December 18, 2017

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 Supplemental Response to NRC Request for Additional Information No. 04 (eRAI No. 8760) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 04 (eRAI No. 8760)," dated April 25, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 04 (eRAI No.8760)," dated June 26, 2017

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 Enclosures to this letter contain NuScale's supplemental response to the following RAI Questions from NRC eRAI No. 8760:

- 09.01.01-1
- 09.01.01-2
- 09.01.01-3
- 09.01.01-4
- 09.01.01-7
- 09.01.01-11

Enclosure 1 is the proprietary version of the NuScale Supplemental Response to NRC RAI No. 04 (eRAI No. 8760). NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3) supports this request. Enclosure 2 is the nonproprietary version of the NuScale response.

This letter and the enclosed responses 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
Samuel Lee, NRC, OWFN-8G9A
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8760, proprietary

Enclosure 2: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8760, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-1217-57705

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8760, proprietary

NuScale Power, LLC
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Enclosure 2:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8760, nonproprietary

NuScale Power, LLC
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Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 8760
Date of RAI Issue: 04/25/2017

NRC Question No.: 09.01.01-1

Title 10 of the *Code of Federal Regulations* (10 CFR) 50.68(b)(4) requires, for criticality analyses that take credit for soluble boron, that the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water.

To meet 10 CFR 50.68(b)(4), the staff considers it acceptable to demonstrate through criticality analyses that:

- For normal conditions, k-effective does not exceed 0.95 when flooded with borated water and remains below 1.0 when flooded with unborated water; and
- For abnormal conditions, k-effective does not exceed 0.95 when flooded with borated water.

Technical report TR-0816-49833-P, "Fuel Storage Rack Analysis," contains a criticality analysis for damaged fuel to demonstrate that k-effective remains below 0.95 when flooded with borated water. However, the staff considers the need for the racks to hold five damaged fuel assemblies to be a design feature of the racks and therefore a normal condition, contrary to the statement in FSAR Tier 2, Section 9.1.1.3.2 that damaged fuel constitutes an abnormal condition. Therefore, provide justification that k-effective remains below 1.0 when the racks are flooded with unborated water. To demonstrate compliance with 10 CFR 50.68(b)(4), please update TR-0816-49833-P with such justification and clarify in FSAR Tier 2, Section 9.1.1.3.2 that damaged fuel is not an abnormal condition.

NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 04 (eRAI No. 8760) by NuScale letter RAIO-0617-54653 dated June 26, 2017. Pursuant to a conference call between NRC staff and NuScale on November 8, 2017, NuScale has revised certain sections, tables, and figures of the Technical Report for Fuel Storage Rack Analysis, TR-0816-49833, draft Revision 1. The revisions are related to the

criticality analysis of the fuel storage racks and address NRC staff comments on the original response.

Technical Report Table 3-73 has been revised to update the $k_{95/95}$ values because of the revisions to Table 3-74 as described in the supplemental response to Question 09.01.01-2. Also, for unborated water, the operational bias for structural material at 800 ppm was used instead of the value for no boron.

Impact on DCA:

Technical Report TR-0816-49833, Fuel Storage Rack Analysis, Table 3-73 has been revised as described in the response above and as shown in the markup provided in this response.

- Damaged fuel is concentrated at the center of a fuel storage rack.
- Damaged fuel is positioned in corner locations within the~~near the corner of a~~ fuel storage rack where the poison plates are slightly narrower.
- Damaged fuel is concentrated around a single corner of a single rack.
- All FAs are assumed to be damaged.

The results are shown in Table 3-73. The values of $k_{95/95}$ shown in this table are calculated using Equation 1 in Section 3.3.1, using the appropriate values shown in Table 3-74.

Table 3-73 Fuel storage damaged fuel analysis

~~Scenario~~	~~k_{eff}~~	~~σ~~	~~$k_{95/95}$~~
~~No damaged fuel, full pool~~	~~0.86580~~	~~0.00030~~	~~0.89845~~
~~5 damaged FAs in center of pool~~	~~0.86650~~	~~0.00028~~	~~0.89915~~
~~5 damaged FAs near corner poison plates~~	~~0.86513~~	~~0.00030~~	~~0.89778~~
~~All damaged FAs~~	~~0.87337~~	~~0.00027~~	~~0.90602~~

Scenario	k_{eff}	σ	$k_{95/95}$	Limit
No damaged fuel, full pool, 800 ppm boron	0.86693	0.00009	0.90196	0.95
5 damaged FAs, in center of rack, 800 ppm boron	0.86719	0.00009	0.90222	0.95
5 damaged FAs, in corner locations, 800 ppm boron	0.86696	0.00009	0.90199	0.95
5 damaged FAs, in one corner, 800 ppm boron	0.86677	0.00009	0.90180	0.95
All damaged FAs, 800 ppm boron	0.87381	0.00009	0.90884	0.95
No damaged fuel, full pool, fresh water, 0 ppm boron	0.91602	0.00010	0.94640	1
5 damaged FAs, in center of rack, 0 ppm boron	0.91637	0.00010	0.94675	1
5 damaged FAs, in corner locations, 0 ppm boron	0.91590	0.00009	0.94628	1
5 damaged FAs, in one corner, 0 ppm boron	0.91592	0.00010	0.94630	1
All damaged FAs, 0 ppm boron	0.92407	0.00010	0.95444	1

