POLICY ISSUE
(Information)

June 26, 2019 SECY-19-0066

FOR: The Commissioners

FROM: Margaret M. Doane
Executive Director for Operations

SUBJECT: STAFF REVIEW OF NUSCALE POWER'S MITIGATION STRATEGY FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS

PURPOSE:

The purpose of this paper is to inform the Commission about the U.S. Nuclear Regulatory Commission (NRC) staff's (staff) plan for completing the evaluation of the mitigation strategies proposed in NuScale Power LLC's (NuScale's) design certification application (DCA) in anticipation of certain requirements being codified in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.155, "Mitigation of beyond-design-basis events." This paper does not address any new commitments or resource implications.

SUMMARY:

The NuScale design incorporates several innovative design features that provide enhanced capabilities for mitigating an extended loss of electrical power compared to currently operating nuclear reactor plants. These features include the use of passive safety systems capable of maintaining core cooling, containment, and spent fuel cooling functions and a large reactor pool, which serves as the ultimate heat sink (UHS) for the facility. These features are intended to enable the NuScale design to mitigate beyond-design-basis external events using only installed plant equipment for an extended duration (greater than or equal to 72 hours) without the need for alternating current (ac) power. Although the recently approved regulation governing mitigation of beyond-design-basis events (10 CFR 50.155) does not apply to applicants for design certification, NuScale is voluntarily seeking the NRC's approval of its proposal to use installed design features for mitigation of beyond-design-basis external events.

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If the NRC approves NuScale mitigation strategies as described in this paper in a design certification rulemaking, the rulemaking would finally resolve the issue of whether the installed design features comply with the equipment-related requirements for license applicants prescribed by 10 CFR 50.155(b)(1), (c), and (e), for a duration of at least 72 hours following a beyond-design-basis external event. Such approval would resolve that issue by rule and lend stability to the licensing process because an applicant referencing the NuScale design would not need to include information in its application beyond that which is set forth in the DCA regarding that issue. Accordingly, the staff is sending this paper to inform the Commission about how the staff intends to complete its evaluation of the NuScale design for issues related to adherence to 10 CFR 50.155 and the effect of the finality provisions under Part 52 on the proposed resolutions of those issues.

NuScale's mitigation strategies for an extended loss of ac power differ significantly from the strategies proposed by current licensees and previous applicants. Additionally, the NuScale DCA review raises unique issues with respect to the finality provisions that apply to design certifications under 10 CFR Part 52. Consistent with Staff Requirements Memorandum (SRM)-SECY-15-0065, "Proposed Rulemaking: Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49)," dated August 27, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15239A767), the staff is bringing these issues regarding compliance with the mitigation of beyond-design-basis events rule to the Commission's attention early in the review process.

BACKGROUND:

The following section provides an overview of (1) the NuScale design and approach to mitigation strategies, (2) the regulatory framework for mitigation strategies for beyond-design-basis events, (3) the regulatory framework for finality in design certification, and (4) the mitigation strategies review approach for a previous design certification applicant.

Overview of the NuScale Design and Approach to Mitigation Strategies

In December 2016, NuScale submitted an application to the NRC to certify its small modular reactor design under Part 52. The NuScale design is made up of 12 integral pressurized-water reactor modules. Each reactor operates via natural circulation, and each module includes a reactor vessel that is enclosed by a cylindrical steel containment. Each containment is partially submerged in water in the reactor building safety-related pool, which also acts as the UHS for the module.

