RAIO-1019-67696

October 23, 2019

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. 526 (eRAI No. 9719) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 526 (eRAI No. 9719)," dated October 03, 2019

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. 9719:

- 06.03-8

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 Nadja Joergensen at 541-452-7338 or at njoergensen@nuscalepower.com.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8H12
Omid Tabatabai, NRC, OWFN-8H12
Samuel Lee, NRC, OWFN-8H12
Cayetano Santos, OWFN-8H12
Michael Dudek, NRC, OWFN-8H12

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9719

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NuScale Response to NRC Request for Additional Information eRAI No. 9719

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9719
Date of RAI Issue: 10/03/2019

NRC Question No.: 06.03-8

Title 10 of the *Code of Federal Regulations* (10 CFR) Section 52.47, "Contents of applications; technical information," requires that an application for a design certification must include performance requirements and design information sufficiently detailed to permit its acceptance by the U.S. Nuclear Regulatory Commission (NRC). Specifically, §52.47(a)(2)(iii), states, in part, that the NRC will take into consideration the following reactor design characteristics that include, "the extent to which the reactor incorporates unique, unusual or enhanced safety features having a significant bearing on the probability or consequences of accidental release of radioactive materials."

10 CFR 50, Appendix A, GDC 37 requires, in part, the emergency core cooling system to be designed to permit appropriate functional testing to assure "the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system."

The staff is seeking an as-built performance test of the ECCS to demonstrate the system meets fundamental design requirements of the safety analysis. The integrated functionality of a full scale NuScale ECCS system has not been tested and demonstrated. Although the staff has confidence that NuScale analytical codes have been adequately validated within the existing state of practice, performance of the full scale, as-built ECCS system can be impacted by the geometry and functional arrangement of key components, variations in as-built parameters, and uncertainties associated with complex thermal hydraulic phenomena, especially when considering the integrated system. Functional testing of the full scale ECCS would provide assurance that the as-built system response conforms to analytical predictions.

To date the staff held approximately eleven public meetings where the adequacy of the proposed ECCS performance test (Test #47) was at least one of the topics discussed. The most recent meeting was held on September 11, 2019. Currently, NuScale DCA Part 2, Tier 2, Table 14.2-47, Revision 3 identifies the acceptance criteria for ECCS Test #47 as:

i. *RPV riser level remains above the top of the core*
ii. *CNV pressure remains below design pressure identified in Table 6.2-1*
iii. *CNV temperature remains below design temperature identified in Table 6.2-1*

The proposed acceptance criteria above are not sufficient to demonstrate the as-built performance capability of the ECCS to satisfy design requirements because the stored energy during test conditions is significantly less than the full power stored energy corresponding to the proposed test acceptance criteria (accident acceptance criteria). Therefore, the applicant is requested to modify an existing ECCS test or develop a new test to demonstrate acceptable performance of the as-built ECCS, based on predicted system response under expected test conditions, to ensure the system as a whole meets fundamental design requirements of the safety analysis.

Given the fundamental purpose of this type of test – to confirm the performance of a first-of-a-kind safety system and verify the conservatism in the safety analyses in calculating the performance of a novel design feature – and expected standardization of the NuScale power module design and construction, the requested test is an appropriate candidate for a first-of-a-kind test to be performed for at least the first module only.

NuScale Response:

Subsequent to the September 11, 2019 public meeting, the NRC and NuScale had several public meetings discussing potential changes to Table 14.2-47: Emergency Core Cooling System Test #47. The NRC Staff explained that they were seeking a test which demonstrates the ability of the containment vessel to transfer heat to the ultimate heat sink. As this is a function of the containment system, and not the emergency core cooling system (ECCS), acceptance criteria demonstrating heat transfer were not included in the original ECCS System Level Test #47-1.

To satisfy the NRC Staff's request for a test demonstrating the containment vessel (CNV) response during ECCS operation, a new test was created to replace Test #47-1. This test is a

one-time in-situ system performance test of the ECCS and CNV. The test will be performed during hot functional testing to allow ECCS actuation at elevated reactor coolant system (RCS) pressure and temperature conditions without engaging the inadvertent actuation block (IAB) design feature of the ECCS valves. The two acceptance criteria for this test include maintaining the core covered with water and that the CNV pressure response is as predicted during ECCS operation.

