July 7, 2017 Docket No. 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. 13 (eRAI No. 8795) on NuScale Topical Report TR-0116-21012, "NuScale Power Critical Heat Flux Correlation NSP2," Revision 0

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 13 (eRAI 8795)," dated May 8, 2017.
2. NuScale Topical Report, "NuScale Power Critical Heat Flux Correlation NSP2," TR-0116-21012, Revision 0, dated October 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 Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 8795:

- 29724
- 29725
- 29726

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 13 (eRAI No. 8795). NuScale requests that this enclosure be withheld from public disclosure pursuant to 10 CFR § 2.390. The enclosed affidavits (Enclosures 3 and 4) support this request. Enclosure 3 pertains to the AREVA proprietary information to be withheld from the public while Enclosure 4 pertains to the NuScale proprietary information to be withheld from the public. AREVA proprietary information is denoted by straight brackets (i.e., "[ ]") while NuScale proprietary information is denoted by double curly brackets (i.e., "{{ }}").

Enclosure 2 is the nonproprietary version of the NuScale Response to NRC RAI No. 13 (eRAI No. 8795).

Please feel free to contact Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com if you have any questions.

Sincerely,

Jennie Wike
Manager, Licensing
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, TWFN-6E55
Samuel Lee, NRC, TWFN-6C20
Bruce Bavol, NRC, TWFN-6C20

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8795, proprietary
Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 8795, nonproprietary
Enclosure 3: AREVA Affidavit
Enclosure 4: Affidavit of Zackary W. Rad, AF-0717-54799

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8795, proprietary

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, 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. 8795, nonproprietary

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8795
Date of RAI Issue: 05/08/2017

NRC Question No.: 29724

Title 10 of the Code of Federal Regulations (10 CFR) Part 52, Section 47 and Section 79 require a final safety analysis report (FSAR) to analyze the design and performance of the structures, systems, and components (SSCs). Safety evaluations, performed to support the FSAR, include accident analyses to (1) demonstrate that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation, including the effects of anticipated operational occurrences (AOOs), and (2) determine the number of fuel failures associated with critical heat flux (CHF) that need to be included in the radiological consequences for postulated accidents. An approved CHF correlation is used in establishing a SAFDL for use in such analyses. Thus, an approved CHF correlation is used to establish a partial basis for demonstrating compliance with the following applicable regulations from Title 10 of the Code of Federal Regulations (10 CFR) which include the General Design Criteria (GDCs) of Appendix A to 10 CFR Part 50:

GDC 10, Reactor design, which requires that the reactor core and associated coolant, control, and protection systems be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs.

10 CFR 52.47(a)(2)(iv)(A), 10 CFR 52.47(a)(2)(iv)(B), and GDC 19 as they relate to the evaluation and analysis of the radiological consequences of postulated accidents.

Section 3.1 of TR-0116-21012 describes the data sources used to develop the CHF correlation and provides the test matrices used for testing at Stern Laboratories and the KATHY test loop. NRC staff was not able to identify any discussion regarding the statistical design of the experiments. In particular, NRC staff is questioning whether randomization of the test points was conducted in an effort to preclude the potential for introducing bias into the figure of merit (i.e., CHF). As part of the review of TR-0116-21012, NRC staff needs to establish a finding that the statistical design of the experiment is acceptable. Accordingly, NRC staff requests that NuScale describe how the statisctical design of experiments was treated during testing at Stern Laboratories and the KATHY test loop.

NuScale Response:

The test matrix for the NuScale Power critical heat flux (CHF) testing at Stern Laboratories was designed to include state points distributed across a large range of conditions of pressure, average mass flux, and inlet sub-cooling for all three test bundle designs (unit and guide tube tests with uniform axial power profile, and unit test with cosine axial power profile). Data are taken for each combination of pressure, mass flux, and sub-cooling with no particular state point emphasized more than the others, other than the inclusion of repeat points taken throughout the test campaign, to assure that the test results remain consistent from beginning to end of the a test campaign. This approach is consistent with historical precedent. Taking data at each state point combination allows for a systematic evaluation of trends with regards to pressure, mass flux, and sub-cooling, and a comparison to the expected rod bundle behavior during testing. This approach is preferred over selecting test points to satisfy a particular statistical test design, since a test campaign is comprised of a very large number of test points. The distribution of test points across the envisioned operating space is structured, eliminating any concerns of test design bias.