The NuScale strategy for mitigation of beyond-design-basis external events, as described in its design certification application, relies primarily upon installed plant equipment. Specifically, during a loss of all ac power, the reactor is automatically tripped with all control rods fully inserted upon receipt of a module protection system (MPS) actuation signal. After containment isolation valves are automatically closed, reactor core cooling is maintained by the automatic opening of the decay heat removal system (DHRS) actuation valves. For approximately 24 hours, reactor core decay heat is removed by natural circulation through the steam generator and DHRS condenser to the reactor pool, which serves as the UHS. The DHRS cooling mode passively provides decay heat removal and results in a continuing decrease in reactor coolant system (RCS) pressure and temperature. At approximately 24 hours after the event, the MPS timer automatically actuates the emergency core cooling system (ECCS) by removing direct current (dc) electrical power from the ECCS trip valves, which causes the ECCS reactor vent

valves and reactor recirculation valves to open.[1] As a result, reactor pressure vessel (RPV) pressure rapidly decreases as the containment pressure increases until equilibrium is reached. ECCS becomes the primary method of long-term passive decay heat removal from the RPV to the containment where heat is transferred through the containment wall to the UHS.

NuScale relies on permanently installed structures, systems, and components (SSCs) (DHRS and ECCS) for core cooling during both design basis and beyond-design-basis events. NuScale used realistic initial and boundary conditions to calculate thermal-hydraulic response under postulated beyond-design-basis conditions. Additionally, NuScale submitted to the NRC a letter dated March 28, 2019 (ADAMS Accession No. ML19088A210), in which NuScale indicates (page 4, first full paragraph) that it also analyzes the performance of those SSCs in its long-term cooling analysis in Final Safety Analysis Report (FSAR) Chapter 15 for the initial 72 hours following a design basis event.[2] The strategies to achieve key safety functions required by § 50.155 do not rely on any ac or dc power source.

As a design certification applicant, as described below, NuScale is not required to address the requirements under § 50.155. Nonetheless, NuScale voluntarily seeks NRC approval of its mitigation strategy.

Regulatory Framework for Mitigation Strategies for Beyond-Design-Basis Events

On January 24, 2019, the Commission issued SRM-M190124A: Affirmation Session-SECY-16-0142: Final Rule: Mitigation of Beyond-Design-Basis-Events, with enclosures (ADAMS Accession No. ML19023A038). In SRM-M190124A, the Commission approved a final rule to be codified in the *Code of Federal Regulations* as 10 CFR 50.155 to establish regulatory requirements for nuclear power reactor applicants and licensees to provide strategies to mitigate beyond-design-basis events. SRM-M190124A, Enclosure 1, Changes to Federal Register Notice (unpublished Mitigation Strategies Rule Statements of Consideration (SOC)) (ADAMS Accession No. ML19023A040), describes the Commission's response to the March 11, 2011, Great Tōhoku earthquake and tsunami that disabled the majority of the external and internal electrical power systems at the Fukushima Dai-ichi nuclear power plant in Japan, including the issuance of two orders applicable to Pressurized-water reactors. The first order, Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Order EA-12-049 or Mitigation Strategies Order) (ADAMS Accession No. ML12054A736), required licensees to implement strategies and guidelines to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities, among other things, without reliance on permanently installed ac electrical power sources, including offsite circuits, for an indefinite period of time. The second order, Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool [SFP] Instrumentation" (Order EA-12-051 or SFPI Order) (ADAMS Accession No. ML12056A044), required all U.S. nuclear power plant licensees to have a reliable indication of the water level in the SFPs at their facilities. Since Orders EA-12-049 and EA-12-051 were addressed to all power reactors and holders of construction permits in active or deferred status as of March 12, 2012, neither order applies to the NuScale DCA.

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[1] The NuScale mitigation strategies described in its analysis and in this paper assume, consistent with NRC guidance, continuity of the dc power system. However, in its March 28 letter (ADAMS Accession No. ML19088A210), NuScale indicates if dc power is lost the ECCS valves automatically open to remove decay heat. The staff notes that this transition occurs only once DHRS reduces RCS pressure below the inadvertent actuation block valve setpoint.

[2] The staff's review of the FSAR Chapter 15 thermal hydraulic analysis is ongoing.

