

April 19, 2018

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 Submittal of Comprehensive Vibration Assessment Program Analysis Methods Schedule

REFERENCES:

1. Letter from U.S. Nuclear Regulatory Commission to NuScale Power, LLC, "Comprehensive Vibration Assessment Program for the NuScale Power, LLC Reactor Internals – Analysis Methods," dated March 06, 2018 (ML18064A312)
2. Email from U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 427, RAI 9408 (3.9.2)," dated April 17, 2018
3. Email from U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 386, RAI 9316 (3.9.2)," dated March 13, 2018 (ML18072A149)
4. Email from U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 194, RAI 8884 (3.9.2)," dated August 19, 2017 (ML17231A006)

In a letter dated March 06, 2018 (Reference 1), the U.S. Nuclear Regulatory Commission (NRC) provided a summary of the outstanding review issues associated with the NuScale Power, LLC (NuScale) reactor internals comprehensive vibration assessment program (CVAP). The CVAP is described in Section 3.9.2, "Dynamic Testing and Analysis of Systems, Components, and Equipment," of the NuScale Final Safety Analysis Report, as provided with the NuScale design certification application (DCA).

The purpose of this letter is to acknowledge these open CVAP review issues and to provide a schedule for their resolution that fits within the staff's published review schedule for the NuScale DCA.

The CVAP topics were introduced to NuScale in a closed meeting held on February 23, 2018. At this meeting, the Staff noted that a followup Request for Additional Information (RAI) would be generated to provide more detail on the information required to address several of these issues. RAI 9408 was subsequently issued on April 17, 2018 (Reference 2).

Attachment 1 provides an itemized summary of the open review issues for the CVAP as described in the Reference 1 letter, the RAI 9408 (Reference 2), and those remaining from the earlier CVAP RAI 9316 (Reference 3) and CVAP RAI 8884 (Reference 4).

Attachment 2 is the Response Schedule for Resolution of CVAP Review Issues .

This letter and its attachments make no regulatory commitments and no revisions to any existing regulatory commitments.

Please contact Jennie Wike at (541) 360-0539 or at jwike@nuscalepower.com if you have any questions.

Sincerely,



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Attachment 1: Summary of Open Review Issues for the NuScale CVAP
Attachment 2: Response Schedule for Resolution of CVAP Review Issues

Attachment 1: Summary of Open Review Issues for the NuScale CVAP

CVAP Issues from NRC Letter (Reference 1) –

- 1) ‘The NuScale Power Module (NPM) design contains many features that are not present in the current fleet of operating reactors. Examples include helical coil steam generators (SG) within the reactor pressure vessel with primary-side flow over the tubes, and secondary-side flow inside the tubes (including a phase change from liquid to steam inside the tubes), and a SG tube support structure that differs from features that serve similar safety functions in the operating fleet. Because some features of the NPM design are not present in the current fleet of operating reactors, there are no flow-induced vibration test data from other nuclear power plants available to provide benchmarking for the NuScale analyses.’

NuScale discussion – The cited SG examples are addressed by NuScale’s primary side flow testing (TF-2) and Steam Generator Flow Induced Vibration (SGFIV) testing. The plans for using the data from these tests are discussed in the Measurement and Inspection technical report, to be submitted in August 2018.

- 2) ‘NuScale has emphasized that the design of the NPM is based on equations and data from open literature using conservative assumptions and that large safety margins exist. However, the NRC staff found during an audit that some of the vibration analyses contained apparently nonconservative assumptions or values.’ . . . ‘The staff is concerned about the potential impact of these apparently nonconservative assumptions or values on the margins in the analytical results pertaining to:
 - a. SG tube margin against fluid-elastic instability
 - b. SG tube margin against vortex shedding
 - c. CRDS support margin against vortex shedding
 - d. in-core instrument guide tube (ICIGT) margin against vortex shedding
 - e. decay heat removal system (DHRS) piping margin against acoustic resonance
 - f. control rod assembly guide tube (CRAGT) wear
 - g. tube support cantilever margin against turbulence buffeting’

NuScale discussion – These issues are further detailed in current RAIs:

- a. RAI 9408 Question 03.09.02-74
- b. RAI 9408 Question 03.09.02-74
- c. RAI 9408 Question 03.09.02-73
- d. RAI 9408 Question 03.09.02-73
- e. RAI 9316 Question 03.09.02-54
- f. RAI 9408 Question 03.09.02-75
- g. RAI 9408 Question 03.09.02-74

These RAI questions are understood and responses will be submitted to the Attachment 2 schedule.

- 3) 'The staff also found that non-conservatisms in some flow-induced vibration (FIV) mechanisms such as fluid-elastic instability, vortex shedding, and turbulent buffeting wear analyses may outweigh the conservatisms in these analyses. For example:
- a. SG tube damping is assumed to be 1.5 percent
 - b. Use of averaged flow velocity instead of maximum velocity for reactor internals analyses
 - c. No mesh convergence studies
 - d. No computational results provided for the SG inlet flow restrictor'

NuScale discussion – These issues are further detailed in current RAIs:

- a. RAI 9408 Question 03.09.02-74
- b. RAI 9408 Question 03.09.02-73 and Question 03.09.02-74
- c. RAI 9408 Question 03.09.02-73 and Question 03.09.02-74
- d. RAI 9408 Question 03.09.02-76

These RAI questions are understood and responses will be submitted to the Attachment 2 schedule.