The test matrices at AREVA's KATHY facility were based on the following guidance:

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

The state points for the KATHY test are distributed across the envisioned operating space, although the state point density is not identical to that of Stern testing. There are a large number of data measured from the four tests that cover the operating space fairly evenly. At low pressures and low mass fluxes an increased amount of data was taken because these test conditions tend to be more challenging.

Impact on Topical Report:
There are no impacts to the Topical Report as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8795
Date of RAI Issue: 05/08/2017

NRC Question No.: 29725

Title 10 of the Code of Federal Regulations (10 CFR) Part 52, Section 47 and Section 79 require a final safety analysis report (FSAR) to analyze the design and performance of the structures, systems, and components (SSCs). Safety evaluations, performed to support the FSAR, include accident analyses to (1) demonstrate that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation, including the effects of anticipated operational occurrences (AOOs), and (2) determine the number of fuel failures associated with critical heat flux (CHF) that need to be included in the radiological consequences for postulated accidents. An approved CHF correlation is used in establishing a SAFDL for use in such analyses. Thus, an approved CHF correlation is used to establish a partial basis for demonstrating compliance with the following applicable regulations from Title 10 of the Code of Federal Regulations (10 CFR) which include the General Design Criteria (GDCs) of Appendix A to 10 CFR Part 50:

GDC 10, Reactor design, which requires that the reactor core and associated coolant, control, and protection systems be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs.

10 CFR 52.47(a)(2)(iv)(A), 10 CFR 52.47(a)(2)(iv)(B), and GDC 19 as they relate to the evaluation and analysis of the radiological consequences of postulated accidents.

Section 3.1.1.3 and Section 3.1.2.7 of TR-0116-21012 describe the data acquisition systems at Stern Laboratories and the KATHY test loop, respectively. These sections describe the instrumentation used to measure heater power, coolant flow, pressure, and temperature. The measurements for heater power are described as redundant and diverse at both facilities. The coolant pressure and temperature measurements are described as redundant at both facilities. The flow measurement at Stern Laboratories is described as redundant and diverse. However, from the description of the flow measurement at the KATHY test loop, it is unclear to the NRC staff whether measurement redundancy and diversity were considered. NRC staff relies upon adequate measurement redundancy and diversity to support a finding that the experimental data has been accurately measured. Accordingly, NRC staff requests that NuScale describe how flow measurement redundancy and diversity were treated for the testing at the KATHY test loop, and describe how this treatment is assessed to support application of the KATHY test loop results.

NuScale Response:

The three step process used for ensuring the accuracy of flow measurements for the KATHY test loop is:

1. the utilization of calibrated **[** **]** that conform with the NQA-1 quality assurance program requirements,
2. an extensive loop commissioning, performed prior to CHF test data acquisition, where the flow measurements of **[** **]** and
3. the use of **[** **]**

This process was applied for the CHF tests K8500, K9000, K9100, K9200, and K9300 to ensure the accuracy of the flow measurements. The K8500 CHF test was performed in 2014 for the HMP spacer grid design and the K9000-K9300 CHF tests were performed in 2016 specifically for the NuScale fuel design. The flow measurement devices used for the determination of the flow values in the CHF test results are shown in Figure A.

The KATHY loop flow measurements for the K8500 CHF testing were performed using **[**

]

During the loop commissioning effort for test K8500, prior to the CHF test data acquisition, the flow measurements from the **[**

]

During the course of CHF data acquisition for K8500, the flow measurements **[**

] to detect if deviations higher than the tolerance value were present.

The KATHY loop flow measurements for the K9000-K9300 CHF testing for the NuScale Power fuel design were performed using **[**

]

[

]

[

]

During the loop commissioning effort for K9000-K9300 CHF testing, the flow measurements from the [

]

During the course of CHF data acquisition, the flow measurements from [

]

Therefore, the accuracy of the flow measurements for CHF testing at the KATHY loop is assured through strict adherence to NQA-1 requirements for instrumentation and calibration, as well as redundant and diverse flow measurement during loop commissioning and data collection:

- [

]

