NuScale Power

RAIO-0118-58100

January 09, 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 Supplemental Response to NRC Request for Additional Information No. 189 (eRAI No. 9025) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 189 (eRAI No. 9025)," dated August 19, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 189 (eRAI No.9025)," dated October 18, 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 Question from NRC eRAI No. 9025:

- 09.01.02-14

Enclosure 1 is the proprietary version of the NuScale Supplemental Response to NRC RAI No. 189 (eRAI No. 9025). 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
Anthony Markley, NRC, OWFN-8G9A

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9025, proprietary

Enclosure 2: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9025, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0118-58101

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9025, proprietary

Enclosure 2:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9025, nonproprietary

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

NuScale Power™

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

eRAI No.: 9025
Date of RAI Issue: 08/19/2017

NRC Question No.: 09.01.02-14

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. Specifically, DSRS 3.8.4 Table 1 defines Fd as the force caused by the accidental drop of the heaviest load from the maximum possible height.

FSAR Tier 2, Section 9.1.2 states, "The maximum lift height for a fuel assembly is 45'-3" building elevation. This lift height is required to clear the weir wall between the SFP and RFP." The applicant should clarify that the lift height is defined to the base of the fuel assembly. The applicant should also describe any operational controls to ensure the analyzed drop height will not be exceeded.

In addition, in the TR, on page 122, in Section 3.1.3.4, Item 2, the applicant describes the initial condition for the drop cases, "… the LS-DYNA model applies a uniform gravity load to all bodies and considers the FA at an initial speed before impact that accounts for buoyancy forces." For each drop case, the applicant should provide the drop heights, basis for the maximum drop heights, and calculated initial velocities. The applicant should include a discussion describing whether new FAs may be moved above the surface of the water and therefore have higher drop heights than the spent FAs.

NuScale Response:

This NuScale response is a revision of the original NuScale response from October 18, 2017.

The drop height is based on the bottom of the fuel assembly being located 3" above the weir gate, or at the 45'-3" building elevation. The maximum drop distance is calculated from the bottom of the fuel assembly to the top of the fuel storage rack for the shallow vertical drop. In the case of a deep drop, the maximum drop distance is calculated from the bottom of the fuel assembly to the top of the baseplate.

The fuel handling crane will be limited to the drop height analyzed through stops and other measures (see FSAR Section 9.1.4). The following text was added to Section 9.1.4.5 to clarify the use of controls to limit the drop height:

> Lifting a FA above the maximum lift height (Section 9.1.2.2.2) is prevented by a positive mechanical stop bolted into the mast system. This stop is removable to allow the empty grapple to be raised for maintenance and inspection. The presence of the bolted stop is sensed by a limit switch to allow operation of the FHM.

In addition, text in Section 9.1.4.2.2 was clarified as indicated in the marked-up FSAR pages at the end of this response.

New fuel will be placed in the pool by the new fuel elevator that is located in the southwest corner of the fuel pool. Transportation of new fuel assemblies will only be in this region via the new fuel jib crane, eliminating the concern that the new fuel assemblies will drop onto spent fuel racks (see FSAR Section 9.1.4 as modified by the response to RAI 8818, question 9.1.4-1).

Therefore, geometric and mechanical limits will prevent new fuel from being lifted outside of this area and spent fuel from being lifted above the analyzed drop heights.

The LS-DYNA models for the impact scenarios use an arbitrary drop height of 6” with an initial velocity equal to the velocity achieved in free fall from the defined maximum drop height to 6” from the top of the fuel rack. The 6” drop height eliminates the unnecessary time steps for solution before impact and also provides sufficient time for the program to initialize prior to impact occurring. At impact, the fuel assembly experiences the impact velocity that is equal to the velocity of the fuel assembly dropped from the maximum drop height, thereby simulating the kinetic energy on impact. The acceleration due to gravity is modified for the effects of buoyancy, but drag effects are not considered. The following table summarizes drop heights, the basis for maximum drop heights, and initial velocities. Acceptance criteria and results are shown in Table 3-7 of TR-0816-49833-P. The following table has been added to TR-0816-49833-P as Table 3.7a along with introduction text.