The rule makes Order EA-12-049 and Order EA-12-051 generically applicable. Specifically, § 50.155(b)(1) of the rule requires each applicant for a combined license (COL) to: (1) develop mitigation strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities, and (2) acquire and use offsite assistance and resources to support the functions identified in item (1) indefinitely, or until sufficient site functional capabilities can be maintained without the need for the mitigation strategies.[3] Although § 50.155(b)(1) does not specify any particular equipment to accomplish the functions identified in § 50.155(b)(1)(i), § 50.155(c) requires that any equipment upon which a licensee relies in its strategies must have sufficient capacity and capability to perform the required functions. In addition, § 50.155(e) requires reliable means for remote spent fuel pool level monitoring. The full text of these provisions is available in Enclosure 1 to this paper.

The Commission did not set a separate standard for mitigation strategies for new reactor designs, and, therefore, the performance-based approach of 10 CFR 50.155 applies to new designs as well as to the existing operating fleet. However, as acknowledged in the unpublished Mitigation Strategies Rule SOC, new reactor licensees may establish approaches for developing mitigation strategies that differ from those developed by licensees of operating reactors to mitigate beyond-design-basis events. For example, new reactor licensees may use installed plant equipment for both the initial and long-term response to a loss of all ac power and need not rely on portable equipment and offsite resources to the same extent as licensees of currently operating nuclear power plants. The NRC would consider the specific plant approach to mitigation strategies for beyond-design-basis events on a case-by-case basis.

New § 50.155 will apply to power reactor licensees and power reactor license applicants but is not yet in effect. The rule will become effective 30 days after the date of publication in the *Federal Register*, which the staff expects to occur in the summer of 2019. When the rule becomes effective, a new section in the rule, 10 CFR 52.80(d), will require an applicant for a COL under Part 52 to describe in its application how the application satisfies the rule. The rule does not apply to applicants for design certification.

Regulatory Framework for Finality in Design Certification

The requirements for mitigation strategies under § 50.155 include functions that can be performed by installed SSCs and may therefore be addressed by the facility design. Other requirements, however, address matters that are solely operational. In the case of NuScale, the design aspects of the mitigation strategies that can be reviewed during the design certification stage include the functional capabilities of the passive decay heat removal and emergency core cooling systems. Operational aspects of the new rule include the development and implementation of procedures and training to support the use of plant design features, and other matters such as emergency planning required under new provisions of 10 CFR Part 50, Appendix E. Under the 10 CFR Part 52 design certification process, the design of the standard plant will be finally resolved, but operational matters are not final, as discussed below.

The NRC provides for standard power reactor design certification through rulemaking in 10 CFR Part 52, Subpart B. Reactor design certification rules that the NRC has codified under the Subpart B process appear as appendices to Part 52. Section 52.47(a) requires that an application for certification of a standard power reactor design include an FSAR that describes the facility, presents the design bases and limits on operation, and presents a safety analysis of

[3] Section 50.155(b)(2) includes the requirements of what will be former 10 CFR 50.54(hh)(2). The staff does not currently foresee any issues in regard to NuScale's proposals with respect to § 50.155(b)(2).

the SSCs of the facility as a whole. NuScale describes its proposed mitigation strategy in FSAR Chapter 20, "Mitigation of Beyond-Design-Basis Events." Under 10 CFR 52.63, an NRC determination in a design certification rulemaking that an SSC is adequate to perform a safety function assigned to it in the FSAR finally resolves all issues with respect to the SSC's adequacy to perform that safety function. Section VI of each design certification rule found in the appendices to 10 CFR Part 52 describes the nature and scope of issue resolution the Commission affords to a certified design. Specifically, Section VI, as it appears in every rule certifying a standard design, states that "[a] conclusion that a matter is resolved includes the finding that additional or alternative [SSCs], design features, design criteria, testing, analyses, acceptance criteria, or justifications are not required for the [certified design]." For example, *see* 10 CFR Part 52, Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor [ABWR]," § VI.A.1.[4]

The design certification process resolves design issues early and thereby lends stability to the licensing process. However, design certification does not resolve operational issues. Specifically, § VI.C of each previous design certification rule states:

> The Commission does not consider operational requirements for an applicant or licensee who references this appendix to be matters resolved within the meaning of 10 CFR 52.63(a)(5). The Commission reserves the right to require operational requirements for an applicant or licensee who references this appendix rule, regulation, order, or license condition.

