RAIO-0818-61360

August 10, 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 Response to NRC Request for Additional Information No. 410 (eRAI No. 9310) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 410 (eRAI No. 9310)," dated April 09, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 410 (eRAI No. 9310)," dated June 08, 2018

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 Question from NRC eRAI No. 9310:

- 03.09.02-69

The schedule for questions 03.09.02-70 and 03.09.02-71 were provided in emails to NRC (Greg Cranston) dated May 09, 2018 and July 6, 2018.

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Marieliz Vera, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9310

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9310

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 No. 52-048

eRAI No.: 9310
Date of RAI Issue: 04/09/2018

NRC Question No.: 03.09.02-69

In the response to RAI 8911, Question 03.09.02-47, the applicant stated that although the NPM piping is being analyzed, measured and inspected under the comprehensive vibration assessment program (CVAP), NuScale also agrees that the provisions in the American Society of Mechanical Engineers (ASME) Operations and Maintenance Standard, 2012 Edition (OM-2012), Part 3, "Requirements for Preoperational and Initial Start-Up Vibration Testing of Nuclear Power Plant Piping Systems" can be followed for piping that needs testing per the NuScale CVAP. The NRC staff finds that the selection of piping systems for vibration testing solely based on the results of the CVAP not acceptable. The applicant has the option to analyze and test the NuScale Power Module (NPM) piping under the CVAP per RG 1.20; however this does not alleviate screening and testing the NPM piping systems per the provisions of Part 3 of ASME OM-2012. The criteria for selecting the piping systems for vibration testing should be based on the provisions in Part 3 of ASME OM-2012, and not based on the results of CVAP alone. If the CVAP results identify additional piping systems than those prescribed in Part 3 of ASME OM-2012 for vibration testing, NuScale can choose to voluntarily perform vibration testing on these additional piping systems.

Revise the description in DCD Tier 2, Section 3.9.2.1. Additionally, include in DCD Tier 2, Section 14.2 a piping vibration test during initial startup. Alternatively, modify Test #97 – Thermal Expansion Test to include piping vibration testing.

NuScale Response:

The following supplements the response to RAI 8911 Question 03.09.02-47, as submitted by RAIO-1017-56790, dated October 24, 2017.

All portions of piping within the scope defined in FSAR 3.9.2.1 are considered for testing per ASME Operations and Maintenance Standard, 2012 Edition (OM-2012), Part 3, "Requirements for Preoperational and Initial Start-Up Vibration Testing of Nuclear Power Plant Piping Systems." FSAR Section 3.9.2.1 has been modified to clarify that no ASME Class 1, 2, and 3 Piping is excluded from consideration for vibration testing per ASME OM-2012. The ASME OM-2012 states that, "the Owner shall determine the portions of piping systems to be tested and shall

classify these systems into the vibration monitoring groups...” Therefore, the owner may select the portions of piping in the NuScale design for which vibration testing is performed considering the piping system design and analysis, including the vibration screening and analysis results and scope of testing included in the CVAP.

FSAR Table 14.2-100: Ramp Change in Load Demand (Test #100) has been revised to include consideration of piping vibration testing.

Impact on DCA:

The FSAR Tier 2, Section 3.9.2.1.1, Table 1.8-2, and Table 14.2-100 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 01-61, RAI 02.04.13-1, RAI 03.04.01-4, RAI 03.04.02-1, RAI 03.04.02-2, RAI 03.04.02-3, RAI 03.05.01.04-1, RAI 03.05.02-2, RAI 03.06.02-15, RAI 03.06.03-11, RAI 03.07.01-2, RAI 03.07.01-3, RAI 03.07.02-8, RAI 03.07.02-12, RAI 03.08.04-23S1, RAI 03.08.04-23S2, RAI 03.08.05-14S1, RAI 03.09.02-15, RAI 03.09.02-48, RAI 03.09.02-67, RAI 03.09.02-69, RAI 03.09.03-12, RAI 03.09.06-5, RAI 03.09.06-6, RAI 03.09.06-16, RAI 03.09.06-16S1, RAI 03.09.06-27, RAI 03.11-8, RAI 03.11-14, RAI 03.11-14S1, RAI 03.11-18, RAI 03.13-3, RAI 04.02-1S2, RAI 05.02.03-19, RAI 05.02.05-8, RAI 05.04.02.01-13, RAI 05.04.02.01-14, RAI 06.02.06-22, RAI 06.02.06-23, RAI 06.04-1, RAI 09.01.02-4, RAI 09.01.05-3, RAI 09.01.05-6, RAI 09.03.02-3, RAI 09.03.02-4, RAI 09.03.02-5, RAI 09.03.02-6, RAI 09.03.02-8, RAI 10.02-1, RAI 10.02-2, RAI 10.02-3, RAI 10.02.03-1, RAI 10.02.03-2, RAI 10.03.06-1, RAI 10.03.06-5, RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3, RAI 10.04.10-2, RAI 13.01.01-1, RAI 13.01.01-1S1, RAI 13.02.02-1, RAI 13.03-4, RAI 13.05.02.01-2, RAI 13.05.02.01-2S1, RAI 13.05.02.01-3, RAI 13.05.02.01-3S1, RAI 13.05.02.01-4, RAI 13.05.02.01-4S1, RAI 14.02-7, RAI 19-31, RAI 19-31S1, RAI 19-38, RAI 20.01-13

