RAIO-1117-57084

November 09, 2017

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. 9080 (eRAI No. 9080) on the NuScale Topical Report, "Subchannel Analysis Methodology," TR-0915-17564, Revision 1

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 9080 (eRAI No. 9080)," dated September 10, 2017
2. NuScale Topical Report, "Subchannel Analysis Methodology," TR-0915-17564, Revision 1, dated February 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. 9080:

- 04.04-12

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 9080 (eRAI No. 9080). NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The proprietary enclosure has been deemed to contain Export Controlled Information. This information must be protected from disclosure per the requirements of 10 CFR § 810. 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 Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

Jennie Wike
Manager, Licensing
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Bruce Bavol, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9080, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9080, nonproprietary

Enclosure 3: Affidavit of Thomas A. Bergman, AF-1117-57085

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9080, proprietary

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Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9080, nonproprietary

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Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9080
Date of RAI Issue: 09/10/2017

NRC Question No.: 04.04-12

NSAM Application & NSP2 CHF Correlation Applicability Ranges

General Design Criterion (GDC) 10, “Reactor design” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50 requires that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition”, Section 4.4, “Thermal and Hydraulic Design,” stipulates the staff’s review process for thermal and hydraulic design applications. One of the acceptance criteria specified in SRP Section 4.4 for the evaluation of fuel design limits is to ensure that the hot fuel rod in the core does not experience departure from nucleate boiling (DNB) during normal operation or AOOs. GDC 10 is relevant to the DNB as it is used to establish safety-related margins for the fuel and cladding integrity. To ensure compliance with GDC 10, the staff needs to confirm that the thermal-hydraulic design of the core and the reactor coolant system is accomplished using acceptable analytical methods; is equivalent to or is a justified extrapolation from proven designs; provides adequate margins of safety from conditions that would lead to fuel damage during normal reactor operation and AOOs; and is not susceptible to thermal-hydraulic instability.

Section 2.2 of Volume 5 of the VIPRE-01 manual identifies a spectrum of VIPRE code limitations. Condition No. 3 from the VIPRE-01 MOD- 02 safety evaluation report (SER) stipulates that each user should ensure that the code is not being used in violation of these limitations. Section 2.2 of the VIPRE-01 manual states that VIPRE should not be applied to situations that entail conditions such as low-flow boil-off, annular flow, phase separation involving a sharp liquid/vapor interface, or countercurrent flow. Furthermore, Section 2.2 of Volume 5 of the VIPRE-01 manual also identifies another VIPRE-01 limitation arising due to the omission of several cross-coupling terms from the lateral momentum equation that leads the code to predict the flow field accurately only when wall friction is significant and lateral flow

resistance is fairly large compared to axial flow resistance.

Table 3-1 of the topical report (TR) shows the parameter ranges used to demonstrate the applicability of the NuScale subchannel analysis methodology (NSAM) with the example NSP2 critical heat flux (CHF) correlation. The example NuScale normal/off-normal parameter ranges are 1,700–2,200 psia for pressure, 0.1-0.5 Mlbm/hr-ft2 for local coolant mass flux, and < 20% for the local equilibrium quality. The staff is concerned that all example ranges chosen in the NSAM TR to demonstrate VIPRE application are narrower than the corresponding NSP2 CHF correlation applicability ranges of 300–2,300 psia for pressure, 0.11-0.70 Mlbm/hr-ft2 for local coolant mass flux, and < 95% for the local equilibrium quality, as reported in Table 7-2 of the NSP2 CHF correlation TR. For instance, the example local equilibrium quality used in the NSAM TR is up to only 20%, while the NSP2 CHF correlation limit for local equilibrium quality is up to 95%. Likewise, the example lower limit of pressure used in the NSAM TR is 1,700 psia, which is significantly higher than the 300 psia lower limit of the NSP2 CHF correlation. The staff needs to evaluate the applicability of NSAM for the safety of the NuScale design over the full range of the NSP2 CHF correlation application, as VIPRE-01 was used for the development of NSP2 CHF correlation and the VIPRE-01 based NSAM is expected to be approved for the entire NSP2 CHF correlation range. The applicant is requested to justify the applicability of VIPRE-01 over the spectrum of transients and two-phase phenomena involving the complete NSP2 CHF correlation range, and update the NSAM TR accordingly. The applicant needs to demonstrate that the NuScale application of VIPRE would not violate the code limitations identified by Section 2.2 of Volume 5 of the VIPRE-01 manual, throughout the NSP2 CHF correlation's full range. Submittal of the additional information is required for making the safety finding regarding the overall applicability of the NSAM to the NuScale core safety design.

