RAIO-1217-57792

December 19, 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. 9136 (eRAI No. 9136) on the NuScale Topical Report, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," TR-0516-49417, Revision 0

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 9136 (eRAI No. 9136)," dated November 01, 2017
2. NuScale Topical Report, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," TR-0516-49417, Revision 0, dated July 2016

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 Questions from NRC eRAI No. 9136:

- 01-52
- 01-53
- 01-54
- 01-55
- 01-56

The response to question 01-51 will be provided by January 2, 2018.

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 9136 (eRAI No. 9136). 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 Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
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. 9136, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9136, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-1217-57791

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9136, proprietary

Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9136, nonproprietary

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9136
Date of RAI Issue: 11/01/2017

NRC Question No.: 01-52

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” 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 are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 – Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies that the chosen mathematical models and the numerical solution of those models must be able to predict the important physical phenomena reasonably well from both qualitative and quantitative points of view.

Section 5.5.3, "Steam Generator Model," of topical report (TR), TR-0516-49417-P, indicates that the heat transfer modeling on the secondary side covers the entire range of from subcooled single-phase liquid to superheated vapor.

In order to make an affirmative finding NRC staff requests NuScale to provide a description of the weighting of heat transfer coefficients in PIM for quality based heat transfer regime transitions. (It is acceptable to respond by clarifying that the weighting is linear if that is the case.)

NuScale Response:

There is no weighting for heat transfer coefficients. Upon identification of heat transfer regime transition in a given node, the node length is divided at the transition point and heat transfer is calculated based on the particular heat transfer coefficient and area associated with the particular regime. The full node heat transfer rate is summed up from the parts belonging to each partial node.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9136
Date of RAI Issue: 11/01/2017

NRC Question No.: 01-53

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” 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 are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 – Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies that the chosen mathematical models and the numerical solution of those models must be able to predict the important physical phenomena reasonably well from both qualitative and quantitative points of view.

Section 5.5.3, "Steam Generator Model," of topical report (TR), TR-0516-49417-P, indicates that single phase heat transfer, for both liquid and vapor, is determined according to a Dittus-Boelter correlation. The steam generator (SG) described in section 5.5.3 of the TR is a helical SG.

In order to make an affirmative finding NRC staff requests NuScale to provide justification for the heat transfer correlations on the SG tube side.

- In particular address whether a correction based on the Dean number is or is not required to accurately predict the heat transfer in the single phase convection regime.

NuScale Response:

There is no correction required for heat transfer in the SG tubes because of the helical geometry. The PIM code does not need to calculate {{

}}$^{2(a),(c)}$ This point has been stated in the TR in Section 5.5.3:

{{

}}2(a),(c)

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9136
Date of RAI Issue: 11/01/2017

NRC Question No.: 01-54

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” 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 are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 – Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies that the chosen mathematical models and the numerical solution of those models must be able to predict the important physical phenomena reasonably well from both qualitative and quantitative points of view.

Section 5.5.3, "Steam Generator Model," of topical report (TR), TR-0516-49417-P, indicates that the nucleate boiling heat transfer is determined according to the Chen correlation, which is used for similar purposes and may also be applicable to a helical coil SG. The TR indicates that subcooled boiling is treated by extending the Chen correlation according to the approach described by Collier.

In order to make an affirmative finding NRC staff requests NuScale to justify the application of the subcooled boiling model to helical coil SG tubes.

NuScale Response:

All heat transfer processes simulated in PIM for the SG do not consider adjustments for helical geometry. This includes subcooled boiling. As noted in the response to question 01-53 such adjustment are not necessary as the heat transfer coefficients are scaled to satisfy the initial heat balance.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9136
Date of RAI Issue: 11/01/2017

NRC Question No.: 01-55

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” 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 are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 – Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies that the chosen mathematical models and the numerical solution of those models must be able to predict the important physical phenomena reasonably well from both qualitative and quantitative points of view.

