NuScale Power™

LO-1217-57518

December 08, 2017

Docket No. PROJ0769

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Submittal of Changes to Rod Ejection Accident Methodology Topical Report, TR-0716-50350

REFERENCES: 1. Letter from NuScale Power, LLC to U.S. Nuclear Regulatory Commission, "NuScale Power, LLC Submittal of Topical Report "Critical Heat Flux Correlations", TR-0116-21012, Revision 1", dated November 2017 (ML17335A089)

2. NuScale Topical Report, "Rod Ejection Accident Methodology," TR-0716-50350, Revision 0, dated December 2016 (ML16365A242)

In Reference 1, NuScale Power, LLC submitted a change to the Critical Heat Flux (CHF) Correlations topical report to incorporate a new CHF correlation, NSP4. This submittal provides conforming changes to the Rod Ejection Accident Methodology topical report (Reference 2). The Enclosure to this letter provides a mark-up of the topical report pages incorporating revisions in redline/strikeout format. NuScale will include these changes as part of a future revision to the NuScale Rod Ejection Accident Methodology topical report.

Enclosure 1 is the proprietary version of the Rod Ejection Accident Methodology topical report mark-ups. 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) supports this request. Enclosure 2 is the nonproprietary version of the Rod Ejection Accident Methodology topical report markups.

The proprietary enclosure has been deemed to contain Export Controlled Information. This information must be protected from disclosure per the requirements of 10 CFR § 810.

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

Please feel free to contact Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com if you have any questions.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Rani Franovich, NRC, OWFN-8G9A

Enclosure 1: “Rod Ejection Accident Methodology,” TR-0716-50350, Revision 0, proprietary version
Enclosure 2: “Rod Ejection Accident Methodology,” TR-0716-50350, Revision 0, non-proprietary version
Enclosure 3: Affidavit of Zackary W. Rad, AF-1217-57519

Enclosure 1:

"Rod Ejection Accident Methodology," TR-0716-50350, Revision 0, proprietary version

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, Oregon 97330 Office 541.360-0500 Fax 541.207.3928
www.nuscalepower.com

Enclosure 2:

"Rod Ejection Accident Methodology," TR-0716-50350, Revision 0, non-proprietary version

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, Oregon 97330 Office 541.360-0500 Fax 541.207.3928
www.nuscalepower.com

6.0 Sample Rod Ejection Accident Analysis and Sensitivity Results for the NuScale Design

For each power level and time in life, two sample REA calculations were performed. The first case analyzed an ejection of the CRA of the inner regulating group, CRA 1 in Figure 5-1. The second case analyzed an ejection of a CRA in the outer regulating group, CRA 5 in Figure 5-1. Because these two cases can vary significantly in terms of the ejected CRA worth and ensuing power response, Table 6-2 and Table 6-3 provide only the most limiting of the respective results from both calculation cases.

6.1 Rod Ejection Accident Sample Analysis System Pressure Response Results

The nominal conditions for each of the power levels evaluated for the REA is given in the Table 6-1 below.

Table 6-1 Conditions analyzed for sample calculations

Power Level (%)	0	10	25	45	50	55	60	70	80	100
Time in life	BOC, EOC	EOC	EOC	EOC	BOC, MOC, EOC	EOC	EOC	BOC, MOC, EOC	BOC, EOC	BOC, EOC
PDIL outer group (steps withdrawn)	140	140	140	140	140	140	140	140	140	170
PDIL inner group (steps withdrawn)	125	125	125	125	125	125	125	125	140	170
Core average temperature (°F)	{{									543.3
System flow (kg/s)									}}$^{2(a),(c),ECI}$	587.0

6.2 Rod Ejection Accident Sample Analysis Fuel Response Results

The results of the REA sample evaluation are given below in Table 6-2 and Table 6-3. The SIMULATE-3K code produced the ejected rod worth, β_{eff}, MTC, and FTC values. Each of these values is biased to a conservative value based on the method discussion in Section 5. The peak power and transient F_Q and $F_{\Delta H}$ are outputs of the SIMULATE-3K calculation. The maximum enthalpy rise (Δcal/g) in the hot node, the maximum total enthalpy (cal/gm) in the hot node and the maximum fuel centerline temperature are calculated using the conservative adiabatic fuel heat-up model.

The MCHFR results were first screened using the NRELAP5 code, and those that were most likely to be the limiting conditions using the VIPRE-01 subchannel code were evaluated. Both the NRELAP5 MCHFR and VIPRE-01 MCHFR results are presented. The VIPRE-01 CHF analytical limit, using the NSP2 correlation, is 1.262 and the VIPRE-01 CHF analytical limit, using the NSP4 correlation is 1.284 (Reference 8.2.11). Criteria Limits for the Table 6-2 and 6-3 results are included in Table 7-1.