Table 14.2-47: Emergency Core Cooling System Test #47 was revised to replace System Level Test #47-1 with the ECCS and CNV response test described above. In support of this change, Section 14.2.2.3, Testing of First-of-a-Kind Design Features, and Table 14.2-110: ITP Testing of New Design Features were revised to incorporate information regarding the new test. Additionally, Table 14.2-63: Module Protection System Test #63 was revised to standardize language associated with the IAB RCS pressure threshold.

Impact on DCA:

Tier 2 Section 14.2 "Initial Test Plan Program" has been revised as described in the response above and as shown in the markup provided in this response.

RAI 05.04.07-7S1, RAI 14.02-1

The test results for the CVAP program testing of the first NPM are to inform the required CVAP testing on subsequent NPMs as described in Section 6.0 of TR-0716-50439. All other ITP testing of FOAK design features is performed for each NPM, except as described below.

RAI 06.03-8

Table 14.2-47: Emergency Core Cooling Test #47 includes a one-time in-situ system performance test of the emergency core cooling system (ECCS). The test demonstrates valve and containment response to manual emergency safety feature actuation of the ECCS at hot functional test pressure and temperature.

RAI 05.04.07-7S1

Section 5.4.3.4 contains a description of the decay heat removal system (DHRS) one-time in-situ RCS heat removal test. The test will be performed per test abstract Table 14.2-48: Decay Heat Removal System Test # 48.

RAI 14.02-1

Table 14.2-110 provides a summary of the ITP testing (i.e., preoperational and startup testing) for new design features. Each test will be performed for all NPMs.

RAI 14.02-1

Section 1.5.1 contains a description of testing programs which have been completed or are currently in progress for NuScale design features for which applicable data or operational experience did not previously exist. The section describes tests specific to fuel design, steam generator (SG) and control rod assemblies.

14.2.3.4 Generic Component Testing

Component testing is generally executed after a system's transfer from the construction organization to the startup organization. Generic component testing executes standardized tests for a family of related component types, independent of the component's system assignment. Each generic component test procedure will be completed and approved before the component is required as a prerequisite to a preoperational test performance. The completion of generic component testing will be listed as a prerequisite in each preoperational test procedure as applicable.

Examples of components that may require generic component testing are as follows:

- Mechanical Components
  - pumps
  - motors
  - chillers
  - compressors
- Valves

RAI 06.03-8, RAI 14.03-S1

Table 14.2-47: Emergency Core Cooling System Test # 47

Preoperational test is required to be performed for each NuScale Power Module. **System Level Test #47-1 is only required to be performed once for NPM #1. This test supports first-of-a-kind (FOAK) testing as described in Section 14.2.3.3.**		
The emergency core cooling system (ECCS) is described in Section 6.3, and the functions verified by this test are:		
System Function	**System Function Categorization**	**Function Verified by Test #**
1. The ECCS supports the reactor coolant system (RCS) by opening the ECCS reactor vent valves and reactor recirculation valves when their respective trip valve is actuated by the module protection system (MPS).	safety-related	Test #47-1 Module Protection System Test #63-6
2. The ECCS supports the RCS by providing recirculated coolant from the containment to the reactor pressure vessel (RPV) for the removal of core heat.	safety-related	Test #47-1 Module Protection System Test #63-6
The ECCS functions verified by other tests are:		
System Function	**System Function Categorization**	**Function Verified by Test #**
1. The ECCS supports the RCS by providing low temperature overpressure protection (LTOP) for maintaining the reactor coolant pressure boundary.	safety-related	Module Protection System Test #63-6
2. The ECCS supports the containment system (CNTS) by providing a portion of the containment boundary for maintaining containment integrity.	safety-related	Containment System Test #43-1
3. The ECCS supports MPS by providing post accident monitoring instrument information signals.	nonsafety related	Safety Display and Indication System Test #66-2
Prerequisites Verify an instrument calibration has been completed, with approved records and within all calibration due dates, for all instruments required to perform this test.		
Component Level Tests		
None		
System Level Test #47-1 **Test #47-1 is performed at hot functional testing to allow ECCS actuation at elevated RCS pressure and temperature conditions, without engaging the inadvertent actuation block (IAB).** ~~Test 47-1 is performed at hot functional testing concurrently with Turbine Generator System Test #33-1 (reference Table 14.2-33) and MPS Test #63-6 to allow testing of ECCS actuation at normal operating pressure and elevated temperatures. Test #33-1 heats the RCS from ambient conditions to the highest temperature achievable by module heatup system (MHS) heating. These hot functional testing conditions provide the highest differential pressure and temperature conditions that can be achieved prior to fuel load.~~		
The RCS is heated to the highest temperature achievable by module heatup system (MHS) heating. These hot functional testing conditions provide the highest temperature conditions that can be achieved prior to fuel load. The RCS level is within the expected range of module operation, near the low end of the normal operating range for hot zero power conditions.		

