NuScale Power

LO-0118-58107

January 18, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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**SUBJECT:** NuScale Power, LLC Submittal of Changes to Part 2, Tier 2, Section 3.1 and Part 7, Section 15

**REFERENCES:** Letter from NuScale Power, LLC to Nuclear Regulatory Commission, “NuScale Power, LLC Submittal of the NuScale Plant Design Certification Application,” dated December 31, 2016 (ML17013A229)

During a December 14, 2017 public teleconference with Bruce Bavol, Rebecca Karas, Jeffrey Schmidt, and Timothy Drzewiecki of the NRC staff, NuScale Power, LLC (NuScale) discussed potential updates Part 2, Tier 2, Section 3.1 and Part 7, Section 15 of the referenced Design Certification Application (DCA). As a result of this discussion, NuScale changed Part 2, Tier 2, Section 3.1 and Part 7, Section 15 of the DCA. The Enclosure to this letter provides a markup incorporating revisions in redline/strikeout format. NuScale will include these changes as part of a future revision to the NuScale DCA.

This letter and the enclosed revisions make no new regulatory commitments and no 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,

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Enclosure: Changes to Part 2, Tier 2, Section 3.1 and Part 7, Section 15 of the Design Certification Application

**Enclosure:**

Changes to Part 2, Tier 2, Section 3.1 and Part 7, Section 15 of the Design Certification Application

**Relevant FSAR Chapters and Sections**

For further discussion, see the following chapter and sections:

| | |
|---|---|
| Section 3.9.4 | Control Rod Drive System |
| Section 4.3 | Nuclear Design |
| Section 4.6 | Functional Design of Control Rod Drive System |
| Section 9.3 | Process Auxiliaries |
| Chapter 15 | Transient and Accident Analyses |

### 3.1.3.8 Criterion 27-Combined Reactivity Control Systems Capability

The reactivity control systems shall be designed to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.

**Implementation in the NuScale Power Plant Design**

GDC 27 is not applicable to the NuScale design. The following PDC has been adopted:

> The reactivity control systems shall be designed to have a combined capability of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.
>
> Following a postulated accident, the control rods shall be capable of holding the reactor core subcritical under cold conditions, without margin for stuck rods, provided the ~~probability for a return to power assuming a stuck rod is sufficiently small and~~ specified acceptable fuel design limits for critical heat flux would not be exceeded by the return to power.

The CVCS, with boron addition, and CRDS are designed for a combined capability of controlling reactivity changes that assures the capability to cool the core under postulated accident conditions with margin for stuck rods as explained in Section 4.3.1.5. Conservative analysis indicates that a return to power could occur following a reactor trip under the condition that the highest worth CRA does not insert, coincident with the CVCS being unavailable. Consequently, the GDC is modified for the NuScale design to address the shutdown capability for postulated accidents.

**Conformance or Exception**

The NuScale Power Plant design departs from GDC 27 and supports an exemption from the criterion. The NuScale Power Plant design conforms to PDC 27.

# 15. 10 CFR 50, Appendix A, Criterion 27, Combined Reactivity Control Systems Capability

## 15.1 Introduction and Request

### 15.1.1 Summary

NuScale Power, LLC, (NuScale) requests an exemption from General Design Criterion (GDC) 27 to depart from its historical implementation as a requirement to achieve and maintain subcriticality following a postulated accident, using only safety-related equipment and with margin for stuck rods. Under postulated accident conditions, the NuScale Power Plant design protects public health and safety by reliably controlling reactivity using control rods to assure, with an assumed worst rod stuck out (WRSO), reactor core cooling is maintained. The NuScale Power Plant also relies on insertion of control rods to achieve and maintain reactor subcriticality to assure a safe, stable shutdown condition in the long term following a postulated accident. However, under the conditions that (1) the highest worth control rod assembly is assumed to not insert, (2) the chemical and volume control system (CVCS) is unavailable, and (3) during a small window of operational conditions when boron concentration is low and decay heat is low, a return to low power could occur following an initial period of subcriticality. During such a return to power, core cooling is maintained because the resultant power level is limited and the associated heat generated is within the capacity of the passive heat removal systems. Accordingly, the post-accident shutdown function is of reduced safety significance in the NuScale design.

Therefore, NuScale requests an exemption from GDC 27 to implement a design-specific Principal Design Criterion (PDC) 27. NuScale's reactivity control design basis complies with the express requirements and original intent of GDC 27; however, this exemption request and PDC 27 respond to the shutdown requirement of GDC 27 derived from its historical implementation. NuScale's PDC 27 maintains the existing protection function capability of GDC 27, while clarifying that the shutdown function can be met with all control rods inserted, ~~provided the return to power assuming a stuck rod is sufficiently unlikely and that~~provided the specified acceptable fuel design limits (SAFDLs) for critical heat flux (CHF) would not be exceeded even if ~~it~~a return to power with an assumed stuck rod occurred. As a result of this exemption, the NuScale Power Plant design conforms to a principal design criterion for sufficient post-accident shutdown capability and reliability, rather than of GDC 27 as historically implemented.

