RAIO-0319-64864

March 14, 2019

Docket No. 52-048

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. 377 (eRAI No. 9380) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 377 (eRAI No. 9380)," dated March 02, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 377 (eRAI No.9380)," dated October 25, 2018

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. 9380:

- 06.02.01.01.A-5

Enclosure 1 is the proprietary version of the NuScale Supplemental Response to NRC RAI No. 377 (eRAI No. 9380). 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-8H12
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9380, proprietary

Enclosure 2: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9380, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0319-64865

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9380, proprietary

Enclosure 2:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9380, nonproprietary

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9380
Date of RAI Issue: 03/02/2018

NRC Question No.: 06.02.01.01.A-5

Liquid Water Temperature Stratification inside the Containment

To meet the General Design Criteria (GDCs) 16, 38, and 50 relevant to the containment design basis and guided by the Standard Review Plan (SRP), the staff is reviewing the applicant's analytical models and analysis results that are used for the licensing-basis safety analyses. Specifically, the staff needs to assess the licensing-basis models, constitutive/closure relations, and model input parameters used for the applicant's NPM design basis event (DBE) containment response analyses, in order to conclude that the results are valid over the applicable range of DBE conditions. The regulatory bases identified above are applicable to all questions in this RAI.

As shown in the NuScale Final Safety Analysis Report Table 6.2-2, Containment Analysis Response Results, the limiting transient for containment peak pressure is an inadvertent opening of a reactor recirculation valve (RRV). The NRELAP5 analysis of this transient shows that the pressurized RCS liquid flowing into the CNV will start flashing into steam. As the CNV pressure increases from approximately 2 psia at the start of the transient up to the peak containment pressure, a smaller fraction of the liquid would flash to steam since the degree of superheat is reduced as the containment pressure increases. The liquid falls to the lower bottom of the containment where the condensate from the flashed steam condensing on the cold containment wall also gets accumulated. The condensate eventually becomes subcooled due to CNV pressurization and the heat transfer from the liquid to reactor pool through the CNV wall. NRELAP5 is expected to calculate the flashing/separation of the steam and liquid entering the CNV and liquid water falling to the bottom of the CNV. As the liquid temperature of water entering the CNV increases with time, thermal stratification of this water accumulating in the CNV is expected.

NRELAP5 should be able to accurately calculate this potentially safety-significant, non-equilibrium thermodynamic process. This is important because overestimating the temperatures of the stratified subcooled water inventory in the lower CNV could lead to a lower calculated containment pressure – a non-conservative result. However, the NRELAP5 model of the NPM uses only a few large volume nodes to represent the portion of the CNV volume below the liquid steam interface, and it is not clear whether NRELAP5 accurately simulates the temperature stratification phenomenon in the liquid water accumulated in the CNV. The NRELAP5 peak CNV pressure will be under predicted if the NuScale NRELAP5 model overestimates the mixing and cooling of CNV steam by this relatively cool water in the lower CNV. Thus, a conservative NRELAP5 model for temperature stratification that minimizes the steam cooling by the water accumulating in the CNV, and thus leads to a conservative distribution of energy in the CNV liquid and vapor phases, would be required in a conservative CNV peak pressure analysis.

The staff needs a greater understanding to assess the safety significance of the thermally stratified water in the CNV of the NPM during blowdown out to the time of peak containment pressure. NuScale is requested to provide additional information to enable the staff to assess the impact of liquid thermal stratification and nodalization in the CNV liquid region. For example, NuScale could provide (or make available) a revised nuclear power module (NPM) analysis for the limiting peak CNV pressure design basis event of inadvertent opening of an RRV with sufficiently fine hydrodynamic noding in the CNV liquid region. If additional analysis is performed, please provide (or make available) overlay plots that compare the impact of the revised nodalization on the computed liquid temperature and enthalpy versus time for the nodes up to the node where the liquid/steam interface occurs at the time of peak pressure. This will allow the staff to assess how NRELAP5 evaluates/treats the impact of subcooled water temperature stratification on the calculated CNV peak pressure.

NuScale Response:

During a public call held on January 16, 2019, NuScale agreed to supplement the response to RAI 9380, Question 06.02.01.01.A-5, as submitted by NuScale letter RAIO-1018-62295 dated October 25, 2018, by providing a figure depicting containment (CNV) liquid region temperature, as a function of time, for the inadvertent RRV opening event for each of the three CNV axial nodalization schemes discussed in RAIO-1018-62295.