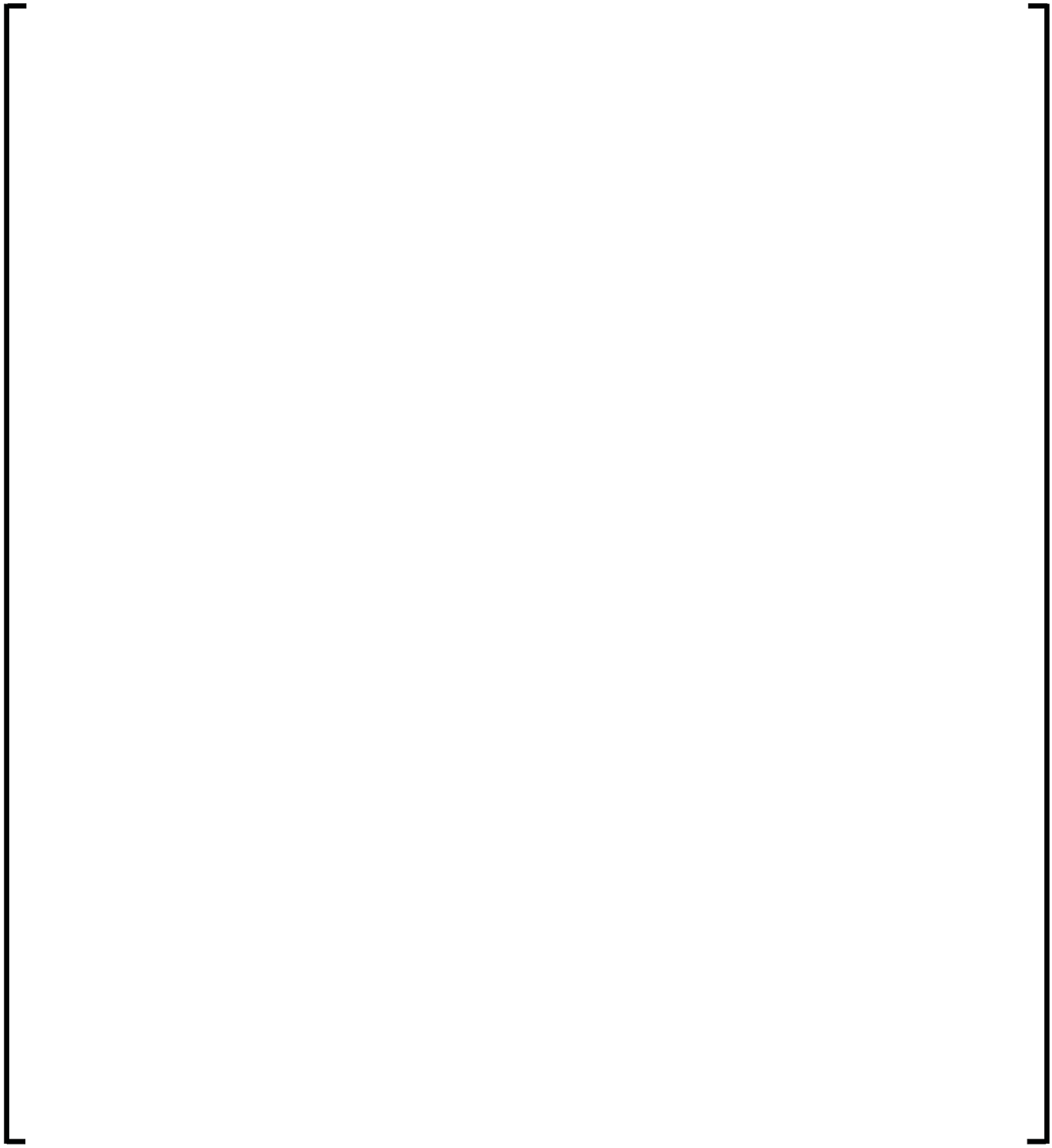


Figure A: Flow Measurement Devices used for the Determination of the Flow Value in the CHF Test Data

Figure B: Comparison of [ ] during the KATHY Test Loop Commissioning for K9000-K9300 CHF Testing [ ]

Impact on Topical Report:
There are no impacts to the Topical Report as a result of this response.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8795
Date of RAI Issue: 05/08/2017

NRC Question No.: 29726

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, Section 47 and Section 79 require a final safety analysis report (FSAR) to analyze the design and performance of the structures, systems, and components (SSCs). Safety evaluations, performed to support the FSAR, include accident analyses to (1) demonstrate that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation, including the effects of anticipated operational occurrences (AOOs), and (2) determine the number of fuel failures associated with critical heat flux (CHF) that need to be included in the radiological consequences for postulated accidents. An approved CHF correlation is used in establishing a SAFDL for use in such analyses. Thus, an approved CHF correlation is used to establish a partial basis for demonstrating compliance with the following applicable regulations from Title 10 of the Code of Federal Regulations (10 CFR) which include the General Design Criteria (GDCs) of Appendix A to 10 CFR Part 50:

GDC 10, *Reactor design*, which requires that the reactor core and associated coolant, control, and protection systems be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs.

