RAIO-0717-55010

July 24, 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. 8800 (eRAI No. 8800) on the NuScale Topical Report, "Accident Source Term Methodology," TR-0915-17565, Revision 1

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 8800 (eRAI No. 8800)," dated June 23, 2017
2. NuScale Topical Report, "Accident Source Term Methodology," TR-0915-17565, Revision 1, dated April 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. 8800:

- 15.00.03-2
- 15.00.03-3
- 15.00.03-4

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 8800 (eRAI No. 8800). 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 Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, TWFN-6E55
Samuel Lee, NRC, TWFN-6C20
Anthony Markley, NRC, TWFN-6E55

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8800, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 8800, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0717-55012

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8800, proprietary

NuScale Power, LLC
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Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 8800, nonproprietary

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Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8800
Date of RAI Issue: 06/23/2017

NRC Question No.: 15.00.03-2

10 CFR 52.47(a)(2)(iv) requires that an application for a design certification include a final safety analysis report that provides a description and safety assessment of the facility. The safety assessment analyses are completed, in part, to show compliance with the radiological consequence evaluation factors in 52.47(a)(2)(iv)(A) and 52.47(a)(2)(iv)(B) for offsite doses, 10 CFR Part 50, Appendix A, GDC 19 for control room radiological habitability, and the requirements related to the technical support center in 10 CFR 50.47(b)(8) and (b)(11) and Paragraph IV.E.8 of Appendix E to 10 CFR Part 50. The radiological consequences of design basis accidents are evaluated against these regulatory requirements and the dose acceptance criteria given in NuScale design specific review standard (DSRS) Section 15.1.3 Regulatory Guide 1.183 provides dose assessment guidance.

NuScale licensing topical report TR-0915-17565-P, Rev.1, "Accident Source Term Methodology," provides a proposed methodology for the performance of design basis accident radiological consequence analyses for the NuScale design. The staff requires the following information to complete its review of the subject topical report to evaluate compliance with the applicable NRC requirements:

The proposed methodology for determining the iodine decontamination factor for the pool during a fuel handling accident is an extrapolation of an equation from the Burley paper (“Evaluation of Fission Product Release and Transport for a Fuel Handling Accident,” G. Burley, NRC, Oct. 5, 1997) that forms the underlying basis for the pool iodine decontamination factor given in RG 1.183. As stated on page 16 of the Burley paper, the most important parameters related to the iodine decontamination factor within the pool include the gas bubble dimensions, contact time and partition factor.

a. The methodology proposed assumes that the range of gas bubble characteristics (e.g., bubble diameter, bubble effective diameter, bubble velocity) is not different at rise heights over 23 feet. Please provide justification for this assumption.
b. The Burley paper assumed that the time for contact between the pool water and the gas bubbles as they rise to the surface of the pool was short

compared to the time it takes to get to an equilibrium iodine concentration. How did you determine if this assumption is applicable to the deeper pool depth for the NuScale design?

c. What is the basis for applying the partition factor ranges used in the Burley paper to bubble rise heights greater than 23 feet?

NuScale Response:

Question a.

The proposed methodology for determining the iodine decontamination factor for the pool during a fuel handling accident is withdrawn and is replaced with the standard Regulatory Guide 1.183 Appendix B guidance of using an overall effective decontamination factor of 200 when the depth of water above the damaged fuel is 23 feet or greater. Therefore, no justification for the assumption of gas bubble characteristics associated with the previously proposed methodology is provided.

A markup of TR-0915-17565 is provided to show this methodology change.

Question b.

As discussed in the response to Question a., the proposed methodology for determining the iodine decontamination factor for the pool during a fuel handling accident is withdrawn. Therefore, no justification for the assumption of gas bubble contact time associated with the previously proposed methodology is provided.

Question c.

As discussed in the response to Question a., the proposed methodology for determining the iodine decontamination factor for the pool during a fuel handling accident is withdrawn. Therefore, the basis for applying the partition factor ranges used in the Burley paper to bubble rise heights greater than 23 feet is not provided.

Impact on Topical Report:
Topical Report TR-0915-17565, Accident Source Term Methodology, has been revised as described in the response above and as shown in the markup provided in this response.

TABLES

7. STARNAUA is appropriate for modeling natural removal of containment aerosols for the NuScale design.
8. No maximum limit on ~~elemental~~ iodine decontamination factor for natural removal of containment aerosols.
9. {{

   }}$^{2(a),(c)}$
10. Utilizing the iodine spiking assumptions of RG 1.183 is appropriate.
11. ~~Generalized process for determining the analytical effective decontamination factor based on a minimum depth of water above the damaged fuel in a fuel handling accident.~~Utilizing the iodine decontamination factor assumptions of RG 1.183 for the fuel handling accident is appropriate.
12. With respect to accident analysis, it is appropriate to neglect the small secondary side volume that could contain activity from primary to secondary leakage for the NuScale design.
13. For pH_T values of 6.0 or greater, the amount of iodine re-evolution that could occur between pH_T values of 6.0 and 7.0 is negligible and not included in the dose calculation.
14. Containment shine of the radiation in the containment airspace through the containment vessel, reactor pool water, and then through the reactor building walls or ceiling to the environment is negligible for the NuScale design.