Table 1.8-2: Combined License Information Items

Item No.	Description of COL Information Item	Section
COL Item 1.1-1:	A COL applicant that references the NuScale Power Plant design certification will identify the site-specific plant location.	1.1
COL Item 1.1-2:	A COL applicant that references the NuScale Power Plant design certification will provide the schedules for completion of construction and commercial operation of each power module.	1.1
COL Item 1.4-1:	A COL applicant that references the NuScale Power Plant design certification will identify the prime agents or contractors for the construction and operation of the nuclear power plant.	1.4
COL Item 1.7-1:	A COL applicant that references the NuScale Power Plant design certification will provide site-specific diagrams and legends, as applicable.	1.7
COL Item 1.7-2:	A COL applicant that references the NuScale Power Plant design certification will list additional site-specific piping and instrumentation diagrams and legends as applicable.	1.7
COL Item 1.8-1:	A COL applicant that references the NuScale Power Plant design certification will provide a list of departures from the certified design.	1.8
COL Item 1.9-1:	A COL applicant that references the NuScale Power Plant design certification will review and address the conformance with regulatory criteria in effect six months before the docket date of the COL application for the site-specific portions and operational aspects of the facility design.	1.9
COL Item 1.10-1:	A COL applicant that references the NuScale Power Plant design certification will evaluate the potential hazards resulting from construction activities of the new NuScale facility to the safety-related and risk significant structures, systems, and components of existing operating unit(s) and newly constructed operating unit(s) at the co-located site per 10 CFR 52.79(a)(31). The evaluation will include identification of management and administrative controls necessary to eliminate or mitigate the consequences of potential hazards and demonstration that the limiting conditions for operation of an operating unit would not be exceeded. This COL item is not applicable for construction activities (build-out of the facility) at an individual NuScale Power Plant with operating NuScale Power Modules.	1.10
COL Item 2.0-1:	A COL applicant that references the NuScale Power Plant design certification will demonstrate that site-specific characteristics are bounded by the design parameters specified in Table 2.0-1. If site-specific values are not bounded by the values in Table 2.0-1, the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of its combined license application.	2.0
COL Item 2.1-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site geographic and demographic characteristics.	2.1
COL Item 2.2-1:	A COL applicant that references the NuScale Power Plant design certification will describe nearby industrial, transportation, and military facilities. The COL applicant will demonstrate that the design is acceptable for each potential accident, or provide site-specific design alternatives.	2.2
COL Item 2.3-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific meteorological characteristics for Section 2.3.1 through Section 2.3.5, as applicable.	2.3
COL Item 2.4-1:	A COL applicant that references the NuScale Power Plant design certification will investigate and describe the site-specific hydrologic characteristics for Section 2.4.1 through Section 2.4.14, ~~as applicable~~except Section 2.4.8 and Section 2.4.10.	2.4
COL Item 2.5-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific geology, seismology, and geotechnical characteristics for Section 2.5.1 through Section 2.5.5, below.	2.5

Table 1.8-2: Combined License Information Items (Continued)