10 CFR 52.47(a)(2)(iv)(A), 10 CFR 52.47(a)(2)(iv)(B), and GDC 19 as they relate to the evaluation and analysis of the radiological consequences of postulated accidents.

Section 3.1.2.7 of TR-0116-21012 provides a high level discussion on the use of “reference points” at the KATHY test loop, which are used to verify test repeatability. There is no similar description of repeatability testing at Stern Laboratories within TR-0116-21012. During an audit of the KATHY test loop, NRC staff noted that, “Test repeatability [at the KATHY test loop] is verified by returning the test loop to pre-defined points and repeating tests at these points. This is in contrast to CHF testing at Stern where random state points within the testing domain are rerun.” NRC staff has not obtained sufficiently detailed information (e.g., repeatability test results, acceptance criteria) to demonstrate acceptable test repeatability for either Stern Laboratories or the KATHY test loop. As part of the review of TR-0116-21012, NRC staff needs to establish a finding that the variability in the CHF measured at repeated test points is acceptably low. Accordingly, NRC requests that NuScale provide evidence to show that repeatability tests were conducted at both Stern Laboratories and the KATHY test loop, and that the variability in the results are acceptably low.

NuScale Response:

For the NuScale Power critical heat flux (CHF) testing at Stern Laboratories, several different state points throughout the range of conditions are repeated in pairs. For each of these, the error is calculated with:

$$error = \frac{|Power_{initial} - Power_{repeat}|}{|Power_{initial}|} x\ 100\%$$

The purpose of the repeat points is to assure that the testing is consistent and that nothing has occurred that could skew the overall test results. To this end an acceptance criterion of less than {{

}}[2(a)(c)]

For the NuFuel-HTP2™ CHF testing at AREVA's KATHY facility, {{

}}[2(a)(c)]

Impact on Topical Report:
There are no impacts to the Topical Report as a result of this response.

Enclosure 3:

AREVA Affidavit

AFFIDAVIT

COMMONWEALTH OF VIRGINIA)
) ss.
CITY OF LYNCHBURG)

1. My name is Nathan E. Hottle. I am Manager, Product Licensing, for AREVA Inc. (AREVA) and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA to determine whether certain AREVA information is proprietary. I am familiar with the policies established by AREVA to ensure the proper application of these criteria.

3. I am familiar with the AREVA information contained in the following document: "NuScale Power, LLC Response to NRC Request for Additional Information No. 13 (eRAI No. 8795) on the NuScale Design Certification Application," referred to herein as "Document." Information contained in this Document has been classified by AREVA as proprietary in accordance with the policies established by AREVA Inc. for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by AREVA to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA, would be helpful to competitors to AREVA, and would likely cause substantial harm to the competitive position of AREVA.

The information in this Document is considered proprietary for the reasons set forth in paragraphs 6(c) and 6(d) above.

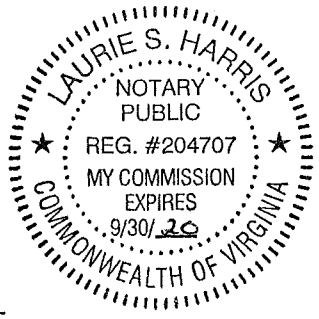
7. In accordance with AREVA's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside AREVA only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Nathan E. Hottle

SUBSCRIBED before me this 3rd day of July, 2017.



Laurie S. Harris

Laurie S. Harris
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA, CITY OF LYNCHBURG
MY COMMISSION EXPIRES: 9/30/2020
Reg. # 204707

Enclosure 4:

Affidavit of Zackary W. Rad, AF-0717-54799

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, 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 process by which NuScale develops its critical heat flux analyses.
NuScale has performed significant research and evaluation to develop a basis for this process 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 RAI Set Number 13 – eRAI no. 8795 – RAI Question Numbers 29724 and 29726.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.

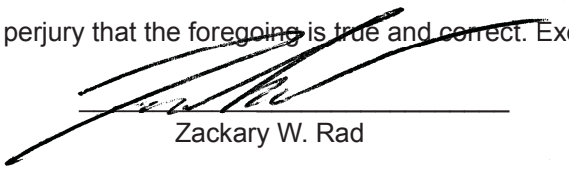
(b) The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, 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 July 7, 2017



Zackary W. Rad