## NuScaleTRRaisPEm Resource

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| **From:** | Bavol, Bruce |
| **Sent:** | Monday, April 10, 2017 1:35 PM |
| **To:** | NuScaleTRRaisPEm Resource |
| **Subject:** | RAI Letter No. 13 for the Review of NuScale TR-0716-50351, “NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces” |
| **Attachments:** | Final RAI 8736_Letter 13.docx |

Dear Mr. Bergman,

Attached please find NRC staff’s request for additional information (**RAI 8736**) concerning NuScale topical report entitled, “NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces.”

Please submit your response by June 12, 2017, to the NRC Document Control Desk. If you have any questions, please feel free to contact me.

Thank you,

Bruce M. Bavol

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NuScale, Licensing Projects Branch 1
Office of New Reactors
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**Hearing Identifier:** NuScale_SMR_DC_TR_Public
**Email Number:** 12

**Mail Envelope Properties** (be79c0b1be094a49bd8901b28896630d)

**Subject:** RAI Letter No. 13 for the Review of NuScale TR-0716-50351, “NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces”
**Sent Date:** 4/10/2017 1:34:43 PM
**Received Date:** 4/10/2017 1:34:44 PM
**From:** Bavol, Bruce

**Created By:** Bruce.Bavol@nrc.gov

**Recipients:**
"NuScaleTRRaisPEm Resource" <NuScaleTRRaisPEm.Resource@nrc.gov>
Tracking Status: None

**Post Office:** HQPWMSMRS03.nrc.gov

| **Files** | **Size** | **Date & Time** |
|---|---|---|
| MESSAGE | 691 | 4/10/2017 1:34:44 PM |
| Final RAI 8736_Letter 13.docx | 38914 | |

**Options**
**Priority:** Standard
**Return Notification:** No
**Reply Requested:** No
**Sensitivity:** Normal
**Expiration Date:**
**Recipients Received:**

April 10, 2017

Mr. Thomas A. Bergman
Vice President, Regulatory Affairs
NuScale Power, LLC
1100 Circle Boulevard, Suite 200
Corvallis, OR 97330

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 13 FOR THE REVIEW OF TOPICAL REPORT TR-0716-50351, "NUSCALE APPLICABILITY OF AREVA METHOD FOR THE EVALUATION OF FUEL ASSEMBLY STRUCTURAL RESPONSE TO EXTERNALLY APPLIED FORCES (DOCKET 52-048)

Dear Mr. Bergman:

In a September 30, 2016, letter, NuScale Power, LLC, (NuScale) submitted Topical Report (TR)-0716-50351, “NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces,” (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16274A468) for the U.S. Nuclear Regulatory Commission (NRC) staff’s review. The NRC staff is performing a detailed review of this TR to enable the staff to reach a conclusion on the safety of the proposed application. The NRC staff has identified that additional information is needed to continue portions of the review. The NRC staff’s request for additional information (RAI), is contained in the enclosure to this letter.

To support the review schedule, NuScale is requested to respond within 60 calendar days of the date of this letter. If changes are needed to the topical report, the NRC staff requests that the RAI response include the proposed wording changes.

If you have any questions or comments concerning this matter, you may contact me at 301-415-6715 or by e-mail at Bruce.Bavol@nrc.gov or you may contact Gregory Cranston at 301-415-0546 or gregory.crantson@nrc.gov.

Sincerely,

**/RA/**

Bruce Bavol, Project Manager
Licensing Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-048
eRAI Tracking No. 8736

Enclosure: Request for Additional Information

## <u>Final RAI 8736</u> (Questions 29611, 29613 - 29616)

## TR-0716-50351, "NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces"

### (Question 29611) 04.02 - Fuel System Design

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Criterion 2, requires that structures, systems, and components (SSCs) important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (II)(2) provides review guidance regarding the review of methods used to analyze loads.