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eRAI No.: 8760
Date of RAI Issue: 04/25/2017

NRC Question No.: 09.01.01-2

Standard Review Plan (SRP) Section 9.1.1 provides guidance for complying with 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 62, "Prevention of criticality in fuel storage and handling," and 10 CFR 50.68. SRP Section 9.1.1 instructs the reviewer to verify that the fuel storage rack data are complete and that the criticality analysis conservatively incorporates fuel storage rack design data. Furthermore, SRP Section 9.1.1 states that the reviewer should evaluate the normal- and abnormal- conditions models to verify that normal and abnormal conditions are modeled correctly and that all modeling approximations and assumptions, including omitted materials, are appropriate.

Points 5 and 6 on Page 290 of TR-0816-49833-P state that the spent fuel storage rack criticality model omits some rack structural components and materials beyond the active fuel length because replacing the effectively non- interacting material with a moderator would increase reactivity. While the staff agrees this may be true for non- borated moderator, the applicant credits soluble boron for abnormal conditions. Because boron is a neutron absorber, replacing rack components with borated moderator may be non-conservative.

Therefore, to demonstrate compliance with GDC 62 and 10 CFR 50.68, please provide justification that replacing structural components and materials of the fuel racks with borated water would be conservative (the moderation effect of the borated moderator outweighs the absorption effect) or would have a negligible effect, and update TR- 0816-49833-P with such justification; or, alternatively, update the analysis to include the currently omitted structural components and materials.

NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 04 (eRAI No. 8760) by NuScale letter RAIO-0617-54653 dated June 26, 2017. Pursuant to a conference call between NRC staff and NuScale on November 8, 2017, NuScale has revised certain sections, tables, and figures of the Technical Report for Fuel Storage Rack Analysis, TR-0816-49833, draft Revision 1. The revisions are related to the

criticality analysis of the fuel storage racks and address NRC staff comments on the original response.

Technical Report Table 3-74 has been revised to update the values for operational bias for temperature, and for sigma, operational bias for temperature, for both unborated and borated water. The temperature bias values were recalculated because the temperature was set to 67 degrees F instead of the correct value of 67.73 degrees F. Also, the values for operational bias for structural material, and for sigma, operational bias for structural material, for borated water have been revised to be more precise. In addition, Table 3-76, Table 3-90, and Figure 3-204 have been revised to update the $k_{95/95}$ values using the updated values in Table 3-74.

Impact on DCA:

Technical Report TR-0816-49833, Fuel Storage Rack Analysis, Tables 3-74, 3-76, and 3-90; and Figure 3-204 have been revised as described in the response above and as shown in the markup provided in this response.

Table 3-74 Factors for $k_{95/95}$ calculation for fuel storage

~~Symbol~~	~~Value~~		~~Source~~
~~Δk_{sys}~~	~~B @ 0 ppm~~	~~0.00420~~	~~Section 3.3.4.1~~
	~~B @ 800 ppm~~	~~0.00376~~	
~~$bias_m$~~	~~-0.00064~~		~~Section 3.3.7~~
~~C~~	~~1.993~~		~~Section 3.3.7~~
~~σ_{sys}~~	~~B @ 0 ppm~~	~~0.000382~~	~~Section 3.3.4.1~~
	~~B @ 800 ppm~~	~~0.000396~~	
~~σ_{bias}~~	~~0.00676~~		~~Section 3.3.7~~
~~**Tolerance Factors for 800 ppm Dissolved Boron**~~			
~~σ_{tol}~~	~~0.001596~~		~~Table 3-72~~
~~Δk_{tol}~~	~~0.02476~~		~~Table 3-72~~
~~**Tolerance Factor for Unborated Moderator**~~			
~~σ_{tol}~~	~~0.001145~~		~~Table 3-71~~
~~Δk_{tol}~~	~~0.01886~~		~~Table 3-71~~

Symbol	**Description**	**Value**	**Source**
$bias_m$	Bias associated with the calculation methodology compared to benchmark	-0.00064	Section 3.3.7
σ_{Bias}	Sigma, Experiment bias	0.00676	Section 3.3.7
C	C, confidence factor	1.99300	Section 3.3.7
Δk_{tol}	Manufacturing tolerance, no boron	0.01886	Table 3-71
σ_{tol}	Sigma, manufacturing tolerance, no boron	0.00108	Table 3-71
Δk_{tol}	Manufacturing tolerance, 800 ppm	0.02476	Table 3-72
σ_{tol}	Sigma, manufacturing tolerance, 800 ppm	0.00160	Table 3-72
Δk_{sys}	Operational bias for temperature, no boron	0.00412	Section 3.3.4.1
σ_{sys}	Sigma, operational bias for temperature, no boron	0.00142	Section 3.3.4.1

