RAIO-0818-61515

August 22, 2018

Docket: PROJ0769

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. 9374 (eRAI No. 9374) on the NuScale Topical Report, "Non-Loss of Coolant Accident Analysis Methodology," TR-0516-49416, Revision 1

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 9374 (eRAI No. 9374)," dated May 09, 2018
2. NuScale Topical Report, "Non-Loss of Coolant Accident Analysis Methodology," TR-0516-49416, Revision 1, dated August 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 Question from NRC eRAI No. 9374:

- 15.00.02-24

The response to question 15.00.02-22 will be provided by September 12, 2018 and the response to question 15.00.02-23 will be provided by September 28, 2018.

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 9374 (eRAI No. 9374). 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 Paul Infanger at 541-452-7351 or at pinfanger@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. 9374, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9374, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0818-61516

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9374, proprietary

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Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9374, nonproprietary

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

eRAI No.: 9374
Date of RAI Issue: 05/09/2018

NRC Question No.: 15.00.02-24

TR-0516-49416-P supports the conclusions in the NuScale FSAR, which under 10 CFR 52.47 must describe the facility, present the design bases and the limits on its operation, and present a safety analysis of the structures, systems, and components and of the facility as a whole. RG1.203 describes the EMDAP, which the NRC staff considers acceptable for use in developing and assessing EMs used to analyze transient and accident behavior. Element 1 of the EMDAP guides an applicant to establish its requirements for the EM capability, including identification of systems, components, phases, geometries, fields, and processes that should be modeled. Furthermore, Step 11 of the EMDAP discusses establishment of the EM structure:

> *The special concerns related to integrating the component calculational devices into a complete EM are frequently referred to collectively as the EM methodology. The way in which the devices are connected spatially and temporally should be described.*

TR-0516-49416-P, Section 6.1.5 describes the NRELAP5 model of the DHRS in the NPM plant model:

> *Although in the actual NPM the DHRS heat exchanger is located in the reactor cooling pool, {{*

}}$^{2(a),(c)}$

This statement implies that {{

}}$^{2(a),(c)}$ NIST-1 tests discussed in TR Section 5.3 show that thermal stratification in the cooling pool is an important aspect of the coolant dynamics, and the staff is concerned about its effects on overall DHRS heat removal.

During an audit discussion (Round 2, Issue 7), the applicant stated that there are no significant effects due to thermal stratification and natural circulation in the cooling pool since the surface of the DHRS is hot enough for boiling heat transfer to occur; therefore, the saturation temperature of the pool is more important than the bulk temperature. TR Section 6.1.5 discusses that {{

}}$^{2(a),(c)}$ Based upon the dominant bulk boiling heat transfer mode, the applicant's conclusion was that the DHRS performance would not be sensitive to temperature gradients; the surface of the tube is insensitive to the bulk fluid condition and drives itself to a superheated condition to result in as much boiling as necessary. Furthermore, the applicant stated that cooler liquid near the bottom of the DHRS should enhance the DHRS performance, and {{

}}$^{2(a),(c)}$ However, the staff needs justification for these statements.

Information Requested:

The staff notes that the heat flux is much higher in the bulk boiling regime (i.e., nucleate pool boiling) than under subcooled conditions. The heat flux limit will determine the heat transfer mode. It may be possible to exceed the critical heat flux, resulting in film boiling, depending upon the surface temperature conditions. Demonstrate that the potential for dryout (vapor blanketing) which would reduce DHRS performance, and progressively shift the thermal center downward in the DHRS, does not exist or is negligible, for instance by comparing the calculated local heat flux to the CHF for various elevations along the DHRS tubes.

NuScale Response:

The information presented in this response for the decay heat removal system (DHRS) examines system performance and characteristics with both steady-state sizing calculations and representative transient results. The former examines the heat removal capabilities as a function of pool temperature utilizing a simplified DHRS model, whereas the latter examines these capabilities utilizing a representative non-LOCA design basis event.

As stated in Section 3.3 of TR-0516-49416, two trains of decay heat removal equipment are provided, one attached to each steam generator, where each train is capable of removing 100 percent of the decay heat load and cooling the reactor coolant system (RCS) via a passive condenser immersed in the reactor pool. For this arrangement, steam from the associated steam generator enters the top of the DHRS heat exchanger after the DHRS actuation valves open.

Figure 1 shows the heat flux at the top of the condenser is {{

}}2(a),(c)

Figure 1. Top of condenser heat flux vs. inventory for different pool temperatures

The heat flux profile is plotted in Figure 2 as a function of vertical position relative to the bottom of the DHRS condenser for an inventory case of {{ }}2(a),(c). As expected, the upper nodes in the condenser have a higher heat flux causing a transition to convection heat transfer around the {{

}}2(a),(c)

{{

}}2(a),(c)

Figure 2. Condenser heat flux vs. elevation for different pool temperatures

{{

}}2(a),(c)

Figure 3. Integrated condenser heat transfer vs. elevation for different pool temperatures

The margin to critical heat flux (CHF) on the exterior of the DHRS condenser tubes, {{

}}2(a),(c)

When considering the effect of the pool temperature, another important factor is the natural circulation driving force. Since the static pressure caused by the liquid column is what pushes liquid into the steam generator, the natural circulation driving force can be represented by the collapsed liquid level in the condenser. Figure 4 demonstrates that the pool temperature {{

}}2(a),(c)

{{

}}2(a),(c)

Figure 4. Condenser level vs. inventory for different pool temperatures

With respect to the design-basis events evaluated with TR-0516-49416, sensitivity studies were performed on the loss of alternating current (AC) power transient to assess DHRS performance. In this instance, {{ }}2(a),(c) were varied to evaluate their effects on the DHRS figures of merit, i.e., the reactor pressure vessel (RPV) pressure, the RPV temperature, and the RPV peak pressure. The heat flux values on the DHRS condenser tubes were also considered with respect to the critical heat flux (CHF) limits.

Six sensitivity transients were examined to evaluate the effect of DHRS heat sink conditions on DHRS performance. The sensitivity case matrix is detailed in Table 1.

Table 1. Sensitivity study matrix

{{

}}[2(a),(c)]

{{

}}[2(a),(c)]

Table 2. Sensitivity study results summary

{{

}}[2(a),(c)]

The vertical nodalization of the DHRS heat sink (pool) and the asymmetric heat load of the DHRS condensers result in {{

}}2(a),(c)

The peak heat fluxes to the UHS for the upper three nodes of the DHRS heat exchanger are provided in Table 3.

Table 3. Sensitivity study peak heat flux results

{{

}}2(a),(c)

For all sensitivity cases, {{

}}2(a),(c)

Based on the above discussion, it can be concluded that the effect of pool temperature on DHRS heat removal is minimal. Furthermore, the sensitivity studies confirm that {{

}}2(a),(c)

To summarize, this RAI response concluded that:

{{

}}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-0818-61516

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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 method by which NuScale develops its non-loss of coolant accident analysis methodology.

    NuScale has performed significant research and evaluation to develop a basis for this method 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. 9374, eRAI 9374. 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 August 22, 2018.

Zackary W. Rad