1.3 Abbreviations

Table 1-1. Abbreviations

Term	Definition
ALWR	advanced light water reactor
AST	alternative source term
Bq	Becquerel (unit of radioactivity)
Ci	curie (unit of radioactive decay)
μCi	micro-Curie (1.0E-06 Ci) (unit of radioactive decay)
cfm	cubic feet per minute (unit of flow)
COL	combined license
CR	control room
CVCS	chemical and volume control system

4. Primary coolant leaks into both steam generators at the maximum leak rate allowed by design basis limits. The leakage continues until the reactor is shut down and depressurized and the primary and secondary systems are at an equal pressure.
5. Activity is released to the environment through the condenser until isolation is achieved.
6. Leakage through the secondary isolation valves (main steam and feedwater) occurs in the reactor building until the reactor is shut down and depressurized. No credit is taken for any source term reduction within the reactor building.

The following is a summary of the assumptions used from Appendix H of RG 1.183:

- containment iodine chemical form of 95% cesium iodide, 4.85% elemental iodine, and 0.15% organic iodide
- primary system iodine chemical form of 97% elemental iodine and 3% organic iodide
- no reduction or mitigation of noble gas radionuclides released from the primary system
- density for leak rate conversion: 62.4 pound mass (lbm)/ft^3

3.2.2 Fuel Handling Accident

The methodology for determining FHA radiological consequences is based on the guidance provided in Appendix B of RG 1.183 and Section 15.7.4 of the SRP. The explicit guidance enumerated in Appendix B of RG 1.183, as updated by Regulatory Issue Summary (RIS) 2006-04 (Reference 7.2.11) item 8, is followed ~~with one exception, which is that the iodine decontamination factor will be calculated with a generalized methodology instead of utilizing the prescribed RG 1.183 values for a depth of water above the damaged fuel of 23 feet or greater~~. The methodology assumes failure of all the fuel rods in one irradiated fuel assembly occurs.

As presented in Section 3.3.8 of this report, the NuScale reactor pool has a minimum depth above the damaged fuel greater than the minimum 23 foot depth specified as the basis for the iodine decontamination factor in Reference 7.2.11. ~~Therefore, a generalized methodology for calculating increased decontamination factor was used, and is based on the methodology and assumptions of Reference 7.2.12. This methodology is presented in more detail in Section 3.3.8.~~

The following is a summary of the assumptions used from Appendix B of RG 1.183:

- radionuclides considered include xenon, krypton, halogen, cesium, and rubidium
- overall effective iodine decontamination factor of 200 for the pool
- ~~iodine chemical form of 57 percent elemental iodine and 43 percent organic iodide~~
- no reduction or mitigation of noble gas radionuclides released from the fuel
- release to the environment over a two hour period

3.3.8 Fuel Handling Accident Decontamination

The methodology for determining the radiological consequences of a FHA assumes that the NuScale reactor pool (or spent fuel pool depending on the location of the FHA) has a minimum water depth above the damaged fuel greater than the 23-foot depth specified in RG 1.183. An elemental decontamination factor of 285, an organic decontamination factor of 1, and an overall effective decontamination factor of 200 are assumed per RG 1.183 as updated by RIS 2006-04 (Reference 7.2.11) item 8.~~In accordance with RG 1.183, the guidance of Reference 7.2.12 is utilized to establish a NuScale specific reactor pool decontamination factor for the FHA.~~

~~Page 26 of Reference 7.2.12 defines the pool inorganic decontamination factor to be proportional to an exponential function with the pool depth in the exponent as given by~~

$$DF_{inorg} = e^{\frac{6k_{eff}H}{d_b v_b}} \quad \text{Eq 3-18}$$

~~where,~~

~~d_b = Diameter of bubble~~

~~DF_{eff} = Effective decontamination factor for iodine~~

~~DF_{inorg} = Decontamination factor for inorganic iodine~~

~~F_{inorg} = Fraction of inorganic iodine~~

~~F_{org} = Fraction of organic iodine~~

~~H = Height of bubble rise (i.e., bubble rise height)~~

~~k_{eff} = Effective flow characteristics of bubble~~

~~v_b = Rise velocity of a bubble from pressurized source~~

~~{{~~

~~}}~~

{{

}}2(a),(c)

~~Table 3-5. Comparison of original RG 1.183 values and example effective decontamination factor scaled to varying water depths~~

~~{{~~

~~}}2(a),(c)~~

3.3.9 Iodine Spiking

The NRC's results of the initial screening of Generic Issue (GI) 197 (Reference 7.2.34) describes the phenomenon of iodine spiking observed in operating reactors. After a core power or primary system pressure transient, the iodine concentration in the reactor coolant may increase to a value many times its equilibrium concentration level, followed by a gradual decay back down to a lower level. Iodine spiking occurs when a change in reactor power, temperature, and/or pressure results in the transport of dissolved iodine compounds out of failed fuel rods and into the primary coolant. After reaching peak concentrations, the iodine is then gradually removed by the reactor coolant cleanup systems, radioactive decay, and release to the environment.