Many operational requirements, including those required for compliance with 10 CFR 50.155, do not affect any design feature or SSC within the scope of a proposed standard design. The NRC does not review or approve such operational requirements in the context of the design certification application, and they are not subject to the finality provisions of Part 52.[5]

The Commission's approach to design certification described above relates to the review of mitigation strategies described in a DCA as follows: To the extent a design certification applicant relies on facility SSCs to accomplish the safety functions required by § 50.155(b)(1), these are simply additional safety functions assigned to the SSCs, as analyzed in the FSAR. Accordingly, the design certification can provide for finality under § 52.63 and § VI of the design certification rule for the adequacy of the SSCs to perform their mitigation strategies functions, as analyzed in the FSAR. The staff notes that the FSAR analysis of these SSCs for mitigation strategies purposes need not include the conservatisms necessary for design-basis analyses. Rather, the FSAR may use best-estimate analyses for evaluating SSC performance of functions to mitigate beyond-design-basis events.

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[4] Although the design certification rule for NuScale has not been developed, the staff anticipates that the NuScale certification rule will include similar provisions.

[5] In the context of design certification, the NRC reviews certain operational requirements that are necessary to determine the adequacy of SSC design, such as the Technical Specifications (TS) and ASME Code Inservice Inspection and Inservice Testing requirements. Design certification rules in § VIII.C of each Part 52 appendix control changes to operational requirements included in the design certification application that the NRC completely reviewed and approved in the design certification rulemaking. While the design certification rules do not afford finality under § 52.63 to these NRC-reviewed and approved operational requirements, including TS, generic changes to such operational requirements are subject to 10 CFR 50.109, and plant-specific changes are subject to 10 CFR 2.335. The Statements of Consideration for the final ABWR design certification rule set forth the reasons for this long-standing Commission approach to operational requirements in design certification rules. *See* "Standard Design Certification for the U.S. [ABWR] Design," Final Rule, 62 FR 25,800, 25,805-06 (May 12, 1997).

The staff, however, would not normally consider operational matters required by § 50.155 in a design certification review, except to the extent they relate to the adequacy of permanently installed SSCs relied upon to perform mitigation strategies functions. Such operational matters heavily depend on site-specific conditions. These operational requirements include those for training (§ 50.155(d)), emergency planning (10 CFR Part 50, Appendix E, §§ IV.*F*.2.j and VI.3.c), and development of procedures, acquisition and use of offsite assistance and resources (§ 50.155(b)(1)(ii)). Section 52.63 and § VI finality would not govern operational requirements material to the adequacy of permanently installed SSCs relied on to perform § 50.155 functions, and a COL applicant would ultimately need to address these operational requirements.

Mitigation Strategies Review Approach for a Previous Design Certification Applicant: US APR1400

Although Order EA-12-049 and Order EA-12-051 do not impose requirements on any applicant for certification of a standard design, one applicant for design certification, Korea Hydro and Nuclear Power (KHNP), submitted mitigation strategies for the KHNP APR1400 standard design in the APR1400 Design Control Document, Tier 2, Section 19.3 (ADAMS Accession No. ML12054A735). Specifically, the APR1400 FSAR, § 19.3.2.3, and KHNP's Technical Report APR1400-E-P-NR-14005-P, "Evaluations and Design Enhancements to Incorporate Lessons Learned from Fukushima Dai-Ichi Nuclear Accident," Revision 1, dated March 2017 ADAMS Accession No. ML18044B041), describes the APR1400 mitigation strategies. Because the APR1400 design uses active safety systems, it relies on ac power as current operating reactors do, and accordingly, the APR1400 mitigation strategy is similar to the mitigation strategies used for the current operating fleet. To evaluate these strategies, the NRC staff generally used the interim staff guidance in JLD-ISG-2012-01, Rev. 0, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12229A174), which endorses, with clarifications, the Nuclear Energy Institute (NEI) guidance in NEI 12-06, Rev. 0, "Diverse and Flexible Coping Strategies Implementation Guide" (ADAMS Accession No. ML12242A378). KHNP developed both a primary mitigation strategy and contingencies, but a COL applicant referencing the APR1400 standard design would still have to complete the development and implementation of the mitigation strategies, consistent with the staff's endorsement of NEI 12-06. For the KHNP mitigation strategies, the staff found that the KHNP mitigation strategies were capable of achieving and maintaining the key safety functions of core cooling, containment capability, and SFP cooling for 72 hours following a beyond-design-basis external event. *See* APR1400 Final Safety Evaluation Report at 19-240 (ADAMS Accession No. ML18087A364).