Symbol	Description	Value	Source
Δk_{sys}	Operational bias for temperature, 800 ppm	0.00376	Section 3.3.4.1
σ_{sys}	Sigma, operational bias for temperature, 800 ppm	0.00154	Section 3.3.4.1
Δk_{sys}	Operational bias for structural material, no boron	0.00223	Section 3.3.6.1
σ_{sys}	Sigma, operational bias for structural material, no boron	0.00038	Section 3.3.6.1
Δk_{sys}	Operational bias for structural material, 800 ppm	0.00222	Section 3.3.6.1
σ_{sys}	Sigma, operational bias for structural material, 800 ppm	0.00042	Section 3.3.6.1

3.3.6.3 Assembly Dropped on Top of Rack

A dropped assembly lying on top of the rack in a horizontal position the fuel storage is at least {{ }}2(a),(c) from the top of the active fuel region of the assemblies stored in the rack.

For the fuel storage in water this distance represents approximately {{ }}2(a),(c), which is more than sufficient to neutronically uncouple the dropped assembly from the assemblies stored in the rack. Thus, an assembly dropped on top of a fuel storage rack in the SFP is not a criticality concern.

3.3.6.4 Assembly Dropped Outside of the Fuel Storage Rack

The SFP consists of 14 individual racks, arranged in three rows of five racks, with one corner rack omitted to allow for the FA elevator. For the nominal configuration, there is not enough space to drop a FA between two racks. The only location where an assembly can be dropped adjacent to a rack is in the empty corner with the elevator. In this scenario, the dropped FA is placed as close to the surrounding filled storage racks as possible. ~~This scenario is shown in~~ Figure 3—202 provides a general representation of the relative position for the dropped fuel assembly. Several cases were analyzed that considered a dropped FA, including located in the corner near the three racks, as well as directly adjacent (face-to-face) and half-way between two adjacent fuel assemblies in a rack. The cases also spanned the full width of the rack. The location of the dropped assembly was shown to be statistically insignificant. The results are shown in Table 3-75. The values of $k_{95/95}$ shown in this table are calculated using Equation 1 in Section 3.3.1, using the appropriate values shown in Table 3-74. Thus, an assembly dropped outside of a fuel storage rack in the SFP is not a criticality concern.

Table 3-76 k-effective and $k_{95/95}$ for a seismic event in the fuel storage

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}}2(a),(c)

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}}2(a),(c)

Figure 3—204 $k_{95/95}$ for a seismic event in the fuel storage

3.3.8 Summary of Criticality Evaluations

The results of the criticality analysis are summarized as follows:

- The normal and accident condition temperatures in the spent fuel pool range from 40 degrees F to 212 degrees F. The criticality analysis is performed at a temperature of 67.73 degrees F, and the $k_{95/95}$ calculated including additional bias and uncertainty for a minimum temperature of at 40 degrees F.

- The maximum $k_{95/95}$ with full density moderation in unborated water remains below the applicable limit of 1.0 for fuel stored in the storage racks without credit for burnup.

- The maximum $k_{95/95}$ with full density moderation in 800 ppm (natural boron) borated water remains below the applicable limit of 0.95 for fuel stored in the storage racks without credit for burnup.

- No accident condition is identified that would cause an inadvertent criticality.

- Considered a range of gaps and the seismic analysis confirmed that the gap is still within the allowed range and no permanent deformation occurred.

A summary of the criticality analysis results are presented in Table 3-90.

Table 3-90 Summary of criticality analysis results

Conditions	$k_{95/95}$	Limit
Flooded with unborated water at full moderator density	0.946400.94441	1.0
Flooded with water at 800 ppm boron, full moderator density	0.902010.89941	0.95
Flooded with water at 800 ppm boron, full moderator density, dropped FA	0.902170.89933	0.95
Flooded with water at 800 ppm boron, rack deformation of 1.140 cm compression per cell, which is (greater than the seismic deformation of {{ }}[2(a),(c)] 0.010 in)	0.941650.93926	0.95

The criticality analysis was completed without consideration for loading patterns or zoning consideration. Based on the conservative assumptions used in the criticality analysis, it is acceptable to place fuel in the racks in all cell locations.

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Date of RAI Issue: 04/25/2017

NRC Question No.: 09.01.01-3

SRP Section 9.1.1 provides guidance for complying with 10 CFR Part 50, Appendix A, GDC 62 and 10 CFR 50.68. SRP Section 9.1.1 instructs the reviewer to verify that abnormal conditions are modeled correctly and that all modeling approximations and assumptions are appropriate.

For the abnormal condition of an assembly dropped outside of the fuel storage rack, the staff observed that the current assumed location of the dropped fuel assembly, shown in Figure 3-202 of TR-0816-49833-P, does not appear to be the most limiting in terms of neutronic coupling. The staff expects that a fuel assembly dropped equidistant to and as close as possible to the three racks closest to the bottom left-hand corner of the figure would be most limiting.

Therefore, to demonstrate compliance with GDC 62 and 10 CFR 50.68, please either (a) provide justification as to why the current assumed location is conservative or (b) provide a new analysis of the more limiting location. In addition, update TR-0816-49833-P with this information accordingly.

NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 04 (eRAI No. 8760) by NuScale letter RAIO-0617-54653 dated June 26, 2017. Pursuant to a conference call between NRC staff and NuScale on November 8, 2017, NuScale has revised certain sections, tables, and figures of the Technical Report for Fuel Storage Rack Analysis, TR-0816-49833, draft Revision 1. The revisions are related to the criticality analysis of the fuel storage racks and address NRC staff comments on the original response.

Technical Report Table 3-75 has been revised to update the $k_{95/95}$ values because of the revisions to Table 3-74 as described in the supplemental response to Question 09.01.01-2.

Impact on DCA:

Technical Report TR-0816-49833, Fuel Storage Rack Analysis, Table 3-75 has been revised as described in the response above and as shown in the markup provided in this response.

Table 3-75 Spent fuel pool dropped fuel assembly analysis

Scenario	k_{eff}	σ	$k_{95/95}$
Full pool, no dropped fuel	0.866970.8 6684	0.000090.0 0031	0.902010.8 9949
1 dropped fuel assembly in fuel elevator area	0.867140.8 6668	0.000140.0 0026	0.902170.8 9933

3.3.6.5 Misloaded Fuel Assembly

The fuel storage analysis conservatively assumes the racks are completely loaded with FAs at the maximum reactivity. There are no restrictions on loading patterns, therefore, there is no possibility of misloading an assembly in the fuel storage racks.

3.3.6.6 Fuel Storage Racks Seismic Event

The mechanical analysis of the fuel storage racks for a seismic event demonstrates that the racks do not undergo permanent deformation. However, there is a transient deflection of no more than 0.010 inch{{ }}2(a),(c) per storage tube (see Section 3.1.4.10.6). The seismic event is analyzed with the single fuel storage rack model and periodic radial boundary conditions. The spacing between storage tubes is reduced in a series of cases to determine the maximum deformation that maintains $k_{95/95}$ less than the limit of 0.95. The results are shown in Table 3-76 and Figure 3—204. The values of $k_{95/95}$ shown in this table are calculated using Equation 1 in Section 3.3.1, using the appropriate values shown in Table 3-74. {{

}}2(a),(c)

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eRAI No.: 8760
Date of RAI Issue: 04/25/2017

NRC Question No.: 09.01.01-4

SRP Section 9.1.1 provides guidance for complying with 10 CFR Part 50, Appendix A, GDC 62 and 10 CFR 50.68. SRP Section 9.1.1 instructs the reviewer to evaluate the normal- and abnormal-conditions models to verify that normal and abnormal conditions are modeled correctly and that all modeling approximations and assumptions are appropriate. The reviewer is also to verify that normal-conditions models have been prepared for the full range of normal conditions.

In its criticality analyses, the applicant assumed a water density of 0.9982 g/cm^3, corresponding to a temperature of 67°F. According to Page 293 of TR-0816-49833-P, the spent fuel pool temperature range considering normal operation and accidents is 40-212°F. The staff notes that the water density assumed in the criticality analyses should correspond to the highest density possible within the spent fuel pool temperature range since this will maximize reactivity; in this case, the assumed density should correspond to that of 40°F water.

Therefore, to demonstrate compliance with GDC 62 and 10 CFR 50.68, please either (1) perform the criticality analyses assuming the maximum possible water density in the spent fuel pool or (2) provide justification for not assuming the maximum possible water density in the spent fuel pool. In addition, update TR-0816-49833-P accordingly.

NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 04 (eRAI No. 8760) by NuScale letter RAIO-0617-54653 dated June 26, 2017. Pursuant to a conference call between NRC staff and NuScale on November 8, 2017, NuScale has revised certain sections, tables, and figures of the Technical Report for Fuel Storage Rack Analysis, TR-0816-49833, draft Revision 1. The revisions are related to the criticality analysis of the fuel storage racks and address NRC staff comments on the original response.

Technical Report Sections 3.3.1 and 3.3.4.1; Tables 3-69, 3-70, and 3-74; and Figure 3-203 have been revised to update temperature values used in the analysis and the related results.

As described in the response to Question 09.01.01-4, to perform the criticality analysis assuming the maximum possible water density in the spent fuel pool, a bias term was developed based on an extrapolation to 40 degrees F. For this supplemental response, the bias was recalculated because the temperature was set to 67 degrees F instead of the correct value of 67.73 degrees F. Also, Table 3-67 has been revised to clarify a note on dimensions used in the analysis.

Impact on DCA:

Technical Report TR-0816-49833, Fuel Storage Rack Analysis, Sections 3.3.1 and 3.3.4.1; Tables 3-67, 3-69, 3-70, and 3-74; and Figure 3-203 have been revised as described in the response above and as shown in the markup provided in this response.

Criticality benchmark calculations are performed to establish the values of $bias_m$ and σ_{bias}. These calculations benchmark the ability of the criticality code to predict the reactivity of a system based on comparison to critical experiments. The criticality benchmark calculations and their applicability to the fuel rack analyses are documented in Section 3.3.7.

