November 30, 2021 Docket No. 99902078

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of Supplemental Topical Report "Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1," TR-108553, Revision 0

REFERENCES:

1. Letter from NuScale Power, LLC to NRC, "NuScale Power, LLC Submittal of the Approved Version of NuScale Topical Report TR-0116-20825, 'Applicability of AREVA Fuel Methodology for the NuScale Design,' Revision 1 (NRC Project No. 0769)," dated February 9, 2018 (ML18040B306)

2. Letter from NuScale Power, LLC to NRC, "NuScale Power, LLC Submittal of Approved Version of NuScale Topical Report 'NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces,' TR-0716-50351, Revision 1," dated May 1, 2020 (ML20122A248)

NuScale Power, LLC (NuScale) hereby submits Revision 0 of the "Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1," (TR-108553). The purpose of this submittal is to request that the NRC review and approve the bases for Nuclear Regulatory Commission approval of an extension to the range of applicability for the fuel analysis and structural response methodologies approved in Reference 1 and 2 to the operating domain of the NuScale Power Module at higher-rated power levels. NuScale respectfully requests that the acceptance review be completed in 60 days from the date of transmittal, and the review schedule be transmitted within the same period.

Enclosure 1 contains the proprietary version of the report entitled "Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1," TR-108553, Revision 0. NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3 and 4) supports this request. Enclosure 3 pertains to the NuScale proprietary information, denoted by double braces (i.e., "{{ }}"). Enclosure 4 pertains to the Framatome Inc. (formerly AREVA Inc.) proprietary information, denoted by brackets (i.e., "[ ]"). Enclosure 2 contains the nonproprietary version of the report.

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

If you have any questions, please contact Rebecca Norris at 541-452-7539 or at RNorris @nuscalepower.com.

Sincerely,

Mark W. Shaver

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Enclosure 1: "Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1," TR-108553-P, Revision 0, proprietary version
Enclosure 2: "Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1," TR-108553-NP, Revision 0, nonproprietary version
Enclosure 3: Affidavit of Mark W. Shaver, AF-109820
Enclosure 4: Affidavit of Morris Byram

Enclosure 1:

"Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1," TR-108553-P, Revision 0, proprietary version

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Enclosure 2:

“Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1,” TR-108553-NP, Revision 0, nonproprietary version

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Licensing Topical Report

Framatome Fuel and Structural Response Methodologies Applicability to NuScale

Supplement 1 to TR-0116-20825-P-A, Revision 1, Applicability of AREVA Fuel Methodology for the NuScale Design

Supplement 1 to TR-0716-50351-P-A, Revision 1, NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces

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Abstract

The purpose of this topical report supplement is to provide the bases for Nuclear Regulatory Commission approval of an extension to the range of applicability for the fuel analysis and structural response methodologies approved in topical reports TR-0116-20825-P-A, Revision 1, "Applicability of AREVA Fuel Methodology for the NuScale Design" and TR-0716-50351-P-A, Revision 1, "NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces" to the operating domain of the NuScale Power Module at higher-rated power levels.

Executive Summary

The set of NRC-approved codes and methods detailed in TR-0116-20825-P-A, Revision 1 (Reference 11.1.1) was adequate for the NuScale Power Module (NPM) described in the Design Certification (DC). The range of applicability of those codes and methods is extended to encompass the operating domain of the NPM at higher rated power levels.

Applicability of the seismic analysis methodology to NuScale fuel and operating conditions was approved by the NRC in TR-0716-50351-P-A, Revision 1 (Reference 11.1.2). An evaluation demonstrated that this accident analysis methodology remains applicable for the seismic analyses at the new NuScale operating conditions.

This report concludes that these codes and methods, in addition to three modifications as approved in Reference 11.1.1 and 11.1.2, remain applicable to the NuScale design at higher-rated power levels.

- Two adjustments to the BAW-10337PA (Reference 11.1.8) methodology are required. Fuel assembly damping values specific to the NuScale design have been derived. Also, a single assembly model for LOCA evaluations will be used in place of a core bounce model. Both of these modifications were approved by the NRC in Reference 11.1.2.
- One adjustment to the BAW-10084PA (Reference 11.1.3) methodology is required. The creep collapse analysis should not be performed [

  ] to ensure a conservative prediction of cladding creep.

