RAIO-0918-61895

September 20, 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. 9466 (eRAI No. 9466) 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. 9466 (eRAI No. 9466)," dated May 07, 2018
2. NuScale Topical Report, "Non-Loss of Coolant Accident Analysis Methodology," TR-0516-49416, Revision 1, dated August 2017
3. NuScale Power, LLC Response to NRC "Request for Additional Information No. 9466 (eRAI No. 93466)," dated July 03, 2018
4. NuScale Power, LLC Response to NRC "Request for Additional Information No. 9466 (eRAI No. 9466)," dated August 28, 2018

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. 9466:

- 15.00.02-10

The response schedule for the remaining questions of RAI No. 9466. eRAI 9466 was provided in an email to NRC (Greg Cranston) dated June 19, 2018.

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 9466 (eRAI No. 9466). 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
Rani Franovich, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9466, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9466, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0918-61896

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9466, proprietary

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
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Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9466, nonproprietary

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

eRAI No.: 9466
Date of RAI Issue: 05/07/2018

NRC Question No.: 15.00.02-10

GDC 10 requires that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs. In addition, GDC 15 requires that the RCS and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the RCPB are not exceeded during any condition of normal operation, including AOOs.

TR-0516-49416-P supports the conclusions relative to GDC 10 and 15 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. DSRS Section 15.0 directs the staff to confirm that the implementation of models or codes are within the applicable ranges and conditions. Furthermore, RG 1.203 describes the EMDAP. Step 4 of the EMDAP (Section 1.1.4) discusses the identification and ranking of key phenomena and processes and states:

“A key feature of the adequacy assessment is the ability of the EM or its component devices to predict appropriate experimental behavior. Once again, the focus should be on the ability to predict key phenomena, as described in the first principle. To a large degree, the calculational devices use collections of models and correlations that are empirical in nature. Therefore, it is important to ensure that they are used within the range of their assessment.”

TR-0516-49416-P, Section 5.3.1.3 attributes the reasonable to excellent agreement between NRELAP5 calculations and KAIST measured experimental data to {{

}}2(a),(c). However, the NPM DHRS is

designed to operate under natural circulation conditions.

Therefore, it is not clear that the use of the {{ }}2(a),(c), within the range of the assessment, is appropriate for the natural circulation conditions within the NPM. Reasonable to excellent agreement for application of an inappropriate correlation may result from compensating errors, so additional justification is required to demonstrate the adequacy of the present {{ }}2(a),(c) within the NRELAP5 methodology framework.

Information Requested:

Demonstrate the fundamental adequacy of the present approach within the NRELAP5 methodology for application to the NPM safety analysis, for example by providing an assessment of various approaches to representation of condensation heat transfer under conditions of buoyancy-drive flows for the geometries of interest and their potential applicability to the NPM, discussing the range of the applicability of the correlations, the test conditions to which the correlations have been subjected, and the similarity to the conditions expected within the NPM. If a more applicable approach exists, compare it to the current approach, and justify the current approach. Update TR-0516-49416-P and any other affected documentation (e.g., the LOCA EM TR [TR-0516-49422-P]) as appropriate.

NuScale Response:

Although the NuScale Power Module (NPM) DHRS loop flow is passively driven, it is not a natural circulation flow in the strict sense. The flow of steam into the decay heat removal system (DHRS) condenser is driven by a pressure differential established between boiling in the steam generator and condensation in the DHRS condenser; it is not driven by buoyancy, or temperature gradients. This configuration is typical of boiling-condensing systems such as the KAIST and NIST-1 HP03 experimental tests that support the assessment of the NRELAP5 prediction of condensation heat transfer. The NPM DHRS loop is unique from the configuration of the experimental assessments in that the liquid supply to the boiler is driven by a gravity head instead of a mechanical pump. This difference does not limit the use of these separate effects tests for the assessment of the condensation heat transfer correlation in NRELAP5.