### 15.1.2 Regulatory Requirements

10 CFR 52.47(a) states, in part:

> The [design certification] application must contain a final safety analysis report (FSAR) that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the structures, systems, and components and of the facility

for stuck rods. This provision mirrors GDC 27, except that the phrase "in conjunction with poison addition by the emergency core cooling system" has been deleted. The NuScale emergency core cooling system (ECCS) does not add poison. While GDC 27 does not require ECCS poison addition, this change within PDC 27 is made for clarity. NuScale implements the first paragraph of PDC 27 by demonstrating the capability of the reactivity control systems to perform their protection function; that is, to ensure that the capability to cool the core is maintained under accident condition, without regard to subcriticality.

The second paragraph of NuScale PDC 27 requires the control rods to have the capability of holding the reactor core subcritical under cold conditions, following a postulated accident. An equivalent provision is not explicit in GDC 27; rather, the additional provision states and modifies the implied requirement, derived from historical implementation of GDC 27, for the reactivity control systems to perform a shutdown function following a postulated accident. This provision does not require margin for stuck rod if certain conditions on ~~reliability and radiological~~ safety are met, as explained below.

~~The shutdown provision of NuScale PDC 27 requires that, in order to demonstrate shutdown capability with all control rods inserted, the probability for a return to power (assuming a stuck rod) must be sufficiently small. Consistent with the GDC framework, the PDC does not explicitly define a required probability. A probability for return to power, assuming a stuck rod, of less than 1E-4 per reactor year is sufficiently small to meet this criterion. This probability aligns with the NRC's core damage frequency (CDF) goal as a measure of acceptable risk, although the return to power does not result in core damage and thus is not a risk to public health. Section 15.2.1, below, discusses additional precedent relevant to the conclusion that a probability of return to power of less than 1E-4 per reactor year is sufficiently small.~~

The shutdown provision of NuScale PDC 27 ~~further~~ requires that, in order to demonstrate shutdown capability with all control rods inserted, a return to power (assuming a stuck rod) must not cause exceedance of the specified acceptable fuel design limits (SAFDLs) for critical heat flux (CHF). Meeting the specified acceptable fuel design limit (SAFDL) for minimum critical heat flux ratio (MCHFR) ensures adequate heat transfer from the fuel cladding to the reactor coolant and is a key parameter that is used to ensure that the fuel is protected in the NuScale design. MCHFR is the primary SAFDL used as the fuel-related acceptance criteria for Chapter 15 analyses. The other fuel-related SAFDLs used in Chapter 15, such as Fuel Centerline Melt and Fuel Enthalpy, are used primarily for LOCA and Rod Ejection. Using the MCHFR SAFDL is appropriate for overcooling return to power scenarios because it ensures no additional fuel failures following a postulated accident, and thereby prevents further radiological release. These return to power scenarios are limited to very low power levels where fuel centerline melt and fuel enthalpy are not limiting. Other fuel-related SAFDLs such as cladding strain or fuel rod internal pressure are analyzed throughout the operating cycle for normal operation and abnormal operating occurrences, but are not analyzed for infrequent events or accidents, and are not analyzed in Chapter 15.

NuScale PDC 27 is not intended to expand the applicability of GDC 27 beyond its current scope, but only to clarify the shutdown criterion for design basis events within the scope of GDC 27. Shutdown capability after reactivity accidents, specifically rod ejection, is not addressed by GDC 27 or GDC 28. Rather than addressing reactivity insertion for reactivity control or shutdown, GDC 28 is intended to restrict the amount of positive reactivity that can be inserted from reactivity accidents, including rod ejection, and thus limit the

systems as a benefit to the public health and safety. NuScale's shutdown function is highly reliable, as demonstrated by the probability of a return to power. More importantly, a return to power would not result in fuel damage, and thus this exemption would not result in an increase in CDF or risk. Therefore, there is no identified decrease in safety as a result of this exemption.

## 15.4 Conclusion

On the basis of the information presented, NuScale requests that the NRC grant an exemption for the NuScale design certification to allow the design to address a principal design criterion that differs from GDC 27. PDC 27 maintains the existing protection function capability of GDC 27, while clarifying that the shutdown function can be met with all control rods in, provided the ~~return to power assuming a stuck rod is sufficiently unlikely and that specified acceptable fuel design limits~~SAFDLs for CHF would not be exceeded even if a return to power occurred.