These modifications will be applied to the NuScale analyses only. NRC approval of these modifications, described herein, is requested as part of the review and approval of this topical report. With these modifications, all six cited codes and methods are applicable to the NuScale fuel design and are suitable for subsequent NuScale licensing activities.

1.0 Introduction

This document establishes the applicability of the cited Framatome (the company previously known as AREVA) methodologies for use in NuScale fuel analyses for the NPM design. NuScale requests NRC approval to use existing Framatome methodologies for the analysis of NuScale fuel and structural response in the corresponding broadened operating domain.

1.1 Purpose

The NRC approved the codes and methods detailed in TR-0116-20825-P-A, Revision 1 (Reference 11.1.1) and TR-0716-50351-P-A, Revision 1 (Reference 11.1.2). The range of applicability of those codes and methods is expanded to encompass the operating domain of the NPM at higher rated power levels.

1.2 Scope

This supplement shows that the Framatome methodologies and codes that were previously approved are similarly applicable to the fuel, core design, and operating conditions in the forthcoming Standard Design Approval (SDA).

This supplement contains only those sections/subsections that required a re-evaluation or positive confirmation that the applicability of the Framatome code/methods in Reference 11.1.1 and 11.1.2 are still valid. If a specific section or subsection is not contained in the supplement, then no changes were required and no confirmation of applicability is necessary.

This topical report is being submitted as a supplement to both Reference 11.1.1 and Reference 11.1.2.

1.3 Abbreviations

This section is unchanged relative to the abbreviations sections of Reference 11.1.1 and Reference 11.1.2, with the sole addition of SDA, Standard Design Approval.

2.0 Background

NRC approved in Reference 11.1.1 use of Framatome fuel system methodologies and codes for NuScale fuel analyses, including:

- Program to Determine In-Reactor Performance of BWFC Fuel Cladding Creep Collapse (Reference 11.1.3)
- Evaluation of Advanced Cladding and Structural Material (M5®) in PWR Reactor Fuel (Reference 11.1.4)
- COPERNIC Fuel Rod Design Computer Code (Reference 11.1.5)
- Computational Procedure for Evaluating Fuel Rod Bowing (Reference 11.1.6)
- Generic Mechanical Design Criteria for PWR Fuel Designs (Reference 11.1.7)

The NRC approved in Reference 11.1.2 the use of Framatome fuel assembly structural response analysis methodology for the NuScale reactor and fuel design.

This report demonstrates that these methods are applicable to the NuScale fuel design for the operating domain corresponding to higher-rated thermal power. A summary of the NuScale fuel design is provided in the corresponding section of Reference 11.1.1. Design features that are updated from the description in Reference 11.1.1 are provided below.

<u>Fuel rod with M5® cladding</u>

The nominal theoretical density of the pellets is 96.5%, with a possible enrichment up to 5.0 weight percent ^{235}U consistent with current licensing requirements.

Table 2-1 provides additional information on the NuScale fuel design.

Table 2-1 NuScale Fuel Design Parameters

Parameter	NuScale Fuel Design	Framatome 17x17 PWR	Different? (Y/N)
Fuel rod array	17 x 17	17 x 17	N
Fuel rod pitch (inch)	0.496	0.496	N
Fuel assembly pitch (inch)	8.466	8.466	N
Fuel assembly height (inch)	94.0	159.45	Y
Number of guide tubes per bundle	24	24	N
Dashpot region inner diameter (ID) (inch)	0.397	0.397	N
Dashpot region outer diameter (OD) (inch)	0.482	0.482	N
ID above transition (inch)	0.450	0.450	N
OD above transition (inch)	0.482	0.482	N
Number of instrument tubes per bundle	1	1	N
ID (inch)	0.450	0.450	N
OD (inch)	0.482	0.482	N
Number of fuel rods per bundle	264	264	N
Cladding OD (inch)	0.374	0.374	N

Table 2-1 NuScale Fuel Design Parameters (Continued)

Parameter	NuScale Fuel Design	Framatome 17x17 PWR	Different? (Y/N)
Cladding ID (inch)	0.326	0.326	N
Length of total active fuel stack (inch)	78.74	144	Y
Fuel pellet OD (inch)	0.3195	0.3195	N
Fuel pellet theoretical density (%)	96.5	96	Y
Spacer grid span lengths (inch)	20.1	20.6	Y
Fuel rod internal pressure (psig)	215	300	Y

Table 2-2 provides the operating conditions representative of the NuScale design.