Item No.	Description of COL Information Item	Section
COL Item 3.9-13:	A COL applicant that references the NuScale Power Plant design certification will complete an assessment of piping systems inside the reactor building to determine the portions of piping to be tested for vibration and thermal expansion. The piping systems within the scope of this testing include ASME BPVC, Section III, Class 1, 2, and 3 piping systems, other high-energy piping systems inside Seismic Category I structures or those whose failure would reduce the functioning of any Seismic Category I plant feature to an unacceptable level, and Seismic Category I portions of moderate-energy piping systems located outside of containment. The COL applicant may select the portions of piping in the NuScale design for which vibration testing is performed while considering the piping system design and analysis, including the vibration screening and analysis results and scope of testing as identified by the Comprehensive Vibration Assessment Program.	3.9
COL Item 3.10-1:	A COL applicant that references the NuScale Power Plant design certification will develop and maintain a site-specific seismic and dynamic qualification program.	3.10
COL Item 3.10-2:	A COL applicant that references the NuScale Power Plant design certification will develop the equipment qualification database and ensure equipment qualification record files are created for the structures, systems, and components that require seismic qualification.	3.10
COL Item 3.10-3:	A COL applicant that references the NuScale Power Plant design certification will submit an implementation program for Nuclear Regulatory Commission approval prior to the installation of the equipment that requires seismic qualification.	3.10
COL Item 3.11-1:	A COL applicant that references the NuScale Power Plant design certification will submit a full description of the environmental qualification program and milestones and completion dates for program implementation.	3.11
COL Item 3.11-2:	A COL applicant that references the NuScale Power Plant design certification will develop the equipment qualification database and ensure equipment qualification record files are created for the structures, systems, and components that require environmental qualification.	3.11
COL Item 3.11-3:	A COL applicant that references the NuScale Power Plant design certification will implement an equipment qualification operational program that incorporates the aspects in Section 3.11-7 specific to the environmental qualification of mechanical and electrical equipment. This program will include an update to Table 3.11-1 to include commodities that support equipment listed in Table 3.11-1.	3.11
COL Item 3.11-4:	A COL applicant that references the NuScale Power Plant design certification will ensure the environmental qualification program cited in COL Item 3.11-1 includes a description of how equipment located in harsh conditions will be monitored and managed throughout plant life. This description will include methodology to ensure equipment located in harsh environments will remain qualified if the measured dose is higher than the calculated dose.	3.11
COL Item 3.12-1:	A COL applicant that references the NuScale Power Plant design certification may use a piping analysis program other than the programs listed in Section 3.12.4.1; however, the applicant will implement a benchmark program using the models for the NuScale Power Plant standard design.	3.12
COL Item 3.12-2:	A COL applicant that references the NuScale Power Plant design certification will confirm that the site-specific seismic response is within the parameters specified in Section 3.7. A COL applicant may perform a site-specific piping stress analysis in accordance with the methodologies described in this section, as appropriate.	3.12
COL Item 3.13-1:	A COL applicant that references the NuScale Power Plant design certification will provide an in-service inspection program for ASME Class 1, 2 and 3 threaded fasteners. The program will identify the applicable edition and addenda of ASME Boiler and Pressure Vessel Code, Section XI and ensure compliance with 10 CFR 50.55a.	3.13

appropriately protects SSC against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, which may result from equipment failures and from events and conditions outside the nuclear power unit .

- GDC 14 as it relates to SSC of the RCPB being designed to have an extremely low probability of rapidly propagating failure or of gross rupture. Section 3.9.2 addresses dynamic testing of components of the reactor coolant pressure boundary to ensure that they will withstand the applicable design-basis seismic and dynamic loads in combination with other environmental and natural phenomena loads without leakage, rapidly propagating failure, or gross rupture.
- GDC 15 as it relates to the reactor coolant system being designed with sufficient margin to ensure that the RCPB is not breached during normal operating conditions, including AOOs. The RCPB is designed to resist seismic, LOCA, and other environmental loads. Dynamic analyses are described to confirm the structural design adequacy of the reactor coolant pressure boundary. Vibration, thermal expansion, and dynamic effects testing are also described to verify the design.
- 10 CFR 50, Appendix B, as it relates to quality assurance in the dynamic testing and analysis of systems, structures, and components. The NRC-approved NuScale Quality Assurance Program Description discussed in Section 17.5 satisfies the requirements of 10 CFR 50, Appendix B, to ensure that SSC are designed, procured, fabricated, inspected, erected, and tested to standards commensurate with their contribution to plant safety.

3.9.2.1 Piping Vibration, Thermal Expansion, and Dynamic Effects

RAI 03.09.02-69

Piping systems can be damaged by thermal expansion and vibrations due to transient events such as pipe breaks, valve closure, etc. This section addresses the pre-operational testing, and initial startup testing that is performed to verify that the vibrations and thermal expansion and contraction of the as-built piping systems are bounded by the design requirements. The piping systems ~~tested~~within the testing scope include:

- ASME BPVC, Section III (Reference 3.9-1), Class 1, 2, and 3 piping systems identified in Table 3.2-1.
- other high-energy piping systems inside Seismic Category 1 structures or those whose failure would reduce the functioning of any Seismic Category I plant feature to an unacceptably level. See Section 3.6.1.
- Seismic Category I portions of moderate-energy piping systems located outside of containment identified in Table 3.2-1 and Section 3.6.1.