Table 14.2-47: Emergency Core Cooling System Test # 47 (Continued)

Test Objective	Test Method	Acceptance Criteria
i. Verify the RPV liquid level remains above the top of the core during and following ECCS actuation. ii. Verify the heat removal capacity of the ECCS, operating with the containment vessel (CNV), is consistent with the design basis. ~~i.Verify collapsed liquid level remains above the top of the core during ECCS actuation.~~ ~~ii. Containment vessel (CNV) pressure remains below the design pressure limit during ECCS actuation.~~ ~~iii. Containment temperature remains below the design temperature limit during ECCS actuation.~~	i. Ensure RCS pressure is as close to, but below, the IAB RCS pressure threshold as practical. ii. Ensure RCS temperature is at the maximum temperature achievable by heating the RCS using MHS heating. iii. Ensure RCS level is as low in the normal operating band as is practically achievable for the established plant conditions. iv. Manually initiate ECCS from the main control room. v. Allow RPV riser level and CNV level to become relatively stable. ~~Ensure the RCS is at normal operating pressure and at maximum temperature achievable by warming the RCS using MHS heating.~~ ~~i. Manually initiate ECCS from the main control room (MCR).~~ ~~ii. Allow RPV riser level and CNV level to become relatively stable.~~	i. RPV riser level remains above the top of the core. ii. CNV pressure remains within upper and lower bounds calculated using safety analysis methods, while accounting for test initial conditions and instrumentation uncertainty. ~~i.RPV riser level remains above the top of the core.~~ ~~ii. CNV pressure remains below design pressure identified in Table 6.2-1.~~ ~~iii. CNV temperature remains below design temperature identified in Table 6.2-1.~~

RAI 06.03-8

Table 14.2-63: Module Protection System Test #63

Preoperational test is required to be performed for each NuScale Power Module (NPM).		
The module protection system (MPS) is described in Sections 7.0, 7.1, and 7.2 and the functions verified by this test and power ascension testing are:		
System Function	**System Function Categorization**	**Function Verified by Test #**
1. The MPS supports the containment system (CNTS) by removing electrical power to the trip solenoids of the following containment isolation valves (CIVs) on a CNTS isolation actuation signal: • Reactor coolant system (RCS) injection CIVs • RCS discharge CIVs • Pressurizer (PZR) spray CIVs • Reactor pressure vessel (RPV) high point degasification CIVs • Feedwater isolation valves (FWIVs) • Main steam isolation valves (MSIVs) • Main steam isolation bypass valves (MSIBVs) • Containment evacuation system CIVs • Reactor component cooling water system CIVs RVVs • Containment flooding and drain system (CFDS) CIVs	safety-related	Test #63-6
2. The MPS supports the CNTS by removing electrical power to the trip solenoids of the following valves on a decay heat removal system (DHRS) actuation signal. • MSIVs • MSIBVs • FWIVs	safety-related	Test #63-6
3. The MPS supports the emergency core cooling system (ECCS) by removing electrical power to the trip solenoids of the following valves on an ECCS actuation signal. • Reactor vent valves (RVVs) • Reactor recirculation valves (RRVs)	safety-related	Test #63-6

Table 14.2-63: Module Protection System Test #63 (Continued)

