RAIO-1117-57382

November 28, 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 Response to NRC Request for Additional Information No. 244 (eRAI No. 9013) on the NuScale Design Certification Application

**REFERENCE:** U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 244 (eRAI No. 9013)," dated September 29, 2017

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosures to this letter contain NuScale's response to the following RAI Questions from NRC eRAI No. 9013:

- 09.01.02-29
- 09.01.02-30
- 09.01.02-31

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 244 (eRAI No. 9013). 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
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9013, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9013, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-1117-57383

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**Enclosure 1:**

NuScale Response to NRC Request for Additional Information eRAI No. 9013, proprietary

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**Enclosure 2:**

NuScale Response to NRC Request for Additional Information eRAI No. 9013, nonproprietary

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

**eRAI No.:** 9013
**Date of RAI Issue:** 09/29/2017

**NRC Question No.:** 09.01.02-29

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4, 5, 63, and 10 CFR 52.80(a) provide the regulatory requirements for the design of the new and spent fuel storage facilities. SRP Sections 9.1.2 and DSRS Sections 3.8.4 Appendix D describe the specific SRP acceptance criteria for the review of the fuel racks to meet the requirements of the Commission's regulations identified above.

On page 156 of TR-0816-49833-P, in Section 3.1.4.10.1, the applicant discusses the peak accelerations in the X, Y, and Z directions of the rack response for the seven time history analyses. The applicant should explain how the "average acceleration" is determined and justify why this approach results in the maximum stresses in all parts of the rack.

This section of the report also states, "Scrutiny of the acceleration data for TH1 found that fuel storage Rack #14 (for μ=0.20) undergoes the peak acceleration in the Y and Z direction with less than peak acceleration in the X direction. For μ=0.80, fuel storage Rack #13 observes the peak acceleration in the X, Y, and Z directions. Therefore, Racks #14 and #13 are considered to be crucial for design for μ=0.20 and 0.80 respectively using TH1 results."

As indicated above, for the case of μ=0.20, the selected Rack #14 does not experience the maximum acceleration of the racks in the X direction for TH1. In addition, the peak accelerations in the X, Y, and Z directions most probably do not occur at the same time. Therefore, the applicant should explain why only selecting Rack #14 bounds all other racks in TH1 and the racks in the other time history evaluations.

Similarly, for the case of μ=0.80, Rack #13 was selected for TH1; however, the peak accelerations in the X, Y, and Z directions most probably do not occur at the same time. The applicant should explain why only selecting Rack #13 bounds all other racks in TH1 and the racks in the other time history evaluations.

**NuScale Response:**

The accelerations for each part of the spent fuel storage racks in the spent fuel pool are determined from the output ASCII "matsum" file for each run. The accelerations given at any

time point for a part are averaged based on the mass aggregate of all nodes that makes up that part. The “average acceleration” for each spent fuel storage rack is calculated as the mass aggregate of its component parts.

In response to the remaining questions raised in this RAI question, please see the response to Question 09.01.02-30 of RAI 9013. That RAI question response contains a detailed explanation of how the total population of time history loading results was reduced to the subset of results utilized for rack design.

**Impact on DCA:**

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

NuScale Power™

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

**eRAI No.:** 9013
**Date of RAI Issue:** 09/29/2017

**NRC Question No.:** 09.01.02-30

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4, 5, 63, and 10 CFR 52.80(a) provide the regulatory requirements for the design of the new and spent fuel storage facilities. SRP Sections 9.1.2 and DSRS Sections 3.8.4 Appendix D describe the specific SRP acceptance criteria for the review of the fuel racks to meet the requirements of the Commission's regulations identified above.

On Page 161 of TR-0816-49833-P, in Section 3.1.4.10.5, the applicant describes the selection of a reduced set of racks and time histories for the detailed design of the racks based on rack contact forces. These selected racks are in addition to the racks selected based on the maximum average accelerations and the maximum sliding and uplift, which are described in Sections 3.1.4.10 and 3.1.4.10.2 of the technical report, respectively. The selection of the specific racks based on contact forces only includes rack baseplate to rack baseplate contact forces and baseplate to rack exterior surface contact forces. Therefore, explain why the selection of racks for detailed design did not also include contact forces between adjacent rack exterior faces (Table 3-19) and the peak FA impact forces (Table 3-21).