The fuel storage rack analyses assume the racks contain 17X17 fuel assemblies with a 0.374 in. fuel rod diameter and 0.496 in. fuel rod pitch. The FA parameters used for this analysis are shown in Table 3-66. The fuel storage rack analyses assume fresh fuel at the maximum allowable enrichment of 5 wt% U-235. The analyses do not take credit for burnup, zoning, or a loading pattern.

The design parameters for the racks that comprise the fuel storage are shown in Table 3-67. The material compositions are shown in Table 3-68. The analysis for the fuel storage uses a water density at 67.73 degrees F of 0.9982 g/cm^3. A bias term, defined in Section 3.3.4.1, is included in the calculation of $k_{95/95}$ to adjust the system operating temperature to 40 degrees F and a density of 1.0 g/cm^3.

Table 3-67 Fuel rack design parameters for criticality analysis

{{

Description	Nominal Value	Tolerance(Note 2)
{{		
		}}2(a),(c)
Fuel storage rack array size	11x11	
Fuel storage temperature range	40 to 212°F	

{{

}}2(a),(c)

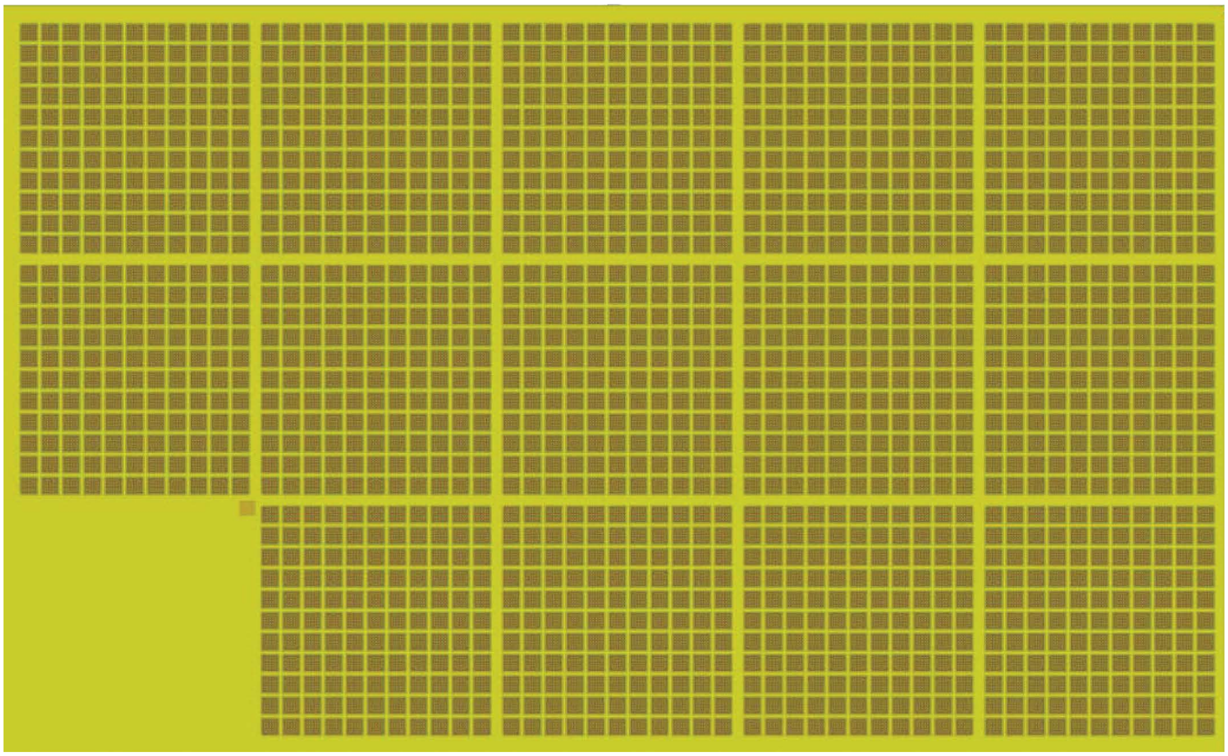

Figure 3—202 KENO-V.a model of the spent fuel pool

3.3.4 Initial Conditions, Boundary Conditions, and Limitations

3.3.4.1 Fuel Storage Model

The normal operating and accident condition temperature for the fuel storage racks is 40 degrees F to 212 degrees F (277.59 degrees K to 373.2 degrees K). The lowest available temperature in the 238 group ENDV/B-VIIENDF/B-VII cross section library is 67.73 degrees F (292.59293 degrees K). Therefore, to evaluate the sensitivity of the system to changes in temperature, cases are evaluated across a temperature range of 67.73 degrees F to 212 degrees F for 0 ppm boron and 800 ppm boron. The moderator density changes with the temperature for these cases, so the variation is due to both the temperature effect on the cross-section as well as the change in moderator density. The uncertainty terms for these cases are calculated using the root sum of squares of the base case and an uncertainty for the extrapolated value which was calculated by the statistical propagation of the errors of the curve fit coefficients.The moderator density is held at 1.0 g/cm^3 for these cases, so the variation is due to the temperature effect on the cross section. In order to evaluate the system for water temperatures as low as 40 degrees F, the reactivity trend calculated for the range of 67 degrees F to 212 degrees F is extrapolated to a temperature of 40 degrees F. The results of the temperature sensitivity calculations and the extrapolated data points are provided in Table 3-69.

