September 3, 2020 Project No. 99902078

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of Presentation Materials Titled "SDAA Pre-Application Presentation: NuScale Updates to the Comprehensive Vibration Assessment Program," PM-0720-71197, Revision 0

NuScale Power, LLC (NuScale) has requested a meeting with the NRC technical staff on September 17, 2020 to discuss the comprehensive vibration assessment program. The purpose of this submittal is to provide presentation materials to the NRC for use during this meeting.

The enclosure to this letter is the nonproprietary presentation titled "SDAA Pre-Application Presentation: NuScale Updates to the Comprehensive Vibration Assessment Program," PM-0720-71197, Revision 0."

This letter makes no regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions, please contact Kyra Perkins at 704-713-5220 or at kperkins@nuscalepower.com.

Sincerely,

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

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Enclosure: "SDAA Pre-Application Presentation: NuScale Updates to the Comprehensive Vibration Assessment Program," PM-0720-71197, Revision 0

Enclosure:

"SDAA Pre-Application Presentation: NuScale Updates to the Comprehensive Vibration Assessment Program," PM-0720-71197, Revision 0

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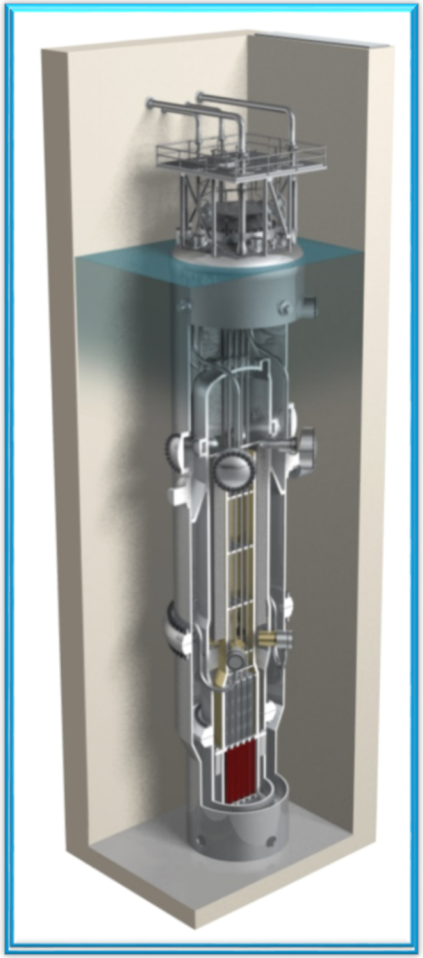
SDAA Pre-Application Presentation



NuScale Updates to the Comprehensive Vibration Assessment Program

September 17, 2020

PM-0720-71197
Revision: 0

Template #: 0000-21727-F01 R6

Presenters

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Mechanical Engineer

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Agenda

- Meeting Purpose
- Meeting Objective
- Background
- Regulatory Guide 1.20 Changes
- SDAA Program Changes
- Summary

Meeting Purpose

- Review guidance in Regulatory Guide (RG) 1.20 Revision 4 and implementation of the Comprehensive Vibration Assessment Program (CVAP) and CVAP Measurement and Inspection Plan (M&IP)
- Present programmatic updates to address design changes and lessons learned from DCA CVAP implementation

Meeting Objective

- NRC to provide clarification of RG 1.20 changes and gain understanding of NuScale's implementation of the CVAP based on the guidance revision
- NRC to gain understanding of and provide feedback on the program changes for the Standard Design Approval Application (SDAA)

Background

- For DCA, NuScale submitted the CVAP Analysis technical report, TR-0716-50439, Revision 2 and the CVAP M&IP technical report, TR-0918-60894, Revision 1
- NRC CVAP audits
  - Phase 1 – May 16, 2017 to November 2, 2017
  - Phase 2 – September 5, 2018 through October 4, 2018
  - Phase 4 – March 4, 2019 through September 19, 2019
  - HCSG Testing – June 24, 2019 through September 30, 2019
- ACRS Meetings
  - Subcommittee – May 16, 2019
  - Full Committee – July 10, 2019
- NRC P6 Final Safety Evaluation Report Section 3.9.2.6 documents acceptability of the DCA CVAP

RG 1.20
Revision 4

RG 1.20 Rev. 4

- **C.1.4: Special Considerations for Classifying Reactor Internals in Multi-Unit Plants and Standard Reactor Designs**
  - "The natural circulation reactor internals in the other units may be classified as a non-prototype after the inspection of the prototype reactor internals following preoperational or initial startup testing."
  - NuScale position
    - modules 2-12 will be identical, non-prototype modules to the valid prototype module 1
    - Based on construction and startup test schedule, the inspections required to achieve valid prototype status of the first module (specifically, the inspections following operation) will not be completed before modules 2-12 begin operation
    - NuScale plans to classify the first module as a prototype and the following, identical modules are non-prototypes, consistent with the guidance for natural circulation reactor internals