In several of the tables, such as Table 3-18 for storage rack baseplate forces and Table 3-21 for peak FA impact forces, the term "Peak Lateral Force" or "Force-Lateral" is used in addition to providing the Peak Horizontal X and Y forces. Explain what these two terms mean and how the peak values are determined.

**NuScale Response:**

Multiple whole pool analyses were performed to investigate the resulting forces and stresses in the racks. The various runs performed are summarized in the table "Summary of Whole Pool Analyses Performed" (see RAI 9011 Response to Question 09.01.02-27). Table "Summary of Seismic Load Cases Considered for Detailed Design" (see RAI 9011 Response to Question 09.01.02-27) contains a summary of the seismic load cases subsequently considered for detailed design of the fuel racks. The following is a more detailed explanation of how the total population of time history loading results was reduced to the subset of results utilized for rack design.

*Note: For the following discussion, the term "result set" refers to the resulting loads on a given rack (i.e., #2 thru #15), for a given time history run (i.e., TH1, LF1, LF2, LF3, LF4, HF1, or HF2), and for a given coefficient of friction (COF) (i.e., 0.20 or 0.80).*

Step 1

A whole pool analysis was performed using time history TH1, COF values of 0.20 and 0.80, with all 14 racks 100% filled (1404 fuel assemblies). This resulted in a total of 28 result sets: (14 racks)(1 time history)(2 COF values) = 28 result sets. The data resulting from these 28 result sets was post-processed and investigated to determine which result set(s) controlled each of the following selection criteria:

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}}2(a),(c)

*Note 1: Investigation of the results confirmed that no such contact occurred.*

For each of the result sets determined to control one or more of the above selection criteria, the displacement time history was exported for use in detailed design of the rack. Additionally, the maximum leg forces were identified.

The racks were subsequently designed for all appropriate load combinations. For load combinations which included Design Basis Event seismic loadings (E'), the findings of the result sets identified above were addressed, as described in the following bullets. The following actions were repeated for each selected result set.

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}}2(a),(c)

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}}2(a),(c)

This concluded the design based on the original whole pool analysis (TH1).

Step 2

- Subsequently, an additional whole pool analysis was performed using multiple time histories (LF1, LF2, LF3, LF4, HF1, HF2) and COF values of 0.20 and 0.80, with all 14 racks 100% filled (1404 fuel assemblies). This produced a total of 168 result sets: (14 racks)(6 time histories)(2 COF values) = 168 result sets. The data produced from these 168 result sets was post-processed and investigated to determine which result set(s) exceeded the controlling results obtained from Step 1 (TH1 analysis/design). The following result sets were selected:

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}}2(a),(c)

*Note 1: Investigation of the results confirmed that no such contact occurred.*

For each of the result sets identified above, the displacement time history was exported for use in detailed design of the rack. Additionally, the maximum leg forces were identified.

The rack design resulting from the Step 1 analysis and design was reviewed for additional load combinations to address the additional result sets identified above. The design process was performed in a similar manner as outlined above for Step 1. These additional design activities confirmed that the rack design originally validated against the TH1 results was also suitable for the result sets identified in Step 2, and retained significant design margin as compared to the applicable code-allowable stresses.

No changes to the original rack design resulted from the additional Step 2 analysis and design activities.