CVAP Issues from February 23, 2018 NRC Meeting –

- 1) The NRC identified wear as a CVAP issue for CRAGT. NuScale took an action to confirm that CRA flow strain is too low to measure. This issue is to be addressed in the response to RAI 9408 Question 03.09.02-75.
- 2) NRC requested that NuScale provide additional detail on the post startup test documentation, as they were not aware of the planned prototype NPM disassembly/inspection/measurement effort. The sequence of events for the startup tests and the inspection program is addressed in the Measurement and Inspection technical report to be submitted in August 2018.
- 3) CRDS and ICIGT Vortex Shedding analysis – NRC questioned the linear support assumption given radial clearances between components and supports of 0.0625 inch for the CRD shaft and 0.01 inch for the ICIGT. NuScale proposed to generate a nonlinear analysis to support the vortex shedding assessment given the radial clearances. This analysis is to be described in the response to RAI 9408 Question 03.09.02-73.
- 4) NRC did not agree that average flow velocity could be assumed to exist throughout the ICIGT and CRD shafts. Accordingly, peak velocity should be used to calculate margins of safety, for conservatism. NuScale indicated that VS can be demonstrated to not exist within the ICIGT/CRD at the riser. This issue is to be addressed in the response to RAI 9408 Question 03.09.02-73 and Question 03.09.02-74.
- 5) 2nd Order Shear Layer evaluation of DHRS piping AR analysis – NuScale agreed to research current industry issues with 2nd order shear layer. This issue is to be addressed in the response to RAI 9316 Question 03.09.02-54.
- 6) SG Inlet Flow Restrictor Test results – NuScale will review its preliminary test results and determine if they can be provided for NRC audit. This issue is to be addressed in the response to RAI 9408 Question 03.09.02-76.
- 7) Leakage flow instability reports/results/rules - NuScale agreed to provide a summary of the leakage flow instability rules with quantitative numbers. This issue is to be addressed in the response to RAI 9408 Question 03.09.02-76.

CVAP Issues from CVAP Audit RAI 9408 –

RAI 9408 (Reference 2) Questions 03.09.02-73 through 03.09.02-77 are questions resulting from the NRC audit of the NuScale CVAP, conducted from May 16, 2017 to November 2, 2017. These RAI questions are understood and responses will be submitted to the Attachment 2 schedule.

CVAP Issues from CVAP RAI 9316 –

RAI 9316 (Reference 3) Questions 03.09.02-50 through 03.09.02-58 are followup questions to the NuScale responses to CVAP RAI 8884. These RAI questions are understood and responses will be submitted to the Attachment 2 schedule.

CVAP Issues from CVAP RAI 8884 –

Three questions remain unanswered from the original RAI 8884 (Reference 4). They are Question 03.09.02-9, Question 03.09.02-10, and Question 03.09.02-11. These RAI questions are understood and responses will be submitted to the Attachment 2 schedule.

Attachment 2: Response Schedule for Resolution of CVAP Review Issues

Open CVAP Issue	Source	Response Date
SG FIV Test Plans for Benchmarking	Reference 1 Item 1	Measurement and Inspection technical report issuance August 24, 2018
Nonconservative Assumptions and Margin Values	Reference 1 Item 2	See corresponding RAI 9408 and 9316 response dates
Nonconservativisms in FIV mechanisms	Reference 1 Item 3	See corresponding RAI 9408 response dates
CRA Flow Strain	February 23, 2018 CVAP Meeting Item 1	See corresponding RAI 9408 Question 03.09.02-75 response date
Post Startup Test Documentation	February 23, 2018 CVAP Meeting Item 2	Measurement and Inspection technical report issuance August 24, 2018
Non Linear Analysis of Radial Support Clearances	February 23, 2018 CVAP Meeting Item 3	See corresponding RAI 9408 Question 03.09.02-73 response date
Average Flow Velocity	February 23, 2018 CVAP Meeting Item 4	See corresponding RAI 9408 Question 03.09.02-73 and 03.09.02-74 response dates
2 nd Order Shear Layer Evaluation	February 23, 2018 CVAP Meeting Item 5	See corresponding RAI 9316 Question 03.09.02-54 response date
SG Inlet Flow Restrictor Test Results	February 23, 2018 CVAP Meeting Item 6	See corresponding RAI 9408 Question 03.09.02-76 response date
Leakage Flow Instability	February 23, 2018 CVAP Meeting Item 7	See corresponding RAI 9408 Question 03.09.02-76 response date
RAI 9408 Question 03.09.02-73	Reference 2	September 17, 2018
RAI 9408 Question 03.09.02-74	Reference 2	September 17, 2018
RAI 9408 Question 03.09.02-75	Reference 2	June 28, 2018
RAI 9408 Question 03.09.02-76	Reference 2	September 17, 2018
RAI 9408 Question 03.09.02-77	Reference 2	September 17, 2018

Open CVAP Issue	Source	Response Date
RAI 9316 Question 03.09.02-50	Reference 3	May 14, 2018
RAI 9316 Question 03.09.02-51	Reference 3	May 14, 2018
RAI 9316 Question 03.09.02-52	Reference 3	September 17, 2018
RAI 9316 Question 03.09.02-53	Reference 3	May 14, 2018
RAI 9316 Question 03.09.02-54	Reference 3	September 17, 2018
RAI 9316 Question 03.09.02-55	Reference 3	September 17, 2018
RAI 9316 Question 03.09.02-56	Reference 3	May 14, 2018
RAI 9316 Question 03.09.02-57	Reference 3	May 14, 2018
RAI 9316 Question 03.09.02-58	Reference 3	May 14, 2018
RAI 8884 Question 03.09.02-09	Reference 4	September 17, 2018
RAI 8884 Question 03.09.02-10	Reference 4	September 17, 2018
RAI 8884 Question 03.09.02-11	Reference 4	September 17, 2018