RG 1.20 Rev. 4 (continued)

- **C.2.a: CVAP for Prototype Reactor Internals**
  - "As part of the CVAP, applicants and licensees should analyze the effects of potential excitation mechanisms that can affect the reactor internals."
  - NuScale position – Leakage flow instability (LFI), flutter and gallop are not mentioned as potential excitation mechanisms. NuScale will continue to include them to demonstrate margin although these mechanisms are not unique to NuScale and are not addressed in RG 1.20 Rev. 4

RG 1.20 Rev. 4 (continued)

- **C.2: CVAP for Prototype of Reactor Internals**
  - "The control rod drive system (CRDS) in some SMRs is not part of the pressure boundary, and therefore the areas of review are different than those for conventional light water reactors. In some SMRs, all internal CRDS components, including the control rod drive mechanism (CRDM), are exposed to primary coolant flow, and corresponding temperature and flow-induced loads. Therefore, all components in a fully immersed CRDS need to be evaluated for flow induced vibration (FIV), acoustic resonance (AR), acoustic induced vibration (AIV), mechanical induced vibration (MIV), and the potential generation of loose parts."
  - NuScale position – whether a component is pressure boundary or not has not influenced NuScale's assessment of whether a component is evaluated for FIV loading. NuScale will address as in DCA.

RG 1.20 Rev. 4 (continued)

- **C.2: CVAP for Prototype Reactor Internals**
  - "In some SMRs that consolidate all major reactor components into a single modular system, additional dynamic excitation might be imparted on the CRDS components. Dynamic excitation because of fluid flow, flow-excited AR, and mechanical sources should be addressed in the CRDS design."
  - NuScale position - NuScale will address as in DCA.

RG 1.20 Rev. 4 (continued)

- **C.2, C.2.1.3.1: Benchmarking of Overall (End-to-End) Computed Response**
  - "End-to-end benchmarking encompasses all bias errors and uncertainties associated with simulations as well as measurements. Rather than benchmarking individual components of the simulation and measurement procedures and combining them (such as using the square root of the sum of the squares method), end-to-end benchmarking compares only the final simulated and measured results, resulting in the end-to-end bias errors and uncertainties."
  - NuScale position - NuScale proposes that (1) the use of ASME V&V 20 methodology in the pre-test predictions and (2) bounding assumptions in the design analysis adequately meet this guideline, since we do not have measured results at the time of the predictive analysis. SRSS is an industry standard method for handling uncertainties that is part of the ASME V&V 20 method.

RG 1.20 Rev. 4 (continued)

- **C.2.1: Vibration and Stress Analysis Program**
  - "The applicant or licensee should compare stress at locations susceptible to fatigue cracking with the ASME BPV Code fatigue limits to validate the analysis. If necessary, the applicant or licensee should perform modifications to the structure or other components to demonstrate design margin to Code allowable limits."
  - NuScale requests clarification on use of ASME BPV code to validate the analysis.
  - NuScale position – The scope of the CVAP work is to assess the stress due to vibration. All other stresses at location susceptible to fatigue cracking are addressed as part of the ASME BPV code analyses.

RG 1.20 Rev. 4 (continued)

- **C.2.1.1.d: Structural, Hydraulic, and Acoustic Modeling**
  - "The vibration and stress analysis program in the CVAP should address the following aspects related to structural, hydraulic, and acoustic modeling frequency response functions (FRF) between key drive and response locations, along with the assumed damping used in the calculations, expressed as vibration or stress normalized by input force."
  - NuScale position – In the DCA, tables with limiting component frequencies are provided, rather than FRF. No changes to address this are currently planned for the SDAA.

RG 1.20 Rev. 4 (continued)

- **C.2.1.1.1: Modes of Vibration**
  - "The applicant or licensee should develop tables of significant structural natural frequencies and accompanying figures of corresponding mode shapes. Benchmarking the analytic mode shapes and natural frequencies necessitates comparing measured and simulated data."
  - The information discussed in this paragraph is not available at the time of the design analysis (i.e. there's no equipment ready to test). A sensitivity of the effect of the frequency on the result is provided in our design analyses and pre-test predictions. For the steam generator (SG), benchmarking using the TF-2 test specimen was performed. No changes to analytical methods are planned for the SDAA.