Figure 3—203 shows how the system responds, with a slightly negative gradient (-1x10^{-4} slope) to increases in temperature, with or without boron in the moderator.

Table 3-69 System sensitivity to nominal temperature

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}}2(a),(c)

{{

}}2(a),(c)

Figure 3—203 System sensitivity to nominal temperature

The operational tolerances for the 0 ppm and 800 ppm boron cases are calculated as the differential between the base (67.73 degrees F) case and the 40 degrees F extrapolated case. The uncertainty terms for these cases are calculated using the root sum of squares of the base case and an assumed uncertainty for the 40 degrees F extrapolated case of 0.001420.00028. These operational tolerance values are applied in the $k_{95/95}$ calculation to account for the positive reactivity bias associated with the lower temperature of 40 degrees F.

Table 3-70 Operational tolerance impact on neutron multiplication

Conditions	Δk_{sys}	$\sigma_{\Delta k sys}$
Operational tolerance, 0 ppm	0.004120.00420	0.001420.000382
Operational tolerance, 800 ppm	0.003760.00376	0.001540.000396

3.3.5 Software Use and Qualification

KENO-V.a controlled by the CSAS5 module of SCALE Version 6.1.3 is qualified for use. SCALE Version 6.1.3 is the software used to perform safety-related calculations in accordance with AREVA procedures.

Table 3-74 Factors for $k_{95/95}$ calculation for fuel storage

Symbol	Value		Source
Δk_{sys}	B @ 0 ppm	0.00420	Section 3.3.4.1
	B @ 800 ppm	0.00376	
$bias_m$	-0.00064		Section 3.3.7
C	1.993		Section 3.3.7
σ_{sys}	B @ 0 ppm	0.000382	Section 3.3.4.1
	B @ 800 ppm	0.000396	
σ_{bias}	0.00676		Section 3.3.7
Tolerance Factors for 800 ppm Dissolved Boron			
σ_{tol}	0.001596		Table 3-72
Δk_{tol}	0.02476		Table 3-72
Tolerance Factor for Unborated Moderator			
σ_{tol}	0.001145		Table 3-71
Δk_{tol}	0.01886		Table 3-71

Symbol	Description	Value	Source
$bias_m$	Bias associated with the calculation methodology compared to benchmark	-0.00064	Section 3.3.7
σ_{Bias}	Sigma, Experiment bias	0.00676	Section 3.3.7
C	C, confidence factor	1.99300	Section 3.3.7
Δk_{tol}	Manufacturing tolerance, no boron	0.01886	Table 3-71
σ_{tol}	Sigma, manufacturing tolerance, no boron	0.00108	Table 3-71
Δk_{tol}	Manufacturing tolerance, 800 ppm	0.02476	Table 3-72
σ_{tol}	Sigma, manufacturing tolerance, 800 ppm	0.00160	Table 3-72
Δk_{sys}	Operational bias for temperature, no boron	0.00412	Section 3.3.4.1
σ_{sys}	Sigma, operational bias for temperature, no boron	0.00142	Section 3.3.4.1

Symbol	Description	Value	Source
Δk_{sys}	Operational bias for temperature, 800 ppm	0.00376	Section 3.3.4.1
σ_{sys}	Sigma, operational bias for temperature, 800 ppm	0.00154	Section 3.3.4.1
Δk_{sys}	Operational bias for structural material, no boron	0.00223	Section 3.3.6.1
σ_{sys}	Sigma, operational bias for structural material, no boron	0.00038	Section 3.3.6.1
Δk_{sys}	Operational bias for structural material, 800 ppm	0.00222	Section 3.3.6.1
σ_{sys}	Sigma, operational bias for structural material, 800 ppm	0.00042	Section 3.3.6.1

3.3.6.3 Assembly Dropped on Top of Rack

A dropped assembly lying on top of the rack in a horizontal position the fuel storage is at least {{ }}2(a),(c) from the top of the active fuel region of the assemblies stored in the rack.

For the fuel storage in water this distance represents approximately {{ }}2(a),(c), which is more than sufficient to neutronically uncouple the dropped assembly from the assemblies stored in the rack. Thus, an assembly dropped on top of a fuel storage rack in the SFP is not a criticality concern.