Summary of Fuel Assembly Impact Scenario Evaluations

Impact Scenario	Maximum Drop Height	Model Initial Velocity	Impact Velocity	Basis for Maximum Drop Height	Assumptions & Conservatisms
Shallow Drop (center strike)	131”	{{ }}2(a),(c)	{{ }}2(a),(c)	Maximum distance from the bottom of the fuel assembly to the top of the rack	Buoyancy is accounted for but drag effects are neglected.
Deep Drop (center strike)	236”	{{ }}2(a),(c)	{{ }}2(a),(c)	Maximum distance from the bottom of the fuel assembly to the top of the rack baseplate	Buoyancy is accounted for but drag effects are neglected.
Deep Drop (corner strike)	236”	{{ }}2(a),(c)	{{ }}2(a),(c)	Maximum distance from the bottom of the fuel assembly to the top of the rack baseplate	Buoyancy is accounted for but drag effects are neglected.
Deep Drop (outside strike)	236”	{{ }}2(a),(c)	{{ }}2(a),(c)	Maximum distance from the bottom of the fuel assembly to the top of the rack baseplate	Buoyancy is accounted for but drag effects are neglected.
Horizontal Drop	220.8”	{{ }}2(a),(c)	{{ }}2(a),(c)	Conservatively Dropped from same elevation as the hook	Dropped from same elevation as the hook, Impact in air
Shallow Drop (corner strike)	131”	{{ }}2(a),(c)	{{ }}2(a),(c)	Maximum distance from the bottom of fuel assembly to rack	Buoyancy is accounted for but drag effects are neglected.

Impact on DCA:

Section 9.1.4 and related Technical Report TR-0816-49833, Fuel Storage Rack Analysis, have been revised as described in the response above and as shown in the markup provided with this response.

verification. The telescoping mast is open at the bottom and has open portals allowing for cooling water flow. The mast design allows the mast and grapple mechanism to rotate about the mast axis.

RAI 09.01.02-14S1

The FHM mast hoist is single-failure-proof and is designed to the requirements of Reference 9.1.4-3 and Reference 9.1.4-4. The hoist is a closed kinematic loop design for added safety. It has redundant gearboxes and braking systems. The reeving ensures that any failure of a rope does not result in the load being uncontrolled. Dual hoist ropes, over-load detection, over-speed detection, and upper and lower hoist limits are incorporated into the FHM to ensure the mast hoist will not experience an active failure that will drop a fuel assembly. Vertical position of the mast is confirmed by two independent instruments to ensure accurate vertical positioning. Mechanical and electrical interlocks prevent raising a fuel assembly above the minimummaximum lift height specified in Section 9.1.2.2.2, which ensures a shielding water depth of at least 10 feet.

The FHM grapple is attached to the telescoping mast. The grapple engages a fuel assembly or other light load core components. The mast is pre-programmed to open or close the grapple in a small vertical height band to ensure the grapple operates only when the fuel assembly is safely seated. The grapple is locked in the closed position by a mechanical mechanism that precludes unintended opening. The grapple release mechanism incorporates mechanical and electrical lockouts, and a redundant release system. Operator action or control failure cannot open the grapple when loaded. The fuel assembly grapple is designed to have flexibility to accommodate fuel assembly bowing or growth from power operations.

RAI 09.01.04-1

The FHM has an auxiliary hoist that will handle a special lifting device to move control rod assemblies during refueling operations. The auxiliary hoist is mounted on the upper structure of the FHM trolley.

RAI 09.01.04-3

New Fuel Jib Crane

The NFJC performs new fuel handling in the new fuel staging area. The NFJC supports fuel handling tools. The NFJC is used to remove new fuel assemblies (NFAs) from their shipping containers, support the NFAs during inspection, and move the NFAs to the NFE. The NFJC is comprised of a telescoping jib beam with an underhung trolley and hoist.

The NFJC jib beam is an engineered welded composite. The jib structure connects to the building wall via two connection brackets. The lower bracket is pinned directly to the end of the jib beam, and the upper bracket connects to the jib tie-rods. Tie rods connect the upper wall bracket to the tip of the jib beam. A rotating drive assembly is mounted to the top of the jib beam near the pivot end. Bumpers on the boom prevent damage in case there is a collision with the wall.

9.1.4.5 Instrumentation and Control

An operator interface is provided with the FHM control console that includes a monitor. The monitor provides the operator with easy-to-understand information on interlock status, current load conditions and bridge, trolley, and hoist position indicating the location of the FHM with respect to the core and spent fuel racks.