RG 1.20 Rev. 4 (continued)

- **C.2.1.1.2: Vibration Damping**
  - "Deviation from the accepted 1 percent damping ratio needs to be justified in determining final vibration and stress levels."
  - NuScale plans to comply with RG 1.20 and use a minimum of 1% damping for the SDA.
- **C.2.1.1.3: Frequency Response Functions**
  - "The uncertainties are often associated with differences between numerical models and as-manufactured structures, such as differences in material properties, connections (e.g., bolts, welds, and rivets), and geometries (e.g., plate and piping thicknesses)."
  - Given these are not yet available, bounding assumptions are used to estimate frequencies. No changes to analytical methods are planned for the SDAA.

RG 1.20 Rev. 4 (continued)

- **C.2.1.2.2: Scale Model Testing**
  - The updated recommendations in this section were addressed in the benchmarking analyses of the NuScale DCA and no changes to those portions of the M&I TR are planned for SDAA.
- **C.2.1.3: Benchmarking of computing responses**
  - "frequencies of the highest stresses (generally any frequency band which contributes 10 percent or more of the RMS level)”
  - NuScale has analyzed limiting frequencies and provided sensitivity analysis to justify the limiting frequency has been chosen, and does not plan to change methodologies for the SDAA.

RG 1.20 Rev. 4 (continued)

- **C.2.1.3.1: Benchmarking of Overall Responses**
  - "The estimates need to be based on the differences between measured and simulated acoustic and/or structural responses averaged over sufficient locations to reasonably characterize all critical regions of a reactor internal. The average of the differences is the bias. It is acceptable to specify uncertainties based on two standard deviations of the differences."
  - "Therefore, frequency-dependent negative bias errors should not be applied to different-sized structures or structures driven by different flow fields. In these cases, loads (or structural response functions) need to be shifted in frequency during the analysis to ensure bounding worst-case interactions between loads and response are identified."
  - NuScale will perform benchmarking and design analysis pre-test predictions as presented in the DCA CVAP and CVAP M&IP technical reports. Different definitions of uncertainty and bias are used based on ASME V&V 20 methods. Pre-test predictions will be updated based on power uprated conditions, however, no methodology changes are planned for SDAA.

RG 1.20 Rev. 4 (continued)

- **C.2.1.4: Preoperational and Startup Testing Analysis**
  - "Coherence needs to be maximized between sensor and critical response locations, such as welds and other stress concentration locations."
  - NuScale requests additional feedback on this guideline for the SDAA.
- **C.2.2.2.c: Guidance for Critical Measurements**
  - "The applicant or licensee should work with the NRC to develop an acceptable program that establishes power levels and durations where power level should be maintained at a suitable percentage and for a suitable period of time to allow for the acquisition of data."
  - NuScale position - This action will be completed during the COL stage, similar to the DCA.

Acronyms

ACRS – Advisory Committee on Reactor Safeguards

AIV – acoustic induced vibration

AR – acoustic resonance

ASME BPV Code – American Society of Mechanical Engineers Boiler Pressure Vessel Code

COL – combined license

CRDM – control rod drive mechanism

CRDS – control rod drive system

CVAP – Comprehensive Vibration Assessment Program

DCA – design certification application

FIV – flow induced vibration

FRF – frequency response function

ICIGT – In-core Instrument Guide Tube

kg/s – kilograms per second

LFI – Leakage flow instability

M&IP – Measurement and Inspection Plan

MIV – mechanical induced vibration

NPM – NuScale Power Module

psia – pounds per square inch (atmospheric)

RG - Regulatory Guide

RMS – root mean square

SDAA – Standard Design Approval Application

SG – steam generator

SMR – small modular reactor

SRSS – square root sum of the squares

TF – test facility

V&V – verification and validation

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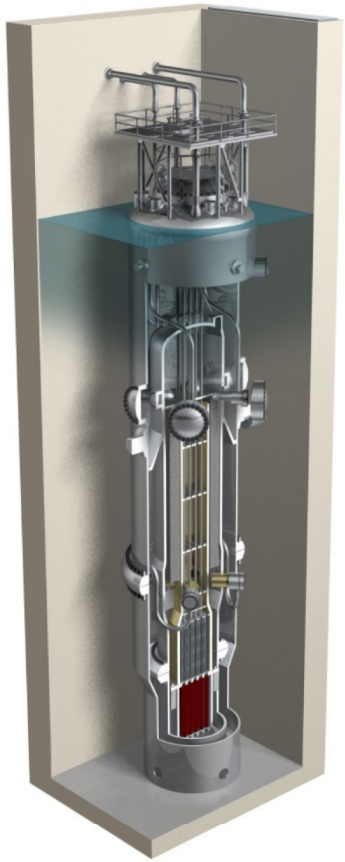

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