RAIO-1217-57788

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. 9065 (eRAI No. 9065) on the NuScale Topical Report, "Loss-of-Coolant Accident Evaluation Model," TR-0516-49422, Revision 0

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 9065 (eRAI No. 9065)," dated October 20, 2017
2. NuScale Topical Report, "Loss-of-Coolant Accident Evaluation Model," TR-0516-49422, Revision 0, dated December 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. 9065:

- 15.06.05-8

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 9065 (eRAI No. 9065). 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: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Rani Franovich, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9065, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9065, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-1217-57789

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9065, proprietary

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9065, nonproprietary

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9065
Date of RAI Issue: 10/20/2017

NRC Question No.: 15.06.05-8

10 CFR Part 50, Appendix K, I.A.1 – *Initial Stored Energy in the Fuel* requires “The steady-state temperature distribution and stored energy in the fuel before the hypothetical accident be calculated for the burn-up that yields the highest calculated cladding temperature (or optionally, the highest calculated stored energy.) To accomplish this, the thermal conductivity of the UO2 shall be evaluated as a function of burn-up and temperature, taking into consideration differences in initial density; and the thermal conductance of the gap between the UO2 and the cladding shall be evaluated as a function of the burn-up, taking into consideration fuel densification and expansion, the composition and pressure of the gases within the fuel rod, the initial cold gap dimension with its tolerances, and cladding creep."

The staff determined that the applicant performed hand calculations of fuel stored energy and fuel rod properties (documented in EC-0000-4888 Section 2.2) and characterized the calculations as biased to maximize the initial stored energy. However, it is not clear to NRC staff that this method of hand calculations of fuel properties taken from the Areva COPERNIC code (Ref. 1.4.18 of the calculation) are indeed conservative in regard to fuel stored energy.

The staff requests that the applicant provide additional information which justifies that the hand calculations are conservative for the various fuel inputs provided by EC-0000-4888. The key parameters for maximizing fuel stored energy are highly interrelated and interdependent and it is not clear that the hand calculation method conservatively incorporates these relationships. Therefore, the justification should include the effect of fuel pellet thermal conductivity degradation, burn-up effect, fuel densification and gap conductance variation through the fuel cycle.

NuScale Response:

Table 2-2 of Reference 1 summarizes the 10 CFR 50 Appendix K requirements and how they are addressed in the loss-of-coolant accident (LOCA) evaluation model, including the fuel stored energy. As concluded in Reference 1, the LOCA evaluation demonstrates that the fuel does not

heat up as a result of core uncovery and/or by reaching a critical heat flux (CHF) condition. The amount of initial stored energy in the fuel during a hypothetical accident is maximized in order to maximize the initial energy inventory inside the reactor pressure vessel (RPV).

The parameters affecting the amount of stored energy in the fuel are:

- total heat generation inside the UO_2 fuel
- thermo-physical properties (thermal conductivity and heat capacity) of the UO_2 fuel and M5 cladding
- gap conductance between UO_2 and M5 cladding determined by the fuel densification, expansion, the fission gas release, cladding creep, etc.

As discussed in Table A-1 of Reference 1, the fuel stored energy is maximized by

- {{

}}$^{2(a),(c),ECI}$ The evaluation model described in Reference 1 is used to perform LOCA analysis for the NuScale Power Module (NPM) which is independent of time in fuel cycle. This is accomplished by assuring that the thermal property modeling bounds exposure variation and changes in core design when calculating the fuel stored energy. This is implemented by considering the fuel vendor-provided equations for the thermo-physical properties assuming:

- {{

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

A detailed analysis of the thermal-mechanical behavior of the NuScale fuel rod design was performed over a wide range of power and burnup conditions using COPERNIC (Reference 2). In order to demonstrate the conservatism of the LOCA Evaluation Model when modeling the fuel heat conduction problem, the fuel temperatures calculated by the NRELAP5 LOCA model and COPERNIC are compared for consistent heat generation and convective boundary conditions for a wide range of exposures or time in fuel cycle.

Figure 3 compares the COPERNIC-calculated gap conductance as a function of average burnup with the constant gap conductance used in the LOCA evaluation model. The constant gap conductance of {{ }}$^{2(a),(c),ECI}$ used in the LOCA model is shown to bound variations due to the exposure.

Figure 4 compares the COPERNIC and NRELAP5 calculated average fuel temperatures as a function of axial position. The burnup-dependent COPERNIC analysis demonstrates that the maximum average fuel temperature is achieved at the fuel exposure of {{ }}$^{2(a),(c),ECI}$. Figure 4 shows that the NRELAP5 LOCA model predicts about {{ }}$^{2(a),(c),ECI}$ hotter fuel temperatures on average. This higher fuel temperature, when combined with the higher volumetric heat capacity described previously, assures a conservatively high stored energy.

References:

1. TR-0516-49422, Revision 0, “Loss-of-Coolant Accident Evaluation Model”, December 2016

2. AREVA Topical Report, 43-10231P-01, “COPERNIC Fuel Rod Design Computer Code”, 1999.

{{

}}2(a),(c),ECI

Figure 1. UO_2 thermal conductivity as a function of burnup and temperature

{{

}}[2(a),(c),ECI]

Figure 2. UO_2 heat capacity as a function of temperature

{{

}}2(a),(c),ECI

Figure 3. COPERNIC gap conductance as a function of average burnup

{{

}}2(a),(c),ECI

Figure 4. Comparison of axial variation of average fuel temperature

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49422, Loss-of-Coolant Accident Evaluation Model, as a result of this response.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-1217-57789

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

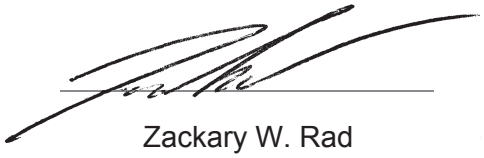
1. I am the Director, Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on 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 loss-of-coolant accident analysis of the NuScale power module.

    NuScale has performed significant research and evaluation to develop a basis for these 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. 9065, eRAI No. 9065. 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