RAIO-0118-58378

January 29, 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. 187 (eRAI No. 9014) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 187 (eRAI No. 9014)," dated August 18, 2017
2. NuScale Power, LLC Response to NRC Request for Additional Information No. 187 (eRAI No. 9014) on the NuScale Design Certification Application, dated November 10, 2017, (ML17314A030)

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 Question from NRC eRAI No. 9014:

- 09.01.02-11

The response to the other ten RAI questions of eRAI 9014 were previously provided in Reference 2. This completes all responses to eRAI 9014.

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 187 (eRAI No. 9014). 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 Response to NRC Request for Additional Information eRAI No. 9014, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9014, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0118-58379

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9014, proprietary

Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9014, nonproprietary

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

eRAI No.: 9014
Date of RAI Issue: 08/18/2017

NRC Question No.: 09.01.02-11

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. DSRS 3.8.4, Appendix D, I.4 specifically states, "The temperature gradient across the rack structure that results from the differential heating effect between full and empty tube(s) should be indicated and incorporated in the design of the rack structure."

The staff review of FSAR Section 9.1.2 and TR-0816-49833 did not identify that the differential heating effect between full and empty tube(s) was incorporated in the design of the rack structure. The applicant should identify where this evaluation is described in the technical report, or justify why it is not incorporated in the design of the rack structure.

NuScale Response:

The spent fuel racks are not constrained in any way (they are freestanding on the bottom of the pool), they are constructed of sheet and plate material, and sit in a large body of water; therefore, differential stresses due to thermal effects will not be significant. To confirm, several load cases were investigated to predict the maximum thermal stresses. Maximum thermal stresses were expected to occur due to localized, concentrated thermal loads. The smallest thermal stresses were expected from a uniform temperature distribution over the fuel storage structure. Therefore, the following scenarios were investigated:

1. Thermal load due to an offloaded fuel assembly was imposed on one corner cell. A corner cell was selected because it is exposed to colder pool ambient water and is reinforced with a corner post and cross bars. Such configuration warrants the largest temperature gradients and structural discontinuities.

2. Thermal load due to an offloaded fuel assembly was imposed on one corner cell and one neighboring cell at the rack periphery. These cells were selected for the same reason as in case 1. Two cells with thermal loads were chosen to investigate their interaction.
3. Thermal load due to an offloaded fuel assembly was imposed on one corner cell and two additional neighboring cells at the rack periphery. These cells were selected for the same reason as in case 1 and 2. Three cells with thermal loads were chosen to investigate their interaction.
4. Thermal load due to an offloaded fuel assembly was imposed on one central cell.
5. Thermal load due to an abnormal condition of blocked flow path was imposed on one corner cell. Only one cell was investigated since occurrence of multiple neighboring cells being blocked is unlikely.
6. Thermal load due to an abnormal condition of blocked flow path was imposed on one central cell.

Figures 1 through 13 show plots of fuel storage rack temperatures and stress intensities.

Review of the fuel storage structural behavior under thermal load due to one or more freshly offloaded fuel assemblies concluded that the maximum stresses are localized at the top portion of cells that are next to an empty cell (no thermal loads). Stresses at the bottom of the fuel storage rack are negligible due to very small temperature gradients and relatively low temperatures. Neighboring fuel storage racks are placed in a way that their bases have no gap between them and their tops maintain gaps. Since there are small temperature differences at the rack bottoms, and tops are free to expand, the whole pool rack assembly did not need to be modeled. In the unlikely case of a significant thermal expansion at the bottom of the fuel storage racks, the maximum forces at the feet, bottom plates, and their connections due to the fuel storage racks thermally expanding and sliding would not exceed forces and resulting stresses generated by seismic motions. These forces and stresses are controlled by the friction between the fuel storage racks and the pool liner, and resulting stresses are secondary.

The maximum stress intensity that is also equal to first principal stress due to thermal load is {{ }}[2(a),(c)]. Figure 6 shows the results of the three fuel cell thermal load, which demonstrates that the stresses of the two thermally loaded cells nearest to the corner decrease slightly compared to the previous two cell load cases, and most importantly, that the largest stress is always at the cell that is next to an empty cell. This result confirms the expectation that once temperatures become more uniform, the stresses decrease. It is expected that a thermal load imposed on more cells or on all cells would not result in a significant increase of stress magnitudes.