Topical Report TR-0716-50351 references topical report ANP-10337-P as the methodology used to obtain the transient response. The staff noted that there are differences between the NuScale development of the damping values presented in TR-0716 -50351 Appendix B and Appendix C of ANP-10337-P. The staff is seeking clarification regarding the methodology used to analyze the NuScale fuel assembly design structural response to externally applied loads.

a. Provide a comparison to test data that confirms the viscous damping analytical methodology (the approach used to determine the NuScale zero flow damping values) is correct.

b. Compare the development of NuScale damping values (see Figure B.3-1) to the development of the general PWR damping values documented in ANP-10337 Appendix C (Figure C-2) and provide a discussion of the differences.

c. Explain why the ratio of the proposed BOL damping value (Table B.4-1 of TR-0716-50351-P[SJ2] ) to the generic PWR damping value (Section 6.1.3.1 and Figure C-2 of ANP-10337P) is noticeably different than the ratio of the proposed EOL value compared with the generic PWR EOL damping value.

d. Confirm that the vertical axis of Figure B.3-1 is mislabeled and is really critical damping ratio with units of percent.

e. The horizontal axis of Figure B.3-1 is labeled as deflection. Describe the definition of "deflection" as used in this figure. If deflection in this figure is not equivalent to the amplitude of ANP-10337 Figure C-1 then provide the data in a form that is directly comparable to ANP-10337 Figure C-1.

Enclosure

**(Question 29613) 04.02 - Fuel System Design**

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Criterion 2, requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (II)(1) provides review guidance regarding the review of input loads including core plate motions.

Section 3.1 of TR-0716-50351-P provides an analysis of the applicability of the referenced methodology tropical report ANP-10337P. Although reactor geometry is discussed, there does not appear to be a comparison provided which discusses the anticipated core plate excitations between the NuScale design and typical PWR designs.

Compare the anticipated core plate excitation of the NuScale to more standard full length PWR excitation. This comparison should include:

a. Frequency spectra of core plate motion associated with design basis seismic load cases for the NuScale and typical PWR reactors.

b. Discussion of the anticipated magnitudes of excitation and justification of the use of the methodology in ANP-10337P for NuScale given the differences in frequency spectra and magnitudes.

**(Question 29614) 04.02 - Fuel System Design**

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Criterion 2, requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (IV)(1) provides review guidance regarding the requirement to maintain control rod insertability.

TR-0716-50351-P section 3.1 references Appendix F of ANP-10337P to provide justification for the use of ASME code Level C stress limits to ensure guide tube functionality for the NuScale fuel assembly design. While Appendix F of ANP-10337P defines the Level C stress limit generally and provides discussions demonstrating that Level C stress limits would prevent generalized buckling of the thin walled tubing, it does not define the amount of localized plastic deformation that would occur nor analyze the potential impact on rod insertion times.

Basic ASME Level C stress limits are defined on an elastic basis. The primary membrane plus bending stress limit for Level C is 1.5 times the yield strength, which implies that a guide tube analyzed and evaluated on an elastic basis could experience significant permanent deformation when realistic elastic-plastic material behavior is accounted for. Permanent guide tube deformation of the amount that is permitted by Level C can potentially obstruct the control rod insertion path.

This issue is expected to be design-specific because the amount of permanent deformation that is possible under Service Level C limits and the number of potential deformed shapes is expected to be related to the specific geometry of the guide tube design and the spacer grid locations. This question is specific to the NuScale guide tube geometry and its material properties under temperature and irradiation conditions expected during service in a NuScale reactor.

a. Demonstrate that NuScale control rods remain insertable when the guide tubes are deformed to the most limiting state permitted by ASME BPVC Service level C limits.

b. Confirm that NuScale control rods still meet insertion time limits even under the limiting state permitted by Service Level C.

**(Question 29615) 04.02 - Fuel System Design**

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Criterion 2, requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (II)(2) provides review guidance regarding the review of analytical methods for the load analysis.

TR-0716-50351-P states that the structural analysis code CASAC is used in the analysis but does not specify which version.

What version of CASAC is used in the analysis of the NuScale fuel assembly structural response to externally applied loads?

**(Question 29616) 04.02 - Fuel System Design**

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Criterion 2, requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (II)(1) provides review guidance regarding the review of inputs for the load analysis.

Appendix A of TR-0716-50351-P discusses the applicability of the NuScale fuel characterization test data to the referenced methodology. Figure A.3-1 provides a first-mode frequency versus deflection amplitude plot, but the definition of deflection as used in this plot is not defined in this appendix.

Define “deflection” as it is appears in Figure A.3-1 (i.e. initial pluck deflection, the peak deflection following pluck release, etc.) and explain how this deflection value is obtained from pluck test data.