NuScale Response:

The NuScale Topical Report, Subchannel Analysis Methodology, TR-0915-17564, presents the expected parameter ranges (Table 3-1) for application of the VIPRE-01 code as part of the overall subchannel analysis methodology. The intent of this table is to show that the range of applicability of the critical heat flux (CHF) correlation greatly encompasses the range over which the NuScale Subchannel Analysis Methodology (NSAM) is expected to be applied.

In addition to the Subchannel Analysis Methodology, NuScale uses the VIPRE-01 code for evaluation of local conditions in support of the development of the CHF correlations (NuScale Power Critical Heat Flux Correlation NSP2, TR-0116-21012). In order to establish CHF trends and limits for the NuScale fuel and core, it is necessary to extend the fluid conditions during CHF testing to conditions not expected in the NuScale core. These conditions (e.g. equilibrium quality) are not expected in any NuScale operation or off-normal events, but are necessary to achieve CHF in the testing. The use of VIPRE-01 for these conditions is consistent with the Nuclear Regulatory Commission (NRC) expectation that the subchannel code and options used

to evaluate reactor performance be consistent with those used to evaluate the CHF test local conditions.

The CHF correlation acts as an additional closure model to the two-phase flow correlations of subcooled void, bulk void, and two-phase friction. Use of common closure models for CHF test data reduction links the calculation of predicted CHF in the subchannel analysis application (via VIPRE-01) back to the actual measured CHF test data. When treated this way, selection of the two-phase correlations becomes less critical because the closure relationship ties a CHF prediction calculated by VIPRE-01 back to actual test data (along with a correlation limit to ensure the 95-percent probability at the 95-percent confidence level criteria [95/95] are met). Through the CHF development process, trends with mass flux, pressure, quality, etc. are evaluated to assess the performance of the correlation across a broad range of these parameters. The CHF correlation is deemed acceptable because these trends are considered reasonable.

In addition to the closure relationships discussed above, the same CHF tests were evaluated with homogeneous models, which means there is no benefit from subcooled boiling or two-phase friction. The resulting local conditions from the CHF tests reflect differences as expected. When the CHF correlation 95/95 design limit was determined, it changed by a total of only {{ }}$^{2(a),(c),ECI}$ critical heat flux ratio (CHFR) points. This illustrates that the chosen closure models will affect the CHF test data local conditions; however, consistent use of the same closure relationships in CHF test data predictions and NSAM application will be reflected in the 95/95 safety design limit used for CHFR comparisons. This difference in safety limits determined from the CHF tests indicate the closure models used in the NSAM are reasonable and appropriate.

Furthermore, Section 5.4 of the NSAM topical report evaluates several combinations of closure models to illustrate the effects differing models have on local conditions and subsequent minimum CHF ratio. As shown in Table 5-3, the evaluation model used and evaluated with the NSAM illustrate the limited sensitivity the closure model combinations have on CHF ratios. In addition, VIPRE-01 and COBRA-FLX comparisons of NuScale reactor transients were performed in Section 5.8.2 of the NSAM topical report. These comparisons utilized different sets of two-phase flow closure models, which affect the predicted local conditions. However, the results indicate that when using the same CHF correlation closure model, the CHFRs demonstrate reasonable agreement. This demonstrates that the VIPRE-01 and NuScale-selected two-phase closure models, when used with the NSAM and evaluation model, are appropriate for all ranges in which the NSAM is to be applied.

NuScale also believes based on its participation in the VIPRE Users Group and discussions with other vendors that the approach described above is consistent with industry practice as stated in Section 5.4 of the topical report. As discussed above, the NSAM use of VIPRE-01 for

NuScale reactor performance evaluations adheres to the limitations identified in Section 2.2 of Volume 5 of the VIPRE-01 manual.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0915-17564, Subchannel Analysis Methodology, as a result of this response.

Enclosure 3:

Affidavit of Thomas A. Bergman, AF-1117-57085

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NuScale Power, LLC

AFFIDAVIT of Thomas A. Bergman

I, Thomas A. Bergman, state as follows:

1. I am the Vice President, 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 subchannel analysis methodology.

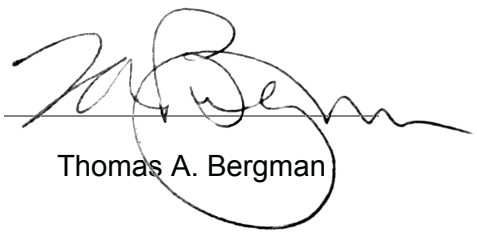
    NuScale has performed significant research and evaluation to develop a basis for this method and has invested significant resources, including the expenditure of a considerable sum of money.

    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. 9080, eRAI No. 9080. 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 11/9/2017.



Thomas A. Bergman