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}}2(a),(c)

Figure 1 Corner Cell Temperature Distribution

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}}2(a),(c)

Figure 2 Corner Cell Stress Intensity

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}}2(a),(c)

Figure 3 Two Cell Temperature Distribution

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}}2(a),(c)

Figure 4 Two Cell Stress Intensity

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}}2(a),(c)

Figure 5 Three Cell Temperature Distribution

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}}2(a),(c)

Figure 6 Three Cell Stress Intensity

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}}2(a),(c)

Figure 7 Center Cell Temperature Distribution

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}}2(a),(c)

Figure 8 Center Cell Temperature Distribution Detailed View

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}}2(a),(c)

Figure 9 Center Cell Stress Intensity

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}}2(a),(c)

Figure 10 Corner Cell Temperature Distribution for Abnormal Condition

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}}2(a),(c)

Figure 11 Corner Cell Stress Intensity for Abnormal Condition

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}}2(a),(c)

Figure 12 Center Cell Temperature Distribution for Abnormal Condition

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}}2(a),(c)

Figure 13 Center Cell Stress Intensity for Abnormal Condition

The calculated stresses due to Level A/B thermal loads are of relatively low magnitude. In addition, subsection NF treats thermal stresses as self-limiting, secondary stresses per paragraph NF-3121.11, and, as such, they need not be considered for primary stress qualifications.

The thermal load is a one-time load occurrence resulting in very low stresses. Note that NF-3200 does not require consideration of fatigue damage. For consideration of fatigue per NF-3300, combined stresses from Level A/B are well below the stress range allowable limits of 15 ksi, per table NF-3332.4-1, for the worst case stress category "F," per table NF-3332.3-1 and loading condition "1", per table NF-3332.2-1.

Assumption 3 in Section 3.1.5.2 of TR-0816-49833 will be replaced with the following:

All materials used in the rack have the same mean rate of thermal expansion and modulus of elasticity. All materials in the rack are assumed to change temperature at approximately the same rate. This assumption is reasonable because the rack temperature is controlled by the surrounding fluid temperature, which will rapidly distribute changes that occur upon the loading of spent fuel. As such, stresses in the rack due to temperature loading are of low magnitude, and are considered as secondary stresses, per NF-3121.11. Therefore, a constant temperature is used for analysis of the rack. An analysis was performed, which verified the adequacy of this assumption.

Impact on DCA:

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

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. A dead load ANSYS analysis is also performed for Level A and B design. Hand calculations are used to evaluate the rack for lifting and stuck assembly loading. Engineering stress-strain curves at design temperatures are used for material properties.

3.1.5.2 Major Assumptions

1. The rack is assumed fully-loaded for deadweight and seismic loading conditions. The total load on a fully-loaded rack is larger than on a partially loaded rack. Under dead and seismic loading conditions, this assumption is considered to be conservative, and therefore, acceptable. The sensitivity of this assumption is explored in Section 3.1.6.

2. The dry weight of the FA without the CRA is used for the Level D analysis. The dry weight of the FA is 830 lb. and the weight of the CRA is 43 lb. The typical design life of a CRA is 20 years. Conservatively assuming a 10-year design life, a two-year fuel cycle length, 16 CRAs in each core, and a feed batch size of 21 FAs per fuel cycle, a total of 192 CRAs would be moved to the SFP over this period of time. Therefore, in a 10-year life, the total weight of the CRAs make up less than 1 percent of the total combined weight of the FAs and the CRAs. This is appropriate for capturing the seismic loadings for Level D analyses. However, 900 lb. is conservatively used for the weight of the FA for the deadweight analysis to include the CRAs with additional margin. This method provides conservative results for Service Level A and B analyses.

3. All materials used in the rack have the same mean rate of thermal expansion and modulus of elasticity. All materials in the rack are assumed to change temperature at approximately the same rate. This assumption is reasonable because the rack temperature is controlled by the surrounding fluid temperature, which would rapidly distribute temperature changes that occur upon the loading of spent fuel. As such, stresses in the rack due to temperature loading are of low magnitude, and are considered as secondary stresses, per NF-3121.11. Therefore, a constant temperature is used for analysis of the rack. An analysis was performed, which verified the adequacy of this assumption.~~Thus, stresses in the rack due to temperature loading are negligible.~~

4. The rack is assumed to be empty and at normal operating temperature for the lift analysis. The lift analysis is provided for installation of the racks prior to use; therefore, it is reasonable to assume that the racks are empty for installation.

5. No additional live loads are considered for this analysis.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0118-58379

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 structure by which NuScale develops its fuel storage rack design.

    NuScale has performed significant research and evaluation to develop a basis for this structure 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. 187, eRAI No. 9014, Question 11. 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 1/29/2018.

Zackary W. Rad