission photons, and gamma output from buildup of radioisotopes in the reactor coolant. The NPM model is conservatively developed using methods similar to the building evaluations. The NPM model determines dose rates for components located below the bioshield.

The fission neutron and fission photon output is based on a total power output of 160 MWt and energy spectrums are based on MCNP6 and SCALE6.1 (Reference 12.3-11) fission neutron and fission gamma distributions. The gamma output from the reactor coolant is based on the reactor coolant isotopic inventory described in Section 12.2. In order to reduce complexity, some region densities (e.g., water and piping in the SGs) are homogenized in the MCNP model. This simplification does not result in significant differences in dose rates. Figure 12.3-3 shows the homogenized regions and the general arrangement of the NPM shielding model.

The shielding thicknesses are selected to reduce the aggregate dose rate from significant radiation sources in surrounding areas to values below the upper limit of the radiation zone depicted in the zone maps (see Figure 12.3-1a through Figure 12.3-1i). Radiation zones are selected to facilitate personnel access for operation and maintenance.

#### 12.3.2.4 Major Component Shielding Design Description

##### 12.3.2.4.1 NuScale Power Module

An NPM is a self-contained nuclear steam supply system composed of a reactor core, a pressurizer, two steam generators integrated within the reactor pressure vessel, CRDMs and valves, and is housed in a compact steel containment vessel. The containment vessel is partially immersed in the reactor pool as shown in Figure 1.2-5.

Biological shielding is provided above each NPM to allow personnel access above the 126' elevation in the RXB. The bioshield design is described in Section 3.7.3.

The containment vessel, pool water, and pool wall provide shielding and attenuation. The pool wall thickness is used for attenuating radiation from the radiation sources associated with the NPM.

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COL Item 12.3-8: A COL applicant that references the NuScale Power Plant design certification will describe the radiation shielding design measures used to compensate for the main steam and main feedwater piping penetrations through the Reactor Building pool wall between the NuScale Power Module bays and the Reactor Building steam galleries near the 100 ft elevation (Shown on Figure 3.6-16 and Figure 3.6-17).