Table 2-2 NuScale Operating Conditions

Parameter	NuScale Design Value	17x17 PWR Value
Rated thermal power (MWt)	250	3455
Average coolant velocity (ft/s)	3.6	16
System pressure (psia)	2000	2280
Core Tave (F)	540	584
Linear heat rate (kW/m)	12.8	18.0
Reactor coolant system (RCS) inlet temperature (F)	485	547
RCS Reynolds number	86,000	468,000
Maximum fuel assembly average burnup (GWd/mtU)	{{ }} 2(a),(c),ECI	49
Fuel assemblies in core	37	193
Fuel assembly loading (kgU)	251	455
Core loading (kgU)	9,269	87,815

2.1 Regulatory Requirements

This section is unchanged relative to the corresponding section of Reference 11.1.1.

3.0 Review of BAW-10084PA, Program to Determine In-Reactor Performance of BWFC Fuel Cladding Creep Collapse

Framatome topical report BAW-10084PA-03 (Reference 11.1.3) documents and summarizes the creep collapse methodology used for Framatome fuel rod designs to ensure that the fuel rods do not collapse during their design lifetime.

The approved CROV code is applicable to Framatome fuel designs but restricted to Zircaloy-4 cladding. Framatome topical report BAW-10227PA "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel" (Reference 11.1.4) extended the application of the CROV code to fuel designs with Framatome's advanced cladding M5®.

3.1 Applications

The CROV methodology has been used to license various PWR fuel types (multiple B&W 15x15 and W-type 17x17 fuel designs). The NuScale fuel rod design is identical to fuel supplied by Framatome to W 17x17 PWR units with respect to cladding material, cladding thickness, and fuel pellet dimensions and properties. Reference 11.1.1 provided a summary of the CROV topical report. A review of this summary and comparison to the NuScale fuel and core identified in Table 2-1 and Table 2-2 confirms that this information is still applicable.

3.2 Topical Report Restrictions

This section is unchanged relative to the corresponding section of Reference 11.1.1.

3.2.1 Safety Evaluation Report

The SER for BAW-10084PA-03 references the TER written for the CROV code by Pacific Northwest Laboratory. The SER approves the usage of BAW-10084PA-03 for all B&W (FRAMATOME) fuel reloads. The SER for the CROV topical report makes no restrictions as to fuel design type. Within the SER for BAW-10084PA-03 there is no restriction that would preclude usage of the CROV topical report for the NuScale fuel design.

3.2.2 Technical Evaluation Report

The conclusions in the SER and TER for BAW-10084PA-03 remain valid for the NuScale fuel.

3.3 NuScale Design Differences and Requirements

No changes are made to the assumed fuel column axial gap nor to the revised methodology for determination of the [ ] for creep collapse analysis.

3.4 Summary and Conclusions for BAW-10084PA CROV Topical Report

Reference 11.1.3 documents and summarizes the creep collapse methodology used for Framatome fuel rod designs to ensure that the fuel rods do not collapse during their design lifetimes. The approved methodology is applicable to the NuScale fuel with a minor [ ] of the NuScale fuel rods.

4.0 Review of BAW-10227PA, M5® Material Topical Report

4.1 Applications

Appendices A to D of Reference 11.1.4 provide detailed information on M5® material properties and analysis models. Appendix A material properties and models, with respect to the cladding fatigue, stress, and buckling analyses, are appropriate for use in NuScale fuel rod licensing calculations because the core conditions remain within the range of past and current PWR operating conditions.

4.2 Topical Report Restrictions

4.2.1 Safety Evaluation Report

A review of this section confirmed that it is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

4.3 NuScale Design Differences and Requirements

No changes are made to the assumed fuel column axial gap nor to the revised methodology for determination of the [ ] for creep collapse analysis.

4.3.1 NuScale Design Applicability

A review of this section confirmed that it is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

4.3.2 COPERNIC Input and Output Parameters

The COPERNIC fuel performance code (Reference 11.1.5) is used to generate the fuel rod performance parameters for the cladding fatigue, stress, and buckling analysis. Inputs to COPERNIC include the fuel rod geometry, power history, back-fill pressure, linear heat generation rate, fast flux, and densification kinetics. These inputs are specific to the NuScale fuel design and NuScale core conditions as described in Table 2-1 and Table 2-2, which remain bounded by past and current PWR operating conditions.