RAI 03.09.02-69

In accordance with COL Item 3.6-1, the COL applicant is responsible for designing the final layout of the piping outside the NPM.

RAI 03.09.02-69

COL Item 3.9-13: A COL applicant that references the NuScale Power Plant design certification will complete an assessment of piping systems inside the reactor building to determine the portions of piping to be tested for vibration and thermal expansion. The piping systems within the scope of this testing include ASME BPVC, Section III, Class 1, 2, and 3 piping systems, other high-energy piping systems inside Seismic Category I structures or those whose failure would reduce the functioning of any Seismic Category I plant feature to an unacceptable level, and Seismic Category I portions of moderate-energy piping systems located outside of containment. The COL applicant may select the portions of piping in the NuScale design for which vibration testing is performed while considering the piping system design and analysis, including the vibration screening and analysis results and scope of testing as identified by the Comprehensive Vibration Assessment Program.

The test program, as described in Section 14.2, verifies that the Class 1, Class 2, Class 3, and other high-energy and Seismic Category 1 piping systems meet functional design requirements and that piping vibrations and thermal expansions are within acceptable levels and will withstand dynamic effects due to operating transients. Piping systems are validated through a series of checks, inspections, and tests, as follows:

- The first validation step is during the manufacturing process at the manufacturing facility and during the construction. The piping systems and other components are inspected to verify the correct assembly and to record the initial positions under cold conditions.
- The second validation step is plant heat up, whereupon the plant is heated to normal operating temperatures. Expansion and contraction of the systems and components is monitored and recorded to verify that it is within the assumed conditions identified in the analyses.
- The third validation step is performance tests. The systems are operated to verify the performance of critical SSC such as valves, controls, and auxiliary equipment. This phase of testing includes transient tests as outlined in Chapter 14 to identify unacceptable expansion and contraction, noise, vibration, and stresses which are not bounded by the design analyses.

The initial test program is described in Section 14.2. The vibration, thermal expansion, and dynamic effect elements of this test program, summarized below, are performed during Phase I pre-operational testing and Phase II initial startup testing.

Phase I - Pre-operational Testing

Preoperational tests are performed to demonstrate that the piping system components meet functional design requirements, and that piping vibrations and thermal expansions and contractions are bounded by the analyses. If the design basis parameters are not bounding compared to the measured values, then corrective actions (i.e. reanalyzing with as-built values) are implemented and the systems are retested.

Phase II - Initial Startup Testing

Initial startup testing is performed after the reactor core is loaded into a NuScale Power Module. These Phase II tests establish that the vibration level and piping reactions to transient conditions are acceptable and bounded by the analyses. If the vibration levels are not bounded, the analyses use the vibration level from the testing as input and verify that the design is acceptable.

3.9.2.1.1 Piping Vibration Details

RAI 03.09.02-69

3.9.2.1.1.1 ~~Piping Included in Comprehensive Vibration Assessment Program~~

~~RAI 03.09.02-47~~RAI 03.09.02-69

~~ASME Code Class 1, 2, and 3 piping systems that are part of the NuScale Power Module are included within the scope of the NuScale Comprehensive Vibration Assessment Program (CVAP) (Reference 3.9-5) Piping systems that meet the screening criteria for applicable flow induced vibration mechanisms are evaluated in the analysis program. If a large margin of safety is not demonstrated, prototype testing is performed in accordance with the CVAP measurement program and the requirements of Part 3 of ASME OM-2012, Division 2 (OM Standards).~~

~~RAI 03.09.02-47~~RAI 03.09.02-69

~~NuScale Power Module components, piping, and supports with a high degree of safety margin are excluded from testing in the prototype measurement program, consistent with the overall measurement program objectives of validating relevant analytical inputs, results, and margins of safety.~~

RAI 03.09.02-69

3.9.2.1.1.2 ~~Piping Not Included in Comprehensive Vibration Assessment Program~~

RAI 03.09.02-69

~~For ASME Code Class 3 piping that is not part of the NuScale Power Module (there is no Code Class 1 or 2 piping which is not part of the NuScale Power Module) and other ASME B31.1 piping outside of containment which requires vibration testing, v~~Vibration test specifications are developed in accordance with ASME OM-2012~~S/G~~, Division 2 (OM Standards), Part 3 (Reference 3.9-3). SRP 3.9.2 recommends using this part of the ASME OM Code for developing preoperational vibration test specifications. Piping vibration testing and assessment are performed in accordance with ASME OM-2012, Division 2 (OM Standards), Part 3 (Reference 3.9-3).

The Phase I and II tests demonstrate that the piping systems withstand vibrations resulting from Service Level A loads and Service Level B loads.