The staff evaluated the APR1400 spent fuel pool level instrumentation using JLD-ISG-2012-03, Rev. 0, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation" (Aug. 29, 2012) (ADAMS Accession No. ML12144A323), which endorses NEI 12-02, Revision 1, "Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," (ADAMS Accession No. ML12240A307) with exceptions and clarifications. The staff determined that the KHNP spent fuel pool level instrumentation was designed in accordance with JLD-ISG-2012-3, and is considered reliable, able to withstand beyond-design-basis natural phenomena, and capable of monitoring key spent fuel pool level parameters.

The approach used to review mitigation strategies and SFP instrumentation for the APR1400 design certification is consistent with the regulatory framework for design certification described above. Specifically, the staff approved the SSC design aspects of the mitigation strategies as

described in the APR1400 FSAR, and this approval is final. However, the operational aspects of the mitigation strategies remain to be addressed by a COL applicant referencing the design.

DISCUSSION:

As indicated above, the rule requiring mitigation strategies to be codified in 10 CFR 50.155 does not apply to applicants for design certification. Since mitigation strategies are generally site-specific, the staff would not normally expect to resolve such strategies in a design certification rulemaking. However, to the extent that a design certification applicant chooses to develop mitigation strategies that are generically applicable to its proposed standard design, the applicant may describe the SSCs it proposes to rely on to perform mitigation functions described in the FSAR. The FSAR would also describe SSC capacity and capability required by § 50.155(c)(1) and how the SSCs are protected from the effects of natural phenomena, as required by § 50.155(c)(2). If found acceptable by the staff, the adequacy of the design of permanently installed SSCs, but not necessarily the operational considerations needed to support their indefinite functionality, would be finally determined under the Commission's long-standing approach to finality stated in § VI of each design certification rule, which is described above.

NuScale's Approach to Mitigation Strategies

As described in NuScale's DCA, and further described in its March 28 letter, NuScale expects future licensees to rely only on permanently installed SSCs for both the initial and long-term response to a beyond-design-basis external event. In the March letter, NuScale states that the installed SSC capabilities fully satisfy the equipment-related requirements for licensees prescribed by 10 CFR 50.155(b)(1), (c), and (e). NuScale also states in the March letter that a COL applicant would need to address certain provisions of § 50.155, such as developing the mitigation strategies required by § 50.155(b)(1) to address actions supplementary to the plant's inherent coping response. In addition, a COL applicant would need to address extensive damage guidelines required under § 50.155(b)(2) and the training requirements of § 50.155(d).

In regard to reactor and containment instrumentation, Revision 2 of the NuScale FSAR indicates in Section 20.1.2.2 that instrumentation remains available to verify that natural circulation passive cooling is established following the event.[6] While NuScale reaffirms in the March letter that the design provides this monitoring capability, the NuScale letter states that monitoring capability (e.g., pressure and temperature information) for the NuScale design is not required to maintain safety (i.e., core cooling, containment, or SFP cooling) or to satisfy the mitigation strategies portion of § 50.155. In regard to the safety functions specified in § 50.155(b)(1)(i), the NuScale FSAR indicates that installed plant equipment is sufficient to maintain those functions for more than 72 hours, and immediate action after 72 hours is not necessary. The FSAR also indicates that installed plant equipment has a coping capability greater than 30 days. In addition, the March letter states that maintaining the required safety functions solely with installed plant equipment for a sufficient duration satisfies the requirements of 10 CFR 50.155, without the need for portable or offsite resources.