In response to the last paragraph of the RAI question: Referring specifically to the terms used in TR-0816-49833-P, Table 3-18, the “Peak Horizontal X Force” represents the maximum horizontal force in the X-direction throughout the investigated set of time history results. Similarly, the “Peak Horizontal Y Force” represents the maximum horizontal force in the Y-direction throughout the investigated set of time history results. For each time step, the forces in the X- and Y-directions are combined using SRSS to determine the effective lateral force at that time step. The “Peak Lateral Force” represents the maximum of those SRSS values throughout the investigated set of time history results. The terms used in TR-0816-49833-P, Table 3-21

represent the same type of data, but for resulting forces on the fuel assembly. “Force-X” is determined in a similar manner as “Peak Horizontal X Force”, “Force-Y” is determined in a similar manner as “Peak Horizontal Y Force”, and “Force-Lateral” is determined in a similar manner as “Peak Lateral Force”.

**Impact on DCA:**

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

NuScale Power™

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

**eRAI No.:** 9013
**Date of RAI Issue:** 09/29/2017

**NRC Question No.:** 09.01.02-31

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4, 5, 63, and 10 CFR 52.80(a) provide the regulatory requirements for the design of the new and spent fuel storage facilities. SRP Sections 9.1.2 and DSRS Sections 3.8.4 Appendix D describe the specific SRP acceptance criteria for the review of the fuel racks to meet the requirements of the Commission's regulations identified above.

The applicant provided the following statements in the Technical Report.

Section 3.1.5.1 "Methodology" (p. 165) states, "Displacement time histories from the LS-DYNA analysis described in Section 3.1.4 are mapped from the simplified model of the worst-loaded racks to the detailed model in ANSYS V15.0.7. The displacement time history is used to develop the stresses seen in the fuel storage rack components during a seismic event for Level D type design."

Section 3.1.5.5.3 "Service Level D" (p. 177) states, "A displacement time history is extracted from this whole pool for the racks with worst-case loading (as documented in Section 3.1.4.11) and then applied to either the simplified or detailed stress model for use in this stress evaluation.

Because the simplified rack model used in the whole pool analysis uses a combination of shell-and-beam elements, displacements at all nodes cannot be accurately mapped to the detailed model and solved simultaneously. To simplify the analysis, stresses in the shell-and-beam elements are analyzed separately."

Section 3.1.5.5.3 "Service Level D," under the heading "Plate-and-Shell Type" (p.177), states, "Once the mapping process is completed, the post-processing file "sfs_post_s.inp" is used to extract the maximum stress intensity for each component and compare it to the allowable stress for plastic analysis. Nodal results are taken for the external surface of the shells, providing membrane plus bending stresses…

Because accelerations are not being directly applied to this model, the fuel-tube density does not need to be modified to account for the mass of the FAs."

To fully understand the approach being used, the applicant is requested to:

(1) describe in greater detail how the mapping process is implemented, including the situation when there is no one-to-one correspondence in nodes,

(2) explain whether the displacement time histories are being mapped to the simplified or detailed model results in a series of static analyses with the mapped displacements, performed one step at a time, or are the results from a dynamic time history analysis, using the whole pool displacement time history as input.

(3) clearly explain why the stress analysis is performed, in some cases, on the simplified rack model rather than the detailed rack model, as stated on page 177.

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**NuScale Response:**

The following are detailed descriptions of scripts utilized to map the whole pool analysis displacements and perform the design. The first set of scripts addresses displacements coming from SHELL elements in the whole pool simplified model (i.e, fuel tubes, baseplate, upper and lower grids). The second set of scripts addresses displacements pulled from BEAM elements of the whole pool simplified model (i.e., corner posts, middle, and top bands).

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}}2(a),(c)

**Detailed description of scripts used for analysis of SHELL elements within the simplified model**

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}}2(a),(c)

**Detailed description of scripts used for analysis of BEAM elements within the simplified model**

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}}2(a),(c)

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}}2(a),(c)

**Impact on DCA:**

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

**Enclosure 3:**

Affidavit of Zackary W. Rad, AF-1117-57383

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**NuScale Power, LLC**

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

1. I am the Director, 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 for structural design by which NuScale develops its fuel storage racks.

    NuScale has performed significant research and evaluation to develop a basis for this methods for structural design 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 No. 244, eRAI No. 9013. 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 11/28/2017.

Zackary W. Rad