NUSCALE POWER™

RAIO-0118-58329

January 26, 2018

Docket: PROJ0769

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 9172 (eRAI No. 9172) 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. 9172 (eRAI No. 9172)," dated November 27, 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 Question from NRC eRAI No. 9172:

- 01-59

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 9172 (eRAI No. 9172). 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
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9172, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9172, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0118-58330

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9172, proprietary

Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9172, nonproprietary

NuScale Power

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9172
Date of RAI Issue: 11/27/2017

NRC Question No.: 01-59

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” states 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. GDC12, "Suppression of reactor power oscillations," requires that oscillations be either not possible or reliably detected and suppressed. The Design-Specific Review Standard (DSRS), 15.9.A, “Design-Specific Review Standard for NuScale SMR Design, Thermal Hydraulic Stability Review Responsibilities,“ indicates that the applicant’s analyses should correctly and accurately identify all factors that could potentially cause instabilities and their consequences. The analyses should also demonstrate that design features that are implemented prevent unacceptable consequences to the fuel. Standard Review Plan (SRP) 15.02, “Review of Transient and Accident Analysis Methods,” states that the evaluation model documentation must be scrutable, complete, unambiguous, accurate, and reasonably well contained. Regulatory Guidance (RG) 1.203, “Transient and Accident Analysis Methods,” indicates that use of NRC unapproved models should initiate an evaluation model review.

Section 5.5.5 “Chemical and Volume Control System Model,” of the topical report (TR), TR-0516-49417- P, provides a brief description of the PIM chemical and volume control system (CVCS) model. Although NuScale’s PIM code is currently an (NRC) unapproved code, NuScale is seeking approval to use the PIM code to perform safety analyses as part of its stability methodology. A qualitative description of the CVCS model in PIM is given in Section 5.5.5 of the TR however, the description is not complete or unambiguous. For example, the TR does not provide the following: a list of all CVCS components modeled by PIM; flow diagrams that show flow rates, inlet/outlet temperatures, including their source and destinations; and equations that describe how flow rates and temperatures are computed.

Operation of CVCS affects Tavg and core flow rate, therefore it may also affect the predicted behavior of the NuScale Power Module steady state operation. For example, section 8.1.6 of the TR, provides a steady state stability analysis where CVCS {{

}}$^{2(a),(c)}$ Therefore additional information is required for the CVCS model description to be considered complete and unambiguous.

In order to make an affirmative finding associated with the above regulatory requirement important to safety, NuScale should provide a detailed description of the CVCS model in PIM that includes: a list of the components of the CVCS, a flow diagram, and equations describing how flow rates and fluid temperature are computed by PIM.

NuScale Response:

The NuScale chemical volume and control system (CVCS) is simple in design and is not required to function during or after an accident. During normal operation, the CVCS recirculates a portion of the primary coolant through demineralizers and filters to maintain primary coolant cleanliness and chemistry. A portion of the recirculated coolant is used to supply the pressurizer sprays for controlling reactor pressure. Primary system coolant inventory is controlled by injection of additional water when the primary coolant levels are low or letdown of primary coolant to the liquid radioactive waste system when coolant inventory is high. Additionally, during the module start-up process, the CVCS is used to add heat to the primary coolant via the module heatup heat exchanger to establish natural circulation flow in the primary coolant system. A diagram of the CVCS is provided in Figure1.

