



March 02, 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 Supplemental 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 Power, LLC Response to NRC "Request for Additional Information No. 9080 (eRAI No.9080)," dated November 09, 2017
3. 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) 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. 9080:

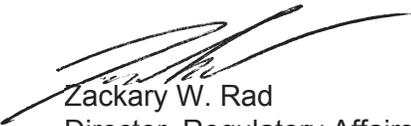
- 04.04-12

Enclosure 1 is the proprietary version of the NuScale Supplemental 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 enclosures have 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,



Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC



Distribution: Samuel Lee, NRC, OWFN-8G9A
Prosanta Chowdhury NRC, OWFN-8G9A
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9080, proprietary

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

Enclosure 3: Affidavit of Zackary W. Rad, AF-0218-58950



Enclosure 1:

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



Enclosure 2:

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

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:

NuScale is providing the following information to supplement the material provided in response to Request for Additional Information (RAI) 04.04-12 (eRAI 9080) submitted to the NRC on November 9, 2017 (ML17313B205). The supplemental information is being submitted as a follow-up to a phone call discussion with the NRC on February 7, 2018 and is related to the range of applicability of the NuScale Subchannel Analysis Methodology (NSAM) described in NuScale Topical Report, "Subchannel Analysis Methodology," TR-0915-17564.

Subchannel Analysis Methodology Range

The NSP2 and NSP4 critical heat flux (CHF) correlations use VIPRE-01 local conditions as a surrogate for actual CHF test data. The resulting CHF correlation, along with its 95/95 limit which captures uncertainties, acts as a closure relation between conditions predicted by VIPRE-01 and the actual test data conditions. The closure models selected for the determination of CHF local conditions and for safety analysis calculations are identical. Using the closure models in this manner removes any fundamental effects that may arise from predicting local thermal-hydraulic conditions differently, and any potential inaccuracies in VIPRE-01 related to high local equilibrium quality are captured in the 95/95 limit.



As documented in the CHF Licensing Topical Report (LTR), “NuScale Power Critical Heat Flux Correlations,” TR-0116-21012, VIPRE-01 local conditions are generated with the Electric Power Research Institute (EPRI) closure model correlations for the subcooled boiling, bulk void, and two-phase friction multiplier. In the November 9, 2017 RAI response, NuScale quantified the effect of these correlations on the 95/95 design limit. The VIPRE-01 CHF testing local conditions were regenerated assuming no subcooled boiling, homogeneous bulk voiding, and homogeneous two-phase friction multiplier correlations. This assumption essentially treats the fluid in a subchannel as perfectly mixed and in equilibrium, which is physically unrealistic and overly conservative. The 95/95 limit resulting from this assumption, which accounts for statistical uncertainties including subregions with higher sensitivities, changed by only {{

}}^{2(a),(c),ECI} critical heat flux ratio (CHFR) points when using the same CHF correlation. The {{
}}^{2(a),(c),ECI} CHFR points are {{
}}^{2(a),(c),ECI} in CHFR absolute value and less than {{
}}^{2(a),(c),ECI} percent difference in CHFR.

In design applications for steady state and transient analyses which are characterized by qualities that are much lower than in the CHF testing database, this effect is even smaller, as documented in Section 5.4 of the NSAM topical report. Therefore, the {{
}}^{2(a),(c),ECI} CHFR point difference is considered to be a conservative upper limit of this effect, and demonstrates that the VIPRE-01 two-phase correlations used for NuScale applications, as presented in the NSAM topical report, are appropriate.

NSAM Applicability Criteria

In the November 9, 2017 response to RAI 04.04-12, NuScale stated “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).” No differentiation of separate applications of VIPRE-01 is intended by the quoted statement. Section 3.3 of the NSAM LTR presents a bulleted list that provides the NSAM applicability criteria, one of which is that the CHF correlation is used within its applicable parameter ranges. The NSAM is applicable for the entire range of the applicable approved CHF correlation.

Example Ranges in NSAM Topical Report Table 3

The pressure, local mass flux, and local equilibrium quality parameter ranges presented in the last column of Table 3-1 of the NSAM LTR are provided only to demonstrate that the conditions expected to be analyzed fall well within the applicability range of the NSP2 CHF correlation. The values presented in Table 3-1 are representative of and {{

}}^{2(a),(c),ECI} presented in the Design Certification Application and do not imply or implement any application limitations for the NSAM or VIPRE-01 code.



Impact on Topical Report:

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



RAIO-0218-58949

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0218-58950

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 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 supplemental 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 3/2/2018.



Zackary W. Rad