4.4 Summary and Conclusions for BAW 10227PA M5® Topical Report

Reference 11.1.4 documents the M5® thermal mechanical methodology used for Framatome fuel rod designs. The methodology is applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.0 Review of BAW-10231PA COPERNIC Fuel Rod Design Topical Report

5.1 Applications

5.1.1 Method of Review

Comparing the NuScale thermal hydraulic conditions to reference information in Table 2-2, the system pressure is lower than that of a typical PWR. With the lower system pressure, the coolant saturation temperature decreases, which lowers the cladding temperature in the two-phase flow region. Average coolant velocity is approximately 25% of the coolant velocity in a typical PWR. The slower coolant velocity will reduce the coolant-to-cladding heat transfer. Coolant average temperature is comparable to that of a typical PWR.

Based on the core design information in Table 2-2, the fuel enrichment is within the range encountered in a typical PWR. The core average linear heat generation rate (LHGR) is approximately 12.8 kW/m, which makes the maximum fuel rod LHGR much less than that of a typical PWR. Maximum predicted fuel assembly burnup is approximately {{ }}$^{2(a),(c),ECI}$. The reactor power density and burnup still produces a lower total accumulated fuel rod fluence than a typical PWR. Based on these comparisons, it can be concluded that the fuel rod still operates in a relatively low power, low exposure, and low fluence range when compared to a typical PWR.

5.1.2 Code Validity Range

This section is unchanged relative to the corresponding section of Reference 11.1.1.

The following sections discuss the major models and databases used in COPERNIC.

5.2 COPERNIC Models Review

5.2.1 Thermal Models

5.2.1.1 Coolant-Cladding Outside Surface Heat Transfer

Coolant pressure, mass flux, and fuel rod surface heat flux will impact the heat transfer coefficient in the [ ] correlation. In the NuScale design, the heat source (fuel rod) and the elevated heat sink (riser) drive the fluid flow through the core. At the coolant-cladding heat transfer side, a standard PWR and the NuScale design are similar except that the NuScale design will have a lower flow rate and a smaller Reynolds number. For NuScale, the Reynolds number is approximately 20% of the Reynolds number in a typical PWR. Because the Reynolds number for NuScale steady state full power operation is higher than 10,000 (a typical threshold for natural convection), forced convection is the appropriate mode of heat transfer for the NuScale design and operating conditions. [

]

[ ]

[ ]. The NuScale RCS pressure falls at the upper limit of that range. The correlation applies to all geometries and for both local and bulk boiling conditions. Hence, the usage of [ ] is appropriate.

5.2.1.2 Pellet-Cladding Heat Transfer

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.2.1.3 Fuel Thermal Conductivity

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.2.1.4 Pellet Radial Power Profile

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.2.1.5 Global Validation on Thermal Models

COPERNIC has been through a global validation by comparing the centerline fuel temperature prediction with measured data to verify that the thermal models are interacting satisfactorily. Based on the operating conditions for NuScale, the fuel rod will have lower burnup and LHGR relative to a typical PWR. The maximum fuel assembly burnup is approximately {{ }}2(a),(c),ECI and the core average LHGR is 12.8 kW/m. The Framatome data supporting the COPERNIC topical report has more measurement data [ ]. Figure 4-73 of the COPERNIC Fuel Rod Design Computer Code, Reference 11.1.5, shows the trend is excellent and the temperature prediction does not have any bias relating to LHGR. Figure 4-70 of Reference 11.1.5 demonstrated that the temperature is [ ]. The database shown in Tables 4-4 and 4-5 of Reference 11.1.5 fully covers the NuScale operating conditions in terms of burnup and LHGR. Note that the Halden data in Table 4-5 has a coolant mass flux of [ ], which forms the low bound of the flow rate in the database. For full power operation the flow rate is greater than 660 kg/(m^2s). Based on this evaluation, the COPERNIC thermal models are acceptable for the NuScale fuel rod.

5.2.1.6 Fission Gas Release Model

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.2.2 Mechanical Models

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.2.3 Cladding Corrosion and Hydriding Models

The M5® waterside corrosion model is formulated in a classical way [

]. The highest oxide thickness measurement was obtained with an [

]. The fuel rod axial location with maximum oxide thickness is typically upstream of the intermediate grids in the upper spans. Therefore, it is significant that the outlet temperatures in the measurement database bound the NuScale outlet temperature. As shown in Figure 8-16 of Reference 11.1.5, there is sufficient measurement data [

], which is appropriate to cover the operation range of NuScale fuel rods.