3.3.6.4 Assembly Dropped Outside of the Fuel Storage Rack

The SFP consists of 14 individual racks, arranged in three rows of five racks, with one corner rack omitted to allow for the FA elevator. For the nominal configuration, there is not enough space to drop a FA between two racks. The only location where an assembly can be dropped adjacent to a rack is in the empty corner with the elevator. In this scenario, the dropped FA is placed as close to the surrounding filled storage racks as possible. ~~This scenario is shown in~~ Figure 3—202 provides a general representation of the relative position for the dropped fuel assembly. Several cases were analyzed that considered a dropped FA, including located in the corner near the three racks, as well as directly adjacent (face-to-face) and half-way between two adjacent fuel assemblies in a rack. The cases also spanned the full width of the rack. The location of the dropped assembly was shown to be statistically insignificant. The results are shown in Table 3-75. The values of $k_{95/95}$ shown in this table are calculated using Equation 1 in Section 3.3.1, using the appropriate values shown in Table 3-74. Thus, an assembly dropped outside of a fuel storage rack in the SFP is not a criticality concern.

NuScale Power

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

eRAI No.: 8760
Date of RAI Issue: 04/25/2017

NRC Question No.: 09.01.01-7

SRP Section 9.1.1 provides guidance for complying with 10 CFR Part 50, Appendix A, GDC 62 and 10 CFR 50.68. SRP Section 9.1.1 states that the normal- and abnormal-conditions models should address dimensional and material tolerances and uncertainties. In addition, the applicant cites ANSI/ANS-57.2 as guidance considered in the spent fuel storage facility design, and SRP Section 9.1.1 includes ANSI/ANS-57.2 as an acceptance criterion for meeting GDC 62. ANSI/ANS-57.2 states that dimensional tolerances should be a factor in determining the fuel assembly arrangement with the highest value of k-effective.

Page 296 of TR-0816-49833-P states that the total uncertainty due to the tolerance analysis (σtol) is calculated as the square root of the sum of the squares (SRSS) of the individual uncertainty values for each tolerance examined. The staff notes that the values of σtol in Tables 3-71 and 3-72 of TR-0816-49833-P seem incorrect based its own confirmatory calculation and its understanding of the method to calculate σtot. Particularly, it appears that the reported values in Tables 3-71 and 3-72 under-calculate the uncertainty by 60 to 105 percent millirho. Because the uncertainty due to mechanical tolerances affects the margin to the criticality limits in 10 CFR 50.68, please confirm that the method used to calculate σtol is SRSS, as described in TR-0816-49833-P, and verify that the values for σtol were calculated correctly. If it is determined that errors were made in TR-0816-49833-P, update either (a) the calculation description or (b) Tables 3-71 and 3-72 and any other calculations or conclusions that use the information in Tables 3-71 and 3-72, as appropriate.

NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 04 (eRAI No. 8760) by NuScale letter RAIO-0617-54653 dated June 26, 2017. Pursuant to a conference call between NRC staff and NuScale on November 8, 2017, NuScale has revised certain sections, tables, and figures of the Technical Report for Fuel Storage Rack Analysis, TR-0816-49833, draft Revision 1. The revisions are related to the criticality analysis of the fuel storage racks and address NRC staff comments on the original response.

Technical Report Table 3-71 was revised to correct values in three rows identified during the review of the criticality analysis for the supplemental responses to RAI 8760.

Impact on DCA:

Technical Report TR-0816-49833, Fuel Storage Rack Analysis, Table 3-71 has been revised as described in the response above and as shown in the markup provided in this response.

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}}2(a),(c)

NuScale Power

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

eRAI No.: 8760
Date of RAI Issue: 04/25/2017

NRC Question No.: 09.01.01-11

GDC 62 requires criticality in the fuel storage and handling system to be prevented by physical systems or processes, preferably by use of geometrically safe configurations. 10 CFR 50.68 defines the limits on k-effective for new and spent fuel storage. The information in the design certification application that supports meeting these regulations needs to be accurate and consistent so the staff is able to make a reasonable assurance finding.

The staff noted that Section 3.3 of TR-0816-49833-P contains several apparent typographical errors that affect technical meaning or details. These errors are listed below:

a. Section 3.3.6.6, "Fuel Storage Racks Seismic Event," states that there is a transient deflection of no more than 0.010 inch per storage tube. However, Table 3-22, "Maximum fuel assembly gap reduction," in Section 3.1.4.10.6 shows that the maximum fuel assembly gap reduction is {{ }}[2(a)(c)], more than twice what is stated in Section 3.3.6.6.
b. Table 3-77, "Parameter range for critical experiment selection," makes it appear as though the criticality analyses used a moderator density of 1.0 g/cm³, while they actually used a density of 0.9982 g/cm³ according to Page 286.
c. Section 3.3.7.1 appears to contain several incorrect references:
    i. In Section 3.3.7.1.1, NUREG/CR-6361 is referenced, while the equations actually come from NUREG/CR-6698
    ii. In Section 3.3.7.1.2, ANSI N15.15-1974 is listed as Reference 21 but should be Reference 22 according to the References list
    iii. The equations listed in Section 3.3.7.1.2 appear to come from ANSI N15.15-1974, not NUREG/CR-6361
d. Section 3.3.7.2 appears to contain some incorrect references and information:
    i. Experiment LEU-COMP-THERM-001 only contains pitches of 2.032 cm (not 1.684 cm)
    ii. Experiment LEU-COMP-THERM-002 only contains pitches of 2.54 cm (not 1.892 cm)
    iii. Experiment LEU-COMP-THERM-010 is from Ref. 23, not 22
    iv. Experiment PAT80 is from Ref. 21, not 23
e. In Section 3.3.7.6, "Bias and Bias Uncertainty," the terms appear to be reversed in the equation for the bias