NuScale, in its March 28 letter, requests that the NRC conclude that the installed SSCs have sufficient capacity and capability to perform core cooling, containment, and SFP cooling

[6] In its March 28, 2019, letter, NuScale stated that FSAR Chapter 20 will be revised to align with the positions described in its March 28, 2019, letter.

functions for a minimum coping duration adequate to allow a licensee to establish an alternate means of removing heat. Specifically, NuScale proposes:

1) a minimum coping duration of 14 days;

2) no need for a licensee to acquire and use offsite resources because the 14-day coping period provides sufficient time for the licensee to establish an alternate means of removing heat, such as obtaining off-site resources on an *ad hoc* basis, through repairs to existing SSCs or commissioning of new SSCs, or reduction of decay heat levels through the passage of time sufficient to allow heat removal through losses to the ambient environment; and

3) no reliance on monitoring for the mitigation strategies.

NuScale indicates, however, that installed instrumentation can provide 72 hours of module and reactor pool monitoring as a supplementary capability. This capability is discussed below.

The NRC Staff's Review of the NuScale Design Certification Mitigation Strategies

Coping Duration Reviewed for Operating Reactors

For the current operating fleet, the staff's reviews have focused on the initial response coping period where the most critical and time-sensitive actions were projected to occur and result in a stable plant condition. For periods of time beyond 72 hours from the initiating event, the staff generally did not expect licensees to have fully developed plans and procedures. This approach reflects a number of considerations including: 1) by 24 hours after a beyond-design-basis external event, site access would likely be restored, 2) by 72 hours after the event, plant conditions would likely be stable and resources would be mobilized, 3) event progression is less predictable the further out in time projections are made, and 4) the capability to connect portable equipment (e.g. portable pumps or generators) and plans for resource replenishment (e.g., fuel oil or water) provide flexibility for a licensee to respond to effects of the event. Thus, by 72 hours after initiation of the event, a licensee's emergency response organization would be engaged in responding to the event, allowing resources and mitigation efforts to be directed to the most critical areas dictated by actual event progression. The guidance in NEI 12-06, Revision 4, Section 3.3, as endorsed by the staff in JLD-ISG-2012-01, Revision 2, reflects this approach.

Adequacy of NuScale SSCs for Coping Duration

For the NuScale DCA, the staff has been reviewing the adequacy of NuScale's proposed approach using permanently installed SSCs for consistency with the functional capabilities required by 10 CFR 50.155 for the first 72 hours following a beyond-design-basis event. Although passive plants may be capable of providing mitigation for a beyond-design-basis external event for greater than 72 hours, performing a detailed review beyond this time period would place unnecessary additional regulatory burden on applicants for certification of passive plant designs that have enhanced loss of electrical power coping capabilities.

The staff acknowledges that the NuScale safety-related reactor pool (i.e., UHS) potentially has the capability to provide passive cooling of 12 NuScale modules for an extended time should a beyond-design-basis external event occur. Analysis of the capability of the UHS assumes that stable plant shutdown conditions will be achieved for each module within 72 hours following the event and that decay heat loads continue to diminish over time. The staff is currently reviewing

the applicant's long-term cooling analysis to evaluate ECCS performance and better understand whether credible transient phenomena exist and could result in increasing heat loads (e.g., return to power[7]) to the safety-related reactor pool. The staff is also considering whether such phenomena may otherwise pose a challenge to core cooling and whether these phenomena may affect long-term core cooling strategies. However, the staff's ability to make a finding beyond 72 hours is limited because both the NuScale design-basis and beyond-design-basis thermal hydraulic calculations do not extend beyond 72 hours after the event. Further, a staff finding on mitigation strategies for the period beyond 72 hours would entail additional analysis by the applicant and staff review, which would be inconsistent with the scope of review performed for operating reactors and other design certifications. Thus, the staff's review of the NuScale design's coping duration will be limited to 72 hours, and a COL applicant referencing the design may need to address the period beyond 72 hours.