The heat transfer in the DHRS condenser is characterized by film condensation. At the tube entrance, where the flow quality remains high, the film flow is laminar. Condensation heat transfer in this regime is governed by conduction through the liquid film which is well

represented by the analytical heat transfer solution given by Nusselt. As the flow quality decreases and the film thickness increases along the length of the tube, film flow becomes turbulent. The condensation heat transfer in this regime is governed by turbulent convection through the liquid film. The interfacial shear at the surface of the condensate film due to the central core gas flow can affect the condensation heat transfer due to impact on the liquid film thickness and the intensity of turbulence in the film.

{{

}}2(a),(c)

To confirm the applicability of the {{

}}2(a),(c) were reviewed and compared to the operating conditions for the NPM DHRS and the range of conditions included in the NRELAP5 experimental assessments. The heat transfer regimes employed by the correlation were calculated as a function of condensing length to demonstrate that the same regimes are being used for the NPM DHRS as for the NRELAP5 assessments and that the same heat transfer mechanisms were involved.

Table 1 presents the ranges for the liquid and vapor Reynolds number (calculated for x=0 and x=1 respectively), the reduced pressure p_r, and the tube diameter for {{

}}2(a),(c)

{{

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

Table 1. - Range of flow conditions from {{ }}[2(a),(c)] NRELAP5 assessments, and NPM DHRS

{{

}}[2(a),(c)] These results are presented in Table 2.

Table 2. - {{ }}[2(a),(c)] for NPM DHRS operation and NRELAP5 experimental assessments

{{

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

As demonstrated in Table 2, {{

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

{{

}}2(a),(c)

{{

}}2(a),(c)

Figure 1. DHRS pressure, steam flow rate into condenser, quality along condensing length, and condensation flow regime for typical non-LOCA transient

Summary:

This response is summarized with the following key points:

1. The steam flow into the NPM DHRS condenser is driven by a pressure differential established between boiling in the steam generator and condensation in the condenser. While the loop flow is passively driven, it is not driven by buoyancy, or temperature gradients. The elevation of the condenser relative to the steam generator allows the use of a gravity head to drain the condenser and supply feedwater to the steam generator. {{ }}[2(a),(c)] nor does it limit the use of separate effects tests for the assessment of the NRELAP5 prediction of condensation heat transfer.
2. Heat transfer in the DHRS condenser is characterized by laminar film condensation at the tube entrance and turbulent film condensation as the film thickness increases along the length of the tube. Laminar condensation heat transfer is governed by conduction through the film. Turbulent condensation heat transfer is governed by turbulent convection through the film which can be affected by the central core gas flow through shear at the vapor-condensate interface.
3. {{ }}[2(a),(c)]
4. The conditions of NPM DHRS operation are consistent with the conditions in the KAIST and NIST-1 HP03 NRELAP5 experimental assessments and are within the applicability range of {{ }}[2(a),(c)] The condensation heat transfer regimes calculated for the NRELAP5 experimental assessments are consistent with the heat transfer regimes during operation of the NPM DHRS.

The present implementation of the {{ }}[2(a),(c)] in NRELAP5 for the prediction of condensation heat transfer in the DHRS was demonstrated as appropriate based on the fundamental applicability of the correlation to the mechanisms of NPM DHRS heat transfer and the consistency between the test conditions of the NRELAP5 experimental assessments and the operating conditions of the NPM DHRS.

References:

1. {{

}}[2(a),(c)]
2. Loss-of-Coolant Accident Evaluation Model, TR-0516-49422, Revision 0.

Impact on DCA:

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

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0918-61896

NuScale Power, LLC
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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 by which NuScale developed its loss-of-coolant accident analysis and non-loss of coolant accident analysis methodologies.

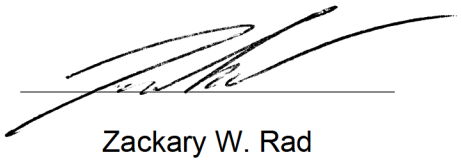
    NuScale has performed significant research and evaluation to develop a basis for these methods and has invested significant resources, including the expenditure of a considerable sum of money.

    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 No. 9466, eRAI No. 9466. 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 September 20, 2018.



Zackary W. Rad