© Copyright ~~2016~~ 2017 by NuScale Power, LLC

6.4.2.7 Reactor Coolant System Pressure

The effect of pressure on CHF involves the physical properties of the water coolant and the inlet subcooling effect. If subcooling is removed as a contributing factor (i.e. inlet subcooling is held constant with varying pressure) then changes in water properties with varying pressure lead to a negative trend of CHF versus pressure. The latent heat of vaporization of water has a negative trend with pressure, which is the primary driver of the negative trend in CHF versus pressure, because liquid-to-vapor phase conversion requires more enthalpy as pressure decreases. The specific vapor volume has an exponential relationship with pressure that is relatively flat above 3.0 to 4.0 MPa, but increases rapidly below this point. This increase in vapor volume at low pressures leads to increased vapor crowding on the surface of the heated rods and a subsequent decrease in heat transfer capability, resulting in lower CHF. These two competing effects are responsible for the change from a negative trend in CHF versus pressure to a positive one below 3.0 to 4.0 MPa. This trend is demonstrated by numerous CHF tests of various designs at multiple testing facilities.

When the subcooling effect is included, which is more appropriate for non-LOCA transient event calculations with VIPRE-01, the trends discussed above do not necessarily hold true. In traditional PWRs, pressure uncertainties are negatively applied (i.e. uncertainty is subtracted from best estimate value). This practice is based on the sensitivity of CHF to pressure seen historically in PWRs. The NPM operates in a different manner than traditional PWRs in that it does not rely on forced circulation via reactor coolant pumps to cool the core, but instead relies upon natural circulation. Relying on natural circulation results in a much lower mass flux (coolant flow) than is experienced in traditional PWR designs. The subcooling effect is influenced greatly by coolant flow in a reactor for a given amount of power. As mass flux increases the subcooling effect grows stronger due to decreasing enthalpy rise, leading to decreasing thermodynamic quality values and higher CHF. At high flows the subcooling effect is dominant and allows for a greater power capacity as pressure increases. {{

}}2(a),(c)

© Copyright ~~2016~~ 2017 by NuScale Power, LLC

8.0 References

8.1 Source Documents

8.1.1 American Society of Mechanical Engineers, *Quality Assurance Program Requirements for Nuclear Facility Applications*, ASMENQA-1-2008, ASME NQA-1a-2009 Addenda, as endorsed by Regulatory Guide 1.28, Revision 4.

8.1.2 *U.S. Code of Federal Regulations,* "Domestic Licensing of Production and Utilization Facilities," Part 50, Title 10, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," (10 CFR 50 Appendix B).

8.1.3 NuScale Topical Report, "NuScale Topical Report: Quality Assurance Program Description for the NuScale Power Plant," NP-TR-1010-859-NP-A, Revision 3.

8.2 Referenced Documents

8.2.1 *U.S. Code of Federal Regulations,* Part 50, Title 10, "Domestic Licensing of Production and Utilization Facilities" (10 CFR 50).

8.2.2 U.S. Atomic Energy Commission, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors," Regulatory Guide (RG) 1.77, May 1974.

8.2.3 U.S. Nuclear Regulatory Commission, Standard Review Plan, "Fuel System Design," NUREG-0800, Section 4.2, Rev. 3, March 2007.

8.2.4 U.S. Nuclear Regulatory Commission, Standard Review Plan, "Spectrum of Rod Ejection Accidents (PWR)," NUREG-0800, Section 15.4.8, Rev. 3, March 2007.

8.2.5 Letter from Paul M. Clifford to Timothy J. McGinty, "Technical and Regulatory Basis for the Reactivity-Initiated Accident Acceptance Criteria and Guidance, Revision 1," March 16, 2015.

8.2.6 NuScale Topical Report, "NuScale Power Critical Heat Flux Correlations~~ NSP2~~," TR-0116-21012, Revision ~~0~~1, dated ~~September~~ November ~~2016~~2017.

8.2.7 NuScale Topical Report, "Nuclear Analysis Codes and Methods Qualification," TR-0616-48793, Revision 0, dated August 2016.

8.2.8 NuScale Topical Report, "Applicability of AREVA Fuel Methodology for the NuScale Design," TR-0116-20825, Revision 1, dated June 2016.

© Copyright ~~2016~~ 2017 by NuScale Power, LLC

Enclosure 3:

Affidavit of Zackary W. Rad, AF-1217-57519

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, Oregon 97330 Office 541.360-0500 Fax 541.207.3928
www.nuscalepower.com

NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

(1) I am the Directof 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 report reveals distinguishing aspects about the process by which NuScale develops its rod ejection accident analysis methodology.

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 enclosure entitled Changes to "Rod Ejection Accident Methodology" Topical Report. 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 December 08, 2017.

Zackary W. Rad