Section 5.5.3, "Steam Generator Model," of topical report (TR), TR-0516-49417-P, indicates that in any given steam generator tube noted, any or all the heat transfer regimes may occur. This allows {{ }}$^{2(a),(c)}$. However, it is not clear from the TR how this methodology is implemented.

In order to make an affirmative finding NRC staff requests NuScale to:

1) Describe the method for {{ }}$^{2(a),(c)}$

2) Describe the method for {{ }}$^{2(a),(c)}$.

NuScale Response:

Items 1 and 2:

Criteria for identifying heat transfer regime transition are as explained in TR-0516-49417-P, Section 5.5.3. For example, single phase regime transitions to boiling heat transfer upon detecting steam quality greater than zero. In this case, a node is divided at the point separating the two regimes, i.e. at zero quality. There is not explicit averaging of the heat transfer coefficient in the divided node. Rather, the heat flux is calculated for each sub-node given the heat transfer coefficient based on the heat transfer regime in that node and the heat transfer area obtained from the location of the regime transition. The heat flux from the whole node is simply the sum of the heat flux from the sub-nodes. So, essentially, the heat transfer calculation in a sub-node is similar to that in a single regime node; the exception being that the boundaries of the sub-nodes are not static and can move continuously during a transient. Although the average heat transfer coefficient in a node divided among different regimes conceptually exists and can be calculated from the available variables, it is not calculated or necessary in the algorithm.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9136
Date of RAI Issue: 11/01/2017

NRC Question No.: 01-56

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” 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 are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 – Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies that the chosen mathematical models and the numerical solution of those models must be able to predict the important physical phenomena reasonably well from both qualitative and quantitative points of view. The evaluation model must be assess against separate effects and integral effects tests.

Section 5.5.3, "Steam Generator Model," of topical report (TR), TR-0516-49417-P, indicates that heat transfer modeling on the secondary side (inside of SG tubes) covers the entire range from subcooled single-phase liquid to superheated vapor. Tube side heat transfer models include Dittus-Boelter for single phase forced convection and a modified Chen correlation for boiling. Additional details of the SG secondary side heat transfer model are discussed in other subsections of section 5.5 of the TR. {{

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

In order to make an affirmative finding NRC staff requests NuScale to provide validation of the SG tube side heat transfer model.

NuScale Response:

A comparison of the PIM and NRELAP5 predictions for the axial behavior in the steam generator region are provided in Figure 1 and Figure 2. Acceptable agreement occurs for both the primary and secondary axial temperature profiles. As the steam generator inlet and outlet temperatures are essentially boundary conditions, therefore agreement is expected. The difference in the slope of the temperature profiles is an indication that there is a difference in the heat transfer profile between the two codes. On the secondary side, there is a relatively large difference after a normalized elevation of 0.6; which is as expected because the simplification of the steam generator heat transfer model in PIM. The difference in the temperature profile has the effect of shifting the center of mass, which is compensated for in the steady state in order to calculate the same primary flow and total power specified by the PIM user input. The dynamic response depends on the relative change of the temperature profile not its absolute value, hence the observed insensitivity for calculated stability.

In the secondary temperature profile in Figure 2 the elevation at which superheat occurs is shifted in the two models. This is attributed to the differences in heat transfer modeling between the two codes.

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}}2(a),(c)

Figure 1 Primary Side Temperature Comparison

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}}2(a),(c)

Figure 2 Secondary Side Temperature Comparison

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-1217-57791

NuScale Power, LLC
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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 methods by which NuScale develops its stability analysis of the NuScale power module.

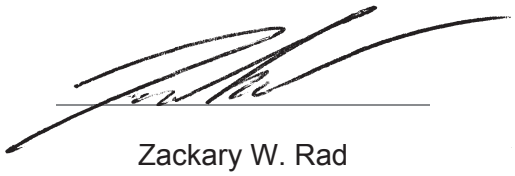
    NuScale has performed significant research and evaluation to develop a basis for this methods and has invested significant resources, including the expenditure of a considerable sum of money.

    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. 9136, eRAI No. 9136. 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 12/19/2017.



Zackary W. Rad