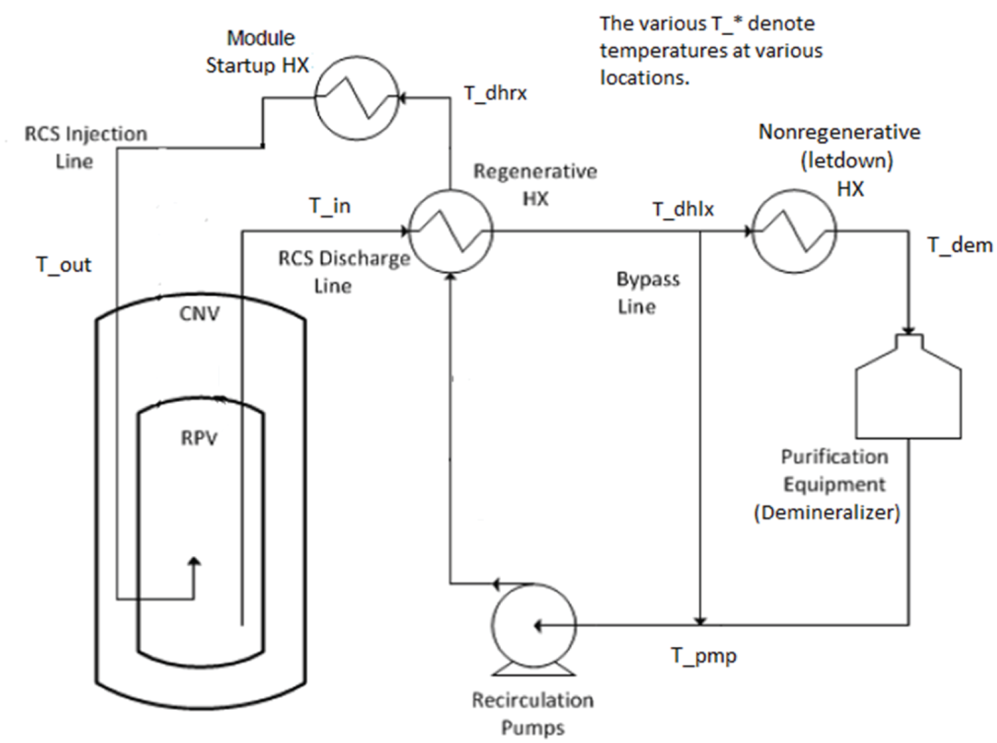

Figure 1: Diagram of the CVCS

Relative to Figure 1, PIM has the following simplifications regarding the CVCS.

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}}2(a),(c)

Modeling of the CVCS is provided for two purposes. First, during at-power operations the model simulates heat losses associated with cooling water to the desired temperature for passing through the chemical exchange systems. This heat loss reduces the amount of energy passing through the steam generators and is consistent with heat balance calculations. Second, the model is necessary to perform module heatup calculations, where a heater in the CVCS supplies energy to the primary system coolant and induces primary coolant flow.

In PIM, the CVCS is modeled by withdrawing letdown at a user-specified flow rate from a user-specified node in the downcomer at the local node conditions, passing the extracted fluid through the CVCS heat exchangers and pumps, and returning charging flow to a user-specified node in the riser. The fluid mass and energy are added to the node via calculations within PIM. No credit for the momentum transfer from the injected flow is taken that might increase the primary loop flow. Letdown flow and charging flow are each lagged by 10 seconds to represent the delaying effects of flow through long pipes.

{{

}}2(a),(c) The amount of heat added by the module heatup heat exchanger is controlled by the user.

The CVCS user input data are given below.

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}}2(a),(c)

Typical input values are as follows.

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}}2(a),(c)

During heatup simulations, the pressure is raised based on a temperature-dependent function input by the user. This function simulates operator action to ensure that adequate subcooling is maintained. This function is input as a set of coefficients, with the following typical values:

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}}2(a),(c)

The pressure is calculated as follows, with T beging taken from the apex of the riser.

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

With P being limited by the initial pressure (minimum), and normal operating pressure (1850 psia max).

The CVCS model in PIM is discussed more below. The variables used in the discussion below are listed in Table1, which relates the variables to locations of Figure 1. Enthalpies and temperatures are related via a state call that assumes subcooled liquid at the RCS pressure.

In PIM subroutine CVC, the regenerative heat changer inlet enthalpy is calculated as:

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

The assumed 10 second lag accounts for the fluid transport time from the CVC inlet inside the downcomer to the regenerative heat exchanger.

An iterative process on the letdown HX heat rate is performed such that the input T_dem is maintained. The initial guess on the liquid enthalpy after the regenerative heat exchanger and before the letdown heat exchanger is:

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

The enthalpy difference across the regenerative heat exchanger is:

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

A guess for the regenerative heat exchanger heat rate is:

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

The liquid enthalpy at the recirculation pump inlet is:

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

Enthalpy after the regenerative heat exchanger and before the startup heater is:

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

Given the enthalpy and pressure, the liquid temperature at the inlets and outlets of the regenerative heat exchanger can be determined, and the LMTD (tmplmt) can be calculated. The regenerative heat exchanger power is:

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

Where ueffrx is a user input (iopt=2) or calculated from the initial CVC conditions (iopt=1) based on letdown HX heat rate and T_dem.

The difference on the regenerative heat exchanger power calculated above is:

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

A new guess for qlx is then formed. The iterative process is concluded when -1<diff<1 (Watt).

The liquid enthalpy at the outlet of the startup heater is:

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

The lagged liquid enthalpy exiting CVC with the assumed 10 second lag for piping is:

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

Net heat added by CVC is:

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

Inside the RPV, the loop flow from the CVC injection volume (icvc) to the offtake volume (jcvc) is reduced by the CVC flow rate.

Table 1 Variables Used in the Calculation

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}}2(a),(c)

The impact of the CVCS flow on the primary flow stability is insignificant at high power and flow given the relative magnitude of the flow and energy circulated through that system is small. At very low primary flow and core power, the fraction of the CVCS flow and energy is no longer insignificant. In the low power and flow regime the CVCS impact on stability in PIM modeling is conservative by design where the injected flow momentum jet-pump-effect is not included. This is conservative since the neglected jet-pump-like momentum increase would be a constant not affected by the feedback processes and therefore stabilizing.

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-0118-58330

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. 9172, eRAI No. 9172. 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 1/26/2018.

Zackary W. Rad