Instrumentation

In its March 28, 2019 letter, NuScale states that instrumentation is not relied upon to maintain core cooling, containment, or SFP cooling. The staff notes that 10 CFR 50.155 does not expressly state that reactor and containment instrumentation must be provided to verify that core cooling and containment functions, respectively, are maintained or restored. However, as discussed in the unpublished Mitigation Strategies Rule SOC, mitigation strategies are intended to address uncertainties associated with beyond-design-basis external events, and the requirements as implemented provide a capability that can be used and adapted to any event that exceeds the external design basis of the facility. A fundamental mitigation strategy element for the existing operating plants is the capability to obtain key parameter readings using portable instruments. The staff describes this capability in SECY-16-0142 as an important consideration for providing flexibility and enabling adaption to unknown events. As described in NEI 12-06, Section 5.3.3, this capability could be described in plant procedures/guidelines and thus a COL applicant could consider that provision when addressing instrumentation beyond 72 hours. Although NuScale has indicated that instrumentation powered by station batteries is not relied upon to support core cooling and containment mitigation strategies, the FSAR currently describes instrumentation capabilities and capacities that are adequate to support decision making during event response.

Staff Review Approach

The staff intends to apply the following approach to complete the evaluation of issues associated with the functions of NuScale design features related to certain provisions of § 50.155, "Mitigation of Beyond-Design-Basis Events."

- The staff will verify that the design capacities and capabilities of the permanently installed SSCs in the NuScale design, as described in the FSAR, are capable of providing adequate core cooling, containment, SFP cooling, and SFP level instrumentation consistent with the requirements of 10 CFR 50.155(b)(1), (c) and (e) for 72 hours following a beyond-design-basis external event.

[7] As discussed in SECY-18-0099, "NuScale Power Exemption Request from 10 CFR Part 50, Appendix A, General Design Criterion 27, Combined Reactivity Control Systems Capability," certain conditions can lead to an overcooling return to power for the NuScale design. Additionally, redistribution and precipitation of soluble boron in the reactor coolant system can lead to a longer-term increase in core reactivity.

- Consistent with the review approach applied for operating reactors and the previous APR1400 DCA review, the staff does not plan to review the NuScale design feature capacity and capability beyond 72 hours following a beyond-design-basis external event in its review of the DCA. However, if the staff determines that there are no credible transient phenomena (e.g., return to power) that could challenge core cooling, containment, or SFP cooling beyond 72 hours, then no additional review or approval of these capabilities would be required at the COL stage. If credible transient phenomena could challenge core cooling, containment, or SFP cooling, then the COL applicant would be required to provide mitigation strategies to address these phenomena. Pursuant to 10 CFR 50.155(b)(1) and 52.80(d), a COL applicant referencing the NuScale design will be required to describe mitigation strategies to maintain or restore core cooling, containment, and SFP cooling for an indefinite period, or until sufficient site functional capabilities can be maintained without the need for the mitigation strategies. The level of detail needed in this area would be commensurate with the time available to provide additional capability (i.e., capabilities that are needed a longer time after the event can be described in less detail than those that are needed at an earlier time). For example, the COL applicant will need to identify the source of the site-dependent makeup water and a plan to add that water to the reactor pool.

- 10 CFR 50.155(e) requires SFP level instrumentation and requires power to maintain instrumentation function until offsite resource availability is reasonably assured. The staff is not planning to review the SFP level instrumentation capability beyond 72 hours in its review of the DCA. The COL applicant referencing NuScale design will be required to address SFP level instrumentation in accordance with 10 CFR 52.80(d). NEI 12-02 provides acceptable guidance for satisfying the requirements of 10 CFR 50.155(e).