Prerequisite Verify an instrument calibration has been completed, with approved records and within all calibration due dates, for all instruments required to perform this test.		
Component Level Tests		
None		
System Level Test #63-1		
Test Objective	**Test Method**	**Acceptance Criteria**
Verify the instrument signals of MPS monitored variables are displayed in the MCR.	Table 7.1-2 lists all of sensors which input to MPS. This test may be performed concurrently with safety display and indication system test #66 -2 for post-accident monitoring Type B and Type C testing described in Section 14.2.12. Inject a single signal as close as practical for each sensor listed in Table 7.1-2 and monitor its response on an MCR workstation and the module-specific safety display instrument panel (if designed for safety display instrument display). If the sensor signal is designed to be disconnected when the NPM is moved then it will be necessary to test the signal from the sensor to the disconnect and then from the disconnect to the MCR display.	Each MPS monitored signal is displayed on an MCR workstation and the module-specific safety display instrument panel (if designed for safety display instrument display).
System Level Test #63-2 (Not Used)		
System Level Test #63-3		
Test Objective	**Test Method**	**Acceptance Criteria**
Verify each ECCS RVV and RRV operates to satisfy its engineered safety feature (ESF)-actuated design stroke time.	This test will verify the stroke time of each RRV and RVV by actuating the valves with RCS pressure below the IAB RCS pressure threshold~~inadvertent actuation block setpoint~~. i. Close all RVVs and RRVs. ii. Verify RCS pressure is below the IAB RCS pressure threshold~~inadvertent actuation block setpoint~~ specified in Technical Specifications (TS). iii. Actuate ECCS using the manual ECCS actuation switches in the MCR.	Each ECCS RRV and RVV travels from fully closed to fully open in less than or equal to the time specified in TS.
System Level Test #63-4 Test #63-4 is performed concurrently with Test #63-6 which operates all of the ESF actuation valves during hot functional testing. Test #63-4 records the stroke times of DHRS actuation valves as they travel to their ESF-actuated position with the RCS pressure at normal operating pressure.		
Test Objective	**Test Method**	**Acceptance Criteria**
Verify each DHRS actuation valve operates to satisfy its ESF-actuated design stroke time.	Time the operation of all DHRS actuation valves as they actuate to their ESF position during the manual ESF actuation testing in Test #63-6.	Each DHRS actuation valve travels from fully closed to fully open in less than or equal to the time specified in Technical Specifications.
System Level Test #63-5 (Not Used)		

RAI 05.04.07-7S1, RAI 06.03-8, RAI 14.02-1, RAI 14.02-5

Table 14.2-110: ITP Testing of New Design Features

New System or Component Design	Design Feature Tested in the Initial Test Program	FSAR Section 14.2 Test Number
Containment isolation valves	• valve leak rate test • valve response to manual engineered safety feature (ESF) action at hot functional test pressure and temperature • valve response time test at hot functional test pressure and temperature • valve response to manual reactor trip at 100% power	#43-1 #63-6 #63-7 #104
Emergency core cooling system (ECCS) valve design	• valve response to manual ESF action at hot functional test pressure and temperature • test of valve inadvertent actuation block at design pressure	#63-6 #63-6
ECCS operation	• Containment response to ECCS operation at hot functional test pressure and temperature.	#47-1
Decay heat removal system (DHRS) valve design	• valve response to manual ESF action at hot functional test pressure and temperature • valve response to manual reactor trip at 100% power	#63-6 #104
DHRS heat exchanger design	• heat exchanger response to manual ESF action at hot functional test pressure and temperature • heat exchanger response to manual reactor trip at 100% power	#48-1 #104
Containment flooding and drain system (CFDS)	• automatic fill of containment • automatic drain of containment	#42
Containment evacuation system	• establish and maintain containment vacuum • provide reactor coolant system (RCS) leakage detection	#41
Containment system level sensors	• provides containment level input for CFDS automatic fill and drain of containment	#42
RCS flow sensors	• provides RCS flow indication during hot functional testing and power ascension testing	#77 #94
Pressurizer (PZR) level sensors	• provides input for PZR level control	#38-1
Island mode operation	• NuScale Power Modules can operate independently from offsite transmission grid.	#105 and #106