Service Level A vibration loads are sustained loads encountered during normal plant startup, operation, refueling, and shutdown. These vibration loads are continuous or steady state over a period of time. If excessive vibration is observed which is outside the bounds of the analyses, a re-analysis to determine the cause and to identify the corrective action is performed.

Service Level B loads are infrequent loads with a high probability of occurrence but which cause no damage or reduction in component function. The vibrations are the result of valve operation, pumps, and other loads from transients. If excessive vibration is observed which is outside the bounds of the analyses, a re-analysis to determine the cause and to identify the corrective action is performed.

The Phase I and Phase II tests do not address vibrations resulting from Service Level C or Service Level D loads.

RAI 03.09.02-69

As Part 3 of ASME OM-2012, Division 2 (OM Standards) states that the Owner shall select the portions of piping systems to be tested. The selection of portions of piping in the NuScale design for which vibration testing is performed as described in this section may consider the piping system design and analysis, including the vibration screening and analysis results and scope of testing as identified by the Comprehensive Vibration Assessment Program (CVAP). ASME Code Class 1, 2, and 3 piping systems that are part of the NuScale Power Module are included within the scope of the NuScale CVAP (Reference 3.9-5). Piping systems that meet the screening criteria for applicable flow induced vibration mechanisms are evaluated in the analysis program. If a large margin of safety (greater than 100 percent margin of safety as defined in the CVAP) is not demonstrated, prototype testing is performed in accordance with the CVAP measurement program and the requirements of Part 3 of ASME OM-2012, Division 2 (OM Standards).

RAI 03.09.02-48

3.9.2.1.1.3 Main Steam Line Branch Piping Acoustic Resonance

NRC Information Notice IN-2002-26, including Supplements 1 & 2, describes fatigue failures of steam dryers in BWRs, which occurred at Quad Cities Units 1 and 2. Later evaluations determined that the failures were caused by acoustic resonance in the main steam line relief valve standpipes. The NuScale design MS lines (NPS 12) include bypass lines (NPS 4) around the secondary main steam isolation valves. During normal operation, the bypass valves are closed, and the bypass lines are closed branches off of the MS lines. This configuration is similar to that of the Quad Cities events. Therefore, evaluations are performed during the detailed design of the MS lines, using acoustic resonance screening criteria and additional calculations as necessary (e.g., Strouhal number) to determine if there is a concern. The methodology contained in "NuScale Comprehensive Vibration Assessment Program Technical Report," TR-0716-50439 is acceptable for this purpose.

RAI 03.09.02-69

Table 14.2-100: Ramp Change in Load Demand (Test #100)

Startup test is required to be performed for each NPM.
This test is performed at approximately 25, 50, 75, and 100 percent reactor thermal power.
Test Objectives
i. Verify the ability of the plant automatic control systems to sustain a ramp increase in load demand. ii. Assess the dynamic response of the plant for ramp increase in load demand.
Prerequisites
i. The NPM is operating in a steady-state condition at the designated power level. ii. The plant's electrical distribution system is aligned for normal operation. iii. Reactor, turbine, and secondary control systems are in automatic mode. iv. If required, verify instrumentation is installed for piping vibration testing.
Test Method
i. Use the main control room turbine controls to provide a 5% of full power per minute load increase in demand at approximately 25, 50, and 75% reactor thermal power. ii. Use the main control room turbine controls to provide a 5% of full power per minute load decrease in demand at approximately 25, 50, and 75, and 100% reactor thermal power. iii. Conduct piping vibration testing, as required, during power changes.
Acceptance Criteria
i. The turbine does not trip. ii. The reactor does not trip. iii. The main steam safety valves do not open. iv. The turbine does not overspeed. v. The primary and secondary control systems, with no manual intervention, maintain reactor power, reactor coolant system temperatures, pressurizer pressure and level, and SG levels and pressures within acceptable ranges during and following the transient. vi. Control system response is reviewed and compared to expected performance. Necessary adjustments to the control systems have been made prior to proceeding to the next power plateau. vii. Water hammer indications a. Audible indications of water hammer are not observed. b. No damage to pipe supports or restraints. c. No damage to equipment. d. No equipment leakage as a result of the ramp change. viii. Piping vibration - System specific steady state and transient vibration testing criteria are established by the piping designer. Actual acceptance criteria will depend on the selected test method, but may include: a. Limits for stresses calculated based on the observed/measured vibration response of the system. b. No permanent deformation or damage is observed in the piping system or supports. c. Vibration displacements are not excessive, would not potentially cause the piping to come in contact with surrounding SSC, and are such that the movement of supports and flexible joints is within their allowable limits.