All inlet and outlet temperatures are below the saturation temperature at 1850 psia (conservative for a core operating at 2000 psia). Hence, local boiling will not exist or will be limited. Based on the current M5® data base and NuScale-specific analyses, the corrosion level for M5® cladding will be significantly less than the [

]. The hydrogen pickup model is consistent with the M5® database. Overall, the corrosion model and hydrogen pickup model are both acceptable for evaluating NuScale fuel.

5.3 Material Properties

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.4 Safety Evaluation and Technical Evaluation Report

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

5.5 Summary and Conclusions

Reference 11.1.5 summarizes Framatome's fuel performance code for evaluating fuel rod thermal and mechanical performance. The methodology described and approved is applicable to the NuScale fuel design and operating conditions as described in Table 2-1 and Table 2-2, and therefore COPERNIC can be used to predict NuScale fuel rod performance and attributes (e.g., rod internal pressure and cladding and pellet temperatures).

6.0 Review of XN-75-32(P)(A) Supplements, Computational Procedure for Evaluating Fuel Rod Bowing Topical Report

6.1 Applications

6.1.1 Fuel Design Comparison

When considering the operating environment, the NuScale core axial flow velocities, cross flow velocities and resulting lateral forces, core outlet temperature, and fuel assembly burnup are lower than those for the Framatome Advanced 17x17 HTP^{TM} fuel design currently in operation where no evidence of severe fuel rod bowing exists. As such, the NuScale fuel design is not expected to exhibit a high propensity for fuel rod bowing. In addition, the fuel rod bowing data for current HTP^{TM} fuel designs continue to demonstrate the adequacy of the applicability of the Framatome rod bow correlation in (Reference 11.1.6) and by extension applicability to the NuScale fuel design. The NuScale fuel design remains within the current experience base with regard to fuel rod bending stiffness and core operating outlet temperature and less limiting regarding end grid slip loads and span lengths. Based on a comparison of these attributes, the NuScale fuel design is expected to have a relatively high resistance to fuel rod bowing, comparable with the Framatome 17x17 HTP^{TM} fuel design.

Therefore, when considering the NuScale fuel design and operating conditions as described in Table 2-1 and Table 2-2, the magnitude of fuel rod bowing is expected to be acceptable and comparable to other HTP^{TM} fuel designs. The applicability of the XN-75-32 (P)(A) (Reference 11.1.6) methodology to the HTP^{TM} fuel design has been approved by the NRC in Reference 11.1.9.

6.1.2 Justification of Critical Heat Flux Penalties

The nominal operating conditions for the NuScale core are approximately a pressure of 136 atm, a mass velocity of 2.6 x 10^6 kg/hr-m^2 and an inlet temperature of 251° C. These NuScale operating conditions are within the range of test conditions examined with the exception of the mass velocity, which is approximately 35% of the minimum mass velocity tested. Figures 1 and 2 in Reference 11.1.6 show the parameter of $\delta_{bow,meas}$ as a function of local mass velocity and pressure. The $\delta_{bow,meas}$ parameter normalizes trends in the data except those due to the presence of the fuel rod bowing and to random scatter.

$$\delta_{bow,meas} = \frac{\left(\dfrac{q''_{meas}}{q''_{pred}}\right)_{no\ bow} - \left(\dfrac{q''_{meas}}{q''_{pred}}\right)_{bow}}{\left(\dfrac{q''_{meas}}{q''_{pred}}\right)_{no\ bow}} \quad \text{Equation 6-1}$$

As stated in Reference 11.1.6 Supplement 1, the critical heat flux (CHF) penalty determined from [

] Therefore, based upon the comparison of CHF test conditions and NuScale operating conditions, the procedure for the calculation of the CHF penalty for potential rod bowing from Reference 11.1.6 is applicable to the NuScale fuel design.

6.1.3 Justification of Linear Heat Rate Generation Rate Penalties

This section is unchanged relative to the corresponding section of Reference 11.1.1.

6.2 Topical Report Restrictions

6.2.1 Technical Evaluation Report

The comparison of the NuScale nominal, operating conditions to the CHF test conditions that form the basis of the fuel rod bowing CHF penalty has led to the conclusion that the procedure for the calculation of the CHF penalty for potential rod bowing from (Reference 11.1.6) is applicable to the NuScale fuel design.