Figures 1 through 4 compare the CNV volume liquid temperature at each axial level for the base, fine, and coarse CNV nodalization sensitivities for the base case inadvertent RRV

opening transient at 60 seconds before the peak CNV pressure, at the time of ECCS opening, at the time of peak CNV pressure, and at 60 seconds after the time of peak CNV pressure. The prediction of CNV volume liquid temperatures for the base, fine, and coarse nodalizations is fairly consistent for the time period around the time of peak CNV pressure.

The CNV volume liquid temperatures below the CNV water level and below the reactor recirculation valve (RRV) elevation show a trend of {{

}}2(a),(c) See Figure 5 for the CNV water level profile.

{{

}}2(a),(c)

Figure 1 CNV Volume Liquid Temperature (60 seconds before peak pressure)

{{

}}2(a),(c)

Figure 2 CNV Volume Liquid Temperature (at time of ECCS actuation)

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}}2(a),(c)

Figure 3 CNV Volume Liquid Temperature (at time of peak pressure)

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}}2(a),(c)

Figure 4 CNV Volume Liquid Temperature (60 seconds after peak pressure)

{{

}}2(A),(C)

Figure 5 CNV Liquid Level (+/- 60 seconds from time of peak pressure)

The CNV volume liquid temperatures above the RRV, elevation (18.5 ft) and below the CNV water level (24.5 ft) at the time of peak CNV pressure, {{

}}2(a),(c)

{{

}}2(a),(c)

{{

}}2(a),(c)

Figure 6 Depiction of CNV Liquid Level at time of ECCS Actuation

{{

}}2(a),(c)

Figure 7 CNV Volume Liquid Temperature (1000 seconds after peak pressure)

Figure 8 and Figure 9 compare the RPV pressure and CNV pressure for the base, fine, and coarse CNV nodalization sensitivities for the base case inadvertent RRV opening transient at the time of peak CNV pressure, as well as, at times +/- 60sec from the time of peak CNV pressure. The difference in the calculated RPV pressure and CNV pressure response for the base, fine, and coarse nodalizations is not significant.

{{

}}2(a),(c)

Figure 8 RPV Pressure (+/- 60 seconds from time of peak pressure)

{{

}}2(a),(c)

Figure 9 Maximum CNV Internal Pressure (+/- 60 seconds from time of peak pressure)

In addition, NuScale agreed to include a table comparing peak pressure results based on each nodalization scheme, used in the sensitivity study that evaluated the effect of coarse versus fine CNV and reactor pool nodalization. The requested information is provided in Table 1 below. It should be noted that the pressure results provided in the table only reflect the impact on CNV internal pressure resulting from the changes in nodalization scheme, in comparison to the base case. These results do not reflect any other changes to the base RRV opening case used to determine the limiting peak pressure case.

Table 1

Nodalization Sensitivity Results

{{

}}2(a),(c)

CNV Volume Axial Nodalization

The results of the CNV axial nodalization sensitivity indicates that the peak internal pressure results for the limiting Inadvertent RRV Opening Event {{ }}2(a),(c) The fine CNV axial nodalization scheme {{ }}2(a),(c) was used in determining the limiting CNV peak pressure of 986 psia.

CNV Heat Structure Nodalization

The results of the CNV heat structure nodalization sensitivity indicates that the peak internal pressure results for the limiting Inadvertent RRV Opening Event {{ }}2(a),(c) The fine CNV heat structure nodalization scheme {{ }}2(a),(c) was used in determining the limiting CNV peak pressure of 986 psia.

Reactor Pool Nodalization

The results of the reactor pool nodalization sensitivity indicates that the peak internal pressure results for the limiting Inadvertent RRV Opening Event {{ }}[2(a),(c)] The fine reactor pool nodalization scheme {{ }}[2(a),(c)] was used in determining the limiting CNV peak pressure of 986 psia.

In summary, Figure 1 through Figure 9 demonstrate there is no significant change in CNV liquid volume temperature, CNV pressure and RCS pressure, when results utilizing the base, coarse and fine CNV axial nodalization schemes are compared. Table 1 demonstrates a minor (less than 3 psi) impact on pressure results when finer CNV axial volume, CNV heat structure and reactor pool nodalization schemes are modeled, in comparison to the base nodalization schemes. The limiting CNV peak pressure case utilizes the fine nodalization schemes, ensuring this minor impact is addressed.

Impact on DCA:

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

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0319-64865

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 analyses by which NuScale develops its NIST-1 HP-02 testing.

   NuScale has performed significant research and evaluation to develop a basis for this analyses 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. 377, eRAI No. 9380. 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 March 14, 2019.

Zackary W. Rad