- In its March 28, 2019, letter NuScale stated that although no instrumentation is within the scope of the equipment relied on for the mitigation strategies and guidelines as addressed by § 50.155(c), the design provides instrumentation capability for at least 72 hours following a beyond-design-basis event using installed instruments and power sources. The staff plans to document in its review of the DCA that instrumentation, excluding SFP level instrumentation, is not relied upon for the mitigation of beyond-design-basis events for core cooling and containment functions for the initial 72 hours. In addition, the staff plans to document that instrumentation is available and provides additional assurance that systems have responded as designed.

CONCLUSION:

The staff developed this paper to inform the Commission of the staff plan for completing its evaluation of the NuScale design for issues related to compliance with § 50.155 and finality under 10 CFR Part 52. Although the rule requiring mitigation strategies to be codified in § 50.155 does not apply to applicants for design certification, NuScale has sought NRC review and approval of certain aspects of its beyond-design-basis event mitigation strategies. To the extent that NuScale describes the design features, capacities, and capabilities of SSCs it proposes to rely on to accomplish the mitigation strategies required by § 50.155, the staff will apply the review approach described in this paper as part of the DCA review.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection.

Margaret M. Doane
Executive Director
for Operations

Enclosure:
Text of 10 C.F.R. § 50.155(b), (c),
and (e) Approved by the Commission

SUBJECT: STAFF REVIEW OF NUSCALE POWER'S MITIGATION STRATEGY FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS; DATED: JUNE 26, 2019

ADAMS Accession No.: ML19148A443 **SECY-012**

OFFICE	NRO/DLSE/LB1	NRO/DSRA/SRSB*	NRR/DLP/PBMB*	OGC
NAME	OTabatabai	RNolan	PBamford	RWeisman (for SVrahoretis)
DATE	5/28/2019	5/29/2019	5/29/2019	6/3/2019
OFFICE	NRR*	NRO	EDO	
NAME	HNieh (BMcDermott for)	FBrown	MDoane	
DATE	6/10/2019	6/4/2019	6/26/19	

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TEXT OF 10 C.F.R. § 50.155(b), (c), and (e) APPROVED BY THE COMMISSION

(b) *Strategies and guidelines.* Each applicant or licensee shall develop, implement, and maintain:

(1) *Mitigation strategies for beyond-design-basis external events.* Strategies and guidelines to mitigate beyond-design-basis external events from natural phenomena that are developed assuming a loss of all ac power concurrent with either a loss of normal access to the ultimate heat sink or, for passive reactor designs, a loss of normal access to the normal heat sink. These strategies and guidelines must be capable of being implemented site-wide and must include the following:

(i) Maintaining or restoring core cooling, containment, and spent fuel pool cooling capabilities; and

(ii) The acquisition and use of offsite assistance and resources to support the functions required by paragraph (b)(1)(i) of this section indefinitely, or until sufficient site functional capabilities can be maintained without the need for the mitigation strategies.

. . . .

(c) *Equipment.* (1) The equipment relied on for the mitigation strategies and guidelines required by paragraph (b)(1) of this section must have sufficient capacity and capability to perform the functions required by paragraph (b)(1) of this section.

(2) The equipment relied on for the mitigation strategies and guidelines required by paragraph (b)(1) of this section must be reasonably protected from the effects of natural phenomena that are equivalent in magnitude to the phenomena assumed for developing the design basis of the facility.

. . . .

(e) *Spent fuel pool monitoring.* In order to support effective prioritization of event mitigation and recovery actions, each licensee shall provide reliable means to remotely monitor wide-range water level for each spent fuel pool at its site until 5 years have elapsed since all of the fuel within that spent fuel pool was last used in a reactor vessel for power generation.

SRM-M190124A, Enclosure 1, Federal Register Notice at 140-41.