7.0 Review of EMF-92-116(P)(A) Generic Mechanical Design Criteria for PWR Fuel Designs Topical Report

7.1 Applications

3.3.3 Fretting wear

Fretting wear is predicted by testing prototypical components in applicable flow conditions that represent the reactor coolant system conditions. A 1000-hour fretting test specific to the NuScale fuel design and operating conditions has been performed. Applicability of the testing was verified by comparing the test conditions with the operating conditions and use of a prototypic test bundle. The mechanical design criterion is therefore unchanged and the method of demonstrating compliance is applicable to the NuScale design.

3.3.6 Axial growth addressing both fuel rod and fuel assembly

Empirical models are used for Framatome fuel rod and fuel assembly growth analyses. The growth analyses consider the dimensional constraints specific to the NuScale fuel design - the core plate to core plate gap constrains the fuel assembly growth and the fuel assembly nozzle to nozzle gap constrains the fuel rod growth. The evaluation also accounts for tolerances specific to the NuScale components. The predicted growth rates are based on fluence values specific to the anticipated NuScale core designs and are within the fluence values that establish the range of applicability for the Framatome growth correlations. The fuel rod growth prediction accounts for the axial growth of M5® cladding material and the fuel assembly growth prediction considers the Zircaloy-4 guide tube material. Therefore, the mechanical design criteria remains unchanged and Reference 11.1.7 applies to the NuScale design.

3.3.8 Fuel lift analysis

The fuel lift analysis accounts for the fuel assembly mass, hold-down spring loads, and hydraulic forces. The mass values and predicted hydraulic forces will be specific to the NuScale design. The flow rate (approximately 3.6 ft/sec) is within the values used in typical Framatome PWR fuel lift analyses. The standard analysis method therefore applies and the mechanical design criterion is unchanged.

7.2 Topical Report Restrictions

This section is still applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

7.3 Summary and Conclusions for EMF-92-116(P)(A) Topical Report

Reference 11.1.7 documents the criteria and methods being applied to specific mechanical analyses that are part of the Framatome work scope for NuScale fuel development. The methodologies are applicable to the NuScale fuel and core design as described in Table 2-1 and Table 2-2.

8.0 Reserved

9.0 Review of BAW-10337P-A

The NuScale fuel design seismic analyses were completed using the NRC-approved Framatome methodology of ANP-10337P-A (Reference 11.1.8). Applicability of the BAW-10337 (Reference 11.1.8) methodology to NuScale fuel and operating conditions was approved in Reference 11.1.2.

An evaluation of Reference 11.1.8 demonstrated that this accident analysis methodology remains applicable for the seismic analyses at the NuScale operating conditions shown in Table 2-2. Specifically, the lower average coolant temperature and higher reactor coolant system pressure have a negligible impact on damping values.

The fuel assembly frequency values predicted for the NuScale operating conditions will increase by less than 1% when accounting for reactor coolant system pressure and temperature values and the fuel pellet theoretical density increase as shown in Table 2-1 and Table 2-2. [

]

Therefore, the seismic analysis methodology as submitted to the NRC in Reference 11.1.2 remains applicable to the NuScale operating conditions.

10.0 Overall Summary and Conclusions

This report provides justification for of the use of six NRC-approved Framatome codes and methods for evaluating performance of the NuScale fuel design. For application of the six Framatome topical reports to NuScale, three minor modifications are required to conservatively predict NuScale fuel behavior, as approved in Reference 11.1.1 and Reference 11.1.2.

- Two adjustments to the BAW-10337PA (Reference 11.1.8) methodology are required. Fuel assembly damping values specific to the NuScale design have been derived. Also, a single assembly model for LOCA evaluations will be used in place of a core bounce model. Both of these modifications were approved by the NRC in Reference 11.1.2.
- One adjustment to the BAW-10084PA (Reference 11.1.3) methodology is required. The creep collapse analysis should not be performed [ ] to ensure a conservative prediction of cladding creep.

These modifications will be applied to the NuScale analyses only. NRC approval of these modifications, described herein, is requested as part of the review and approval of this topical report. With these modifications all six cited Framatome codes and methods are applicable to the NuScale fuel design and are suitable for use in NuScale licensing activities.