All known iodine spiking models are built on an assumed physical causative scenario of a fuel rod with a defect. During power operation, iodine collects on the surfaces of the fuel pellets and internal cladding surface; likely as cesium iodide or another water-soluble salt. However, during operation, the internal free volume of the defective fuel rod is steam-blanketed, and relatively little iodine is transported out to the reactor coolant. If the reactor is shut down, or if power is reduced in a power transient, liquid water will enter the fuel pellet-to-cladding gap volume, dissolving any soluble iodine compounds, which then can readily diffuse out of the cladding defect. Similarly, a pressure transient could force liquid water in or out of the defective fuel rod, thereby transporting iodine into the bulk primary coolant.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8800
Date of RAI Issue: 06/23/2017

NRC Question No.: 15.00.03-3

10 CFR 52.47(a)(2)(iv) requires that an application for a design certification include a final safety analysis report that provides a description and safety assessment of the facility. The safety assessment analyses are completed, in part, to show compliance with the radiological consequence evaluation factors in 52.47(a)(2)(iv)(A) and 52.47(a)(2)(iv)(B) for offsite doses, 10 CFR Part 50, Appendix A, GDC 19 for control room radiological habitability, and the requirements related to the technical support center in 10 CFR 50.47(b)(8) and (b)(11) and Paragraph IV.E.8 of Appendix E to 10 CFR Part 50. The radiological consequences of design basis accidents are evaluated against these regulatory requirements and the dose acceptance criteria given in NuScale design specific review standard (DSRS) Section 15.0.3. Regulatory Guide 1.183 provides dose assessment guidance.

NuScale licensing topical report TR-0915-17565-P, Rev.1, "Accident Source Term Methodology," provides a proposed methodology for the performance of design basis accident radiological consequence analyses for the NuScale design. The staff requires the following information to complete its review of the subject topical report to evaluate compliance with the applicable NRC requirements:

On page 33 of the topical report, it states that based on holding all parameters other than depth of water above the fuel fixed, the inorganic iodine decontamination factor is scaled (from 285, as given in RG 1.183 for 23 ft) by a proprietary factor that includes consideration of the water depth. Please provide the derivation of this scaling factor.

NuScale Response:

As discussed in the response to RAI Question 15.00.03-2 a., the proposed methodology for determining the iodine decontamination factor for the pool during a fuel handling accident is withdrawn. Therefore, the derivation of the scaling factor associated with the previously proposed methodology is not provided.

Impact on Topical Report:
There are no impacts to the Topical Report TR-0915-17565, Accident Source Term Methodology, as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8800
Date of RAI Issue: 06/23/2017

NRC Question No.: 15.00.03-4

10 CFR 52.47(a)(2)(iv) requires that an application for a design certification include a final safety analysis report that provides a description and safety assessment of the facility. The safety assessment analyses are completed, in part, to show compliance with the radiological consequence evaluation factors in 52.47(a)(2)(iv)(A) and 52.47(a)(2)(iv)(B) for offsite doses, 10 CFR Part 50, Appendix A, GDC 19 for control room radiological habitability, and the requirements related to the technical support center in 10 CFR 50.47(b)(8) and (b)(11) and Paragraph IV.E.8 of Appendix E to 10 CFR Part 50. The radiological consequences of design basis accidents are evaluated against these regulatory requirements and the dose acceptance criteria given in NuScale design specific review standard (DSRS) Section 15.0.3. Regulatory Guide 1.183 provides dose assessment guidance.

NuScale licensing topical report TR-0915-17565-P, Rev.1, "Accident Source Term Methodology," provides a proposed methodology for the performance of design basis accident radiological consequence analyses for the NuScale design. The staff requires the following information to complete its review of the subject topical report to evaluate compliance with the applicable NRC requirements:

The proposed method to determine the iodine effective DF also provides for a sensitivity study based on the inorganic fraction of fuel rod gap iodine assumed to be released to the pool. What is the basis for the implied assumption that the inorganic iodine fraction released from the fuel rod gap in the fuel handling accident would be different for the NuScale fuel than the value given in RG 1.183?

NuScale Response:

As discussed in the response to RAI Question 15.00.03-2 a., the proposed methodology for determining the iodine decontamination factor for the pool during a fuel handling accident is withdrawn. Therefore, no discussion of the sensitivity study or implied assumptions associated with the previously proposed methodology is provided.

Impact on Topical Report:
There are no impacts to the Topical Report TR-0915-17565, Accident Source Term Methodology, as a result of this response.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0717-55012

NuScale Power, LLC
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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 methodology by which NuScale develops its accident source term.

    NuScale has performed significant research and evaluation to develop a basis for this methodology 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 Request for Additional Information No. 8800, eRAI 8800. 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 7/24/2017.

Zackary W. Rad