The FHM control system employs a fail-safe programmable logic controller (PLC) for machine control and operation and monitoring control devices. The functions of the PLC include: boundary zone monitoring, enforcing over-travel limits, load condition monitoring, and position monitoring. The PLC processor communicates over an Ethernet network. The machine control program is stored in non-volatile flash memory inside the PLC.

The operator interface consists of an industrialized computer in direct communication with the operational PLC. This computer contains, but is not limited to, the graphic user interface drivers for the operator interface, the database that enables converting of alphanumeric core locations into bridge and trolley positions, data logging files and fuel move sequence(s) when the system is preprogrammed. In addition, the computer provides information for operational interlocks and troubleshooting aids for maintaining the entire system, including the PLC.

The FHE controls are designed using human factors engineering guidelines as presented in Chapter 18. Controls can be operated with gloved hands. The FHE controls are placed to enable the operator to use the controls while visually observing the operations being performed.

For the FHM, in line with the wire rope is a load weighing assembly that constantly monitors the tension on the cables. The design of the weighing assembly ensures that a hoist overload condition does not cause a structural failure resulting in a dropped load. Load cell assemblies are separated structurally. The load weighing assembly has multiple functions including:

- monitoring for slack cable when lowering a load
- monitoring for high loads due to a too heavy load or hitting an obstruction
- monitoring for broken wire rope

An encoder is used to monitor grapple height. Limit switches are hard-wired into the control system as upper limit constraints.

Limit switches trip at setpoints corresponding to high position, low position, and slowdown zones.

RAI 09.01.02-14S1

Lifting a FA above the maximum lift height (Section 9.1.2.2.2) is prevented by a positive mechanical stop bolted into the mast system. This stop is removable to allow the empty grapple to be raised for maintenance and inspection. The presence of the bolted stop is sensed by a limit switch to allow operation of the FHM.

TABLES

3.1.3.6 Analysis, Evaluation, and Data

3.1.3.6.1 Shallow-Drop Analysis

In the shallow-drop analysis, the FA plus CRA are considered to drop vertically and hit the top of the fuel storage rack in the center. This evaluation focuses explicitly on the fuel storage rack. The fuel storage rack is under water and all drops would be slowed by water.

The geometry for the shallow-drop analysis is based on the ANSYS model discussed in Section 3.1.1 and shown in ~~Figure 3—120~~Figure 3—120 through Figure 3—120d.

The summary of the shallow-drop analysis results is shown in Table 3-7. Table 3-7a presents a summary of the drop heights, the basis for maximum drop heights, and initial velocities for the impact scenarios evaluated.

{{

}}2(a),(c)

Figure 3—120 Shallow drop – finite element model

Table 3-7a Summary of Fuel Assembly Impact Scenario Evaluations

Impact Scenario	**Maximum Drop Height**	**Model Initial Velocity**	**Impact Velocity**	**Basis for Maximum Drop Height**	**Conservatisms/ Assumptions**
Shallow Drop (center strike)	131”	{{ }}$^{2(a),(c)}$	{{ }}$^{2(a),(c)}$	Maximum distance from the bottom of the fuel assembly to the top of the rack	Buoyancy is accounted for but drag effects are neglected.
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Horizontal Drop	220.8”	{{ }}$^{2(a),(c)}$	{{ }}$^{2(a),(c)}$	Conservatively Dropped from same elevation as the hook	Dropped from same elevation as the hook, impact in air
Shallow Drop (corner strike)	131”	{{ }}$^{2(a),(c)}$	{{ }}$^{2(a),(c)}$	Maximum distance from the bottom of the fuel assembly to the top of the rack	Buoyancy is accounted for but drag effects are neglected.

3.1.3.6.5 Horizontal Drop Analysis

In the event of a horizontal drop onto the top of the rack, it is conservatively assumed that the FA is dropped from the same elevation as the hook. Note that deep-drop impact is impossible in a horizontal configuration.

The impact velocity in air is {{ }}$^{2(a),(c)}$. This would result in an impact energy of KE_{hor} = {{ }}$^{2(a),(c)}$.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0118-58101

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

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 spent fuel racks.

    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 Supplemental RAI No. 189, eRAI No. 9025. 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 1/9/2018.

Zackary W. Rad