11.0 References

11.1 Referenced Documents

11.1.1 NuScale Power, LLC, "Applicability of AREVA Fuel Methodology for the NuScale Design," TR-0116-20825-P-A, Revision 1.

11.1.2 NuScale Power, LLC, "NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces," TR-0716-50351-P-A, Revision 1.

11.1.3 BAW-10084PA-03 (BAW-10084PA Rev. 3), Program to Determine In-Reactor Performance of BWFC Fuel Cladding Creep Collapse, August 1995.

11.1.4 BAW-10227PA-01 (BAW-10227P-A, Rev. 1), Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel, June, 2003.

11.1.5 BAW-10231PA-01 (BAW-10231PA, Revision 1) COPERNIC Fuel Rod Design Computer Code, January 2004.

11.1.6 XN-75-32 (P)(A), Supplements 1-4, Computational Procedure for Evaluating Fuel Rod Bowing.

11.1.7 EMF-92-116(P)(A) Revision 0, Generic Mechanical Design Criteria for PWR Fuel Designs.

11.1.8 ANP-10337PA-00/BAW-10337P-A, PWR Fuel Assembly Structural Response to Externally Applied Dynamic Excitations.

11.1.9 ANF-89-060(P)(A), Supplement 1, Generic Mechanical Design Report High Thermal Performance Spacer and Intermediate Flow Mixer, February 1991.

Enclosure 3:

Affidavit of Mark W. Shaver, AF-109820

NuScale Power, LLC

AFFIDAVIT of Mark W. Shaver

I, Mark W. Shaver, state as follows:

(1) I am the Director of Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on behalf of NuScale

(2) I am knowledgeable of the criteria and procedures used by NuScale in designating information as a trade secret, privileged, or as confidential commercial or financial information. This request to withhold information from public disclosure is driven by one or more of the following:

(a) The information requested to be withheld reveals distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by NuScale competitors, without a license from NuScale, would constitute a competitive economic disadvantage to NuScale.

(b) The information requested to be withheld consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), and the application of the data secures a competitive economic advantage, as described more fully in paragraph 3 of this Affidavit.

(c) Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(d) The information requested to be withheld reveals cost or price information, production capabilities, budget levels, or commercial strategies of NuScale.

(e) The information requested to be withheld consists of patentable ideas.

(3) Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying topical report supplemental reveals distinguishing aspects about the method by which NuScale develops its Fuel and Structural Response Methodologies.

NuScale has performed significant research and evaluation to develop a basis for this method and has invested significant resources, including the expenditure of a considerable sum of money.

The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale.

If the information were disclosed to the public, NuScale's competitors would have access to the information without purchasing the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, and would deprive NuScale of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

(4) The information sought to be withheld is in the enclosed topical report supplemental entitled "NuScale Power, LLC Submittal of Supplemental Topical Report 'Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1 and Supplement 1 to TR-0716-50351-P-A, Revision 1,' TR-108553, Revision 0." The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.

(5) The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).

(6) Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld:

(a) The information sought to be withheld is owned and has been held in confidence by NuScale.

(b) The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.

(c) The information is being transmitted to and received by the NRC in confidence.

(d) No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.

(e) Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would be difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 30, 2021

Mark W. Shaver

Mark W. Shaver

Enclosure 4:

Affidavit of Morris Byram

A F F I D A V I T

1. My name is Morris Byram. I am Product Manager, Licensing & Regulatory Affairs for Framatome Inc. (Framatome) and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in the Document TR-108553-P, Rev. 0, entitled "Framatome Fuel and Structural Response Methodologies Applicability to NuScale: Supplement 1 to TR-0116-20825-P-A, Revision 1, and Supplement 1 to TR-0716-50351-P-A, Revision 1" and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by Framatome to determine whether information should be classified as proprietary:

(a) The information reveals details of Framatome's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome in product optimization or marketability.

(e) The information is vital to a competitive advantage held by Framatome, would be helpful to competitors to Framatome, and would likely cause substantial harm to the competitive position of Framatome.

The information in this Document is considered proprietary for the reasons set forth in paragraphs 6(b), and 6(d) above.

7. In accordance with Framatome's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside Framatome only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: (11/24/2021)

BYRAM Morris Digitally signed by BYRAM Morris
Date: 2021.11.24 10:56:43 -08'00'

(NAME)

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