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f. In Table 3-90, “Summary of criticality analysis results,” the following items appear to be inconsistent with other information in the report:
   i. $k_{95/95}$ when flooded with unborated water at full moderator density is listed as 0.94440, not 0.94441, in Table 3-69, “System sensitivity to nominal temperature”
   ii. In the last row of the table, the cited seismic deformation of 0.010 is inconsistent with the {{ }}$^{2(a)(c)}$ listed in Section 3.1.4.10.6.

Please address the above items by either (1) updating TR-0816-49833-P to correct them or (2) justifying why the information is accurate

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NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 04 (eRAI No. 8760) by NuScale letter RAIO-0617-54653 dated June 26, 2017. Pursuant to a conference call between NRC staff and NuScale on November 8, 2017, NuScale has revised certain sections, tables, and figures of the Technical Report for Fuel Storage Rack Analysis, TR-0816-49833, draft Revision 1. The revisions are related to the criticality analysis of the fuel storage racks and address NRC staff comments on the original response.

Technical Report Table 3-90 has been revised to update the $k_{95/95}$ values because of the revisions to Table 3-74 as described in the supplemental response to Question 09.01.01-2. Also on the page with Table 3-90, Section 3.3.8 has been revised to correct the temperature.

Impact on DCA:

Technical Report TR-0816-49833, Fuel Storage Rack Analysis, Section 3.3.8 and Table 3-90 have been revised as described in the response above and as shown in the markup provided in this response.

3.3.8 Summary of Criticality Evaluations

The results of the criticality analysis are summarized as follows:

- The normal and accident condition temperatures in the spent fuel pool range from 40 degrees F to 212 degrees F. The criticality analysis is performed at a temperature of 67.73 degrees F, and the $k_{95/95}$ calculated including additional bias and uncertainty for a minimum temperature of at 40 degrees F.

- The maximum $k_{95/95}$ with full density moderation in unborated water remains below the applicable limit of 1.0 for fuel stored in the storage racks without credit for burnup.

- The maximum $k_{95/95}$ with full density moderation in 800 ppm (natural boron) borated water remains below the applicable limit of 0.95 for fuel stored in the storage racks without credit for burnup.

- No accident condition is identified that would cause an inadvertent criticality.

- Considered a range of gaps and the seismic analysis confirmed that the gap is still within the allowed range and no permanent deformation occurred.

A summary of the criticality analysis results are presented in Table 3-90.

Table 3-90 Summary of criticality analysis results

Conditions	$k_{95/95}$	Limit
Flooded with unborated water at full moderator density	0.946400.94441	1.0
Flooded with water at 800 ppm boron, full moderator density	0.902010.89941	0.95
Flooded with water at 800 ppm boron, full moderator density, dropped FA	0.902170.89933	0.95
Flooded with water at 800 ppm boron, rack deformation of 1.140 cm compression per cell, which is (greater than the seismic deformation of {{ }}[2(a),(c)]0.010 in)	0.941650.93926	0.95

The criticality analysis was completed without consideration for loading patterns or zoning consideration. Based on the conservative assumptions used in the criticality analysis, it is acceptable to place fuel in the racks in all cell locations.

Enclosure 3:

Affidavit of Thomas A. Bergman, AF-1217-57705

NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

1. I am the Director of Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on behalf of NuScale.
2. I am knowledgeable of the criteria and procedures used by NuScale in designating information as a trade secret, privileged, or as confidential commercial or financial information. This request to withhold information from public disclosure is driven by one or more of the following:
   a. The information requested to be withheld reveals distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by NuScale competitors, without a license from NuScale, would constitute a competitive economic disadvantage to NuScale.
   b. The information requested to be withheld consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), and the application of the data secures a competitive economic advantage, as described more fully in paragraph 3 of this Affidavit.
   c. Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.
   d. The information requested to be withheld reveals cost or price information, production capabilities, budget levels, or commercial strategies of NuScale.
   e. The information requested to be withheld consists of patentable ideas.
3. Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying Request for Additional Information response reveals distinguishing aspects about the methods by which NuScale develops its fuel storage rack design.

   NuScale has performed significant research and evaluation to develop a basis for this methods and has invested significant resources, including the expenditure of a considerable sum of money.

   The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale. If the information were disclosed to the public, NuScale's competitors would have access to the information without purchasing the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, and would deprive NuScale of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

4. The information sought to be withheld is in the enclosed response to NRC Request for Additional Information Supplemental RAI No. 04, eRAI No. 8760. The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.
5. The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).
6. Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld:
   a. The information sought to be withheld is owned and has been held in confidence by NuScale.
   b. The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.
   c. The information is being transmitted to and received by the NRC in confidence.
   d. No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.
   e. Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would be difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on 12/18/2017.

Zackary W. Rad