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Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of Changes to Final Safety Analysis Report, Chapter 20, “Mitigation of Beyond Design Basis Events”

REFERENCES: Letter from NuScale Power, LLC to Nuclear Regulatory Commission, “NuScale Power, LLC Submittal of the NuScale Standard Plant Design Certification Application, Revision 2,” dated October 30, 2018 (ML18311A006)

During a February 21, 2019 public meeting with the NRC Project Manager and the NRC Staff reviewing Chapter 20, NuScale Power, LLC (NuScale) discussed potential updates to Final Safety Analysis Report (FSAR) Chapter 20, “Mitigation of Beyond Design Basis Events.” NuScale revised Chapter 20 as a result of this discussion. The Enclosure to this letter provides a mark-up of the revised FSAR pages in redline/strikeout format. NuScale will include this change as part of a future revision to the NuScale Design Certification Application.

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

If you have any questions, please feel free to contact Nadja Joergensen at 541-452-7338 or at njoergensen@nuscalepower.com.

Sincerely,

Zackary W. Rad
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Enclosure: Changes to NuScale Final Safety Analysis Report, Chapter 20, “Mitigation of Beyond Design Basis Events”

Enclosure:

Changes to NuScale Final Safety Analysis Report Chapter 20, “Mitigation of Beyond Design Basis Events”

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Table 1.8-2: Combined License Information Items (Continued)

Item No.	Description of COL Information Item	Section
COL Item 18.12-1:	A COL applicant that references the NuScale Power Plant design certification will provide a description of the human performance monitoring program in accordance with applicable NUREG-0711 or equivalent criteria.	18.12
COL Item 19.1-1:	A COL applicant that references the NuScale Power Plant design certification will identify and describe the use of the probabilistic risk assessment in support of licensee programs being implemented during the COL application phase.	19.1
COL Item 19.1-2:	A COL applicant that references the NuScale Power Plant design certification will identify and describe specific risk-informed applications being implemented during the COL application phase.	19.1
COL Item 19.1-3:	A COL applicant that references the NuScale Power Plant design certification will specify and describe the use of the probabilistic risk assessment in support of licensee programs during the construction phase (from issuance of the COL up to initial fuel loading).	19.1
COL Item 19.1-4:	A COL applicant that references the NuScale Power Plant design certification will specify and describe risk-informed applications during the construction phase (from issuance of the COL up to initial fuel loading).	19.1
COL Item 19.1-5:	A COL applicant that references the NuScale Power Plant design certification will specify and describe the use of the probabilistic risk assessment in support of licensee programs during the operational phase (from initial fuel loading through commercial operation).	19.1
COL Item 19.1-6:	A COL applicant that references the NuScale Power Plant design certification will specify and describe risk-informed applications during the operational phase (from initial fuel loading through commercial operation).	19.1
COL Item 19.1-7:	A COL applicant that references the NuScale Power Plant design certification will evaluate site-specific external event hazards (e.g., liquefaction, slope failure), screen those for risk-significance, and evaluate the risk associated with external hazards that are not bounded by the design certification.	19.1
COL Item 19.1-8:	A COL applicant that references the NuScale Power Plant design certification will confirm the validity of the "key assumptions" and data used in the design certification application probabilistic risk assessment (PRA) and modify, as necessary, for applicability to the as-built, as-operated PRA.	19.1
COL Item 19.2-1:	A COL applicant that references the NuScale Power Plant design certification will develop severe accident management guidelines and other administrative controls to define the response to beyond-design-basis events.	19.2
COL Item 19.2-2:	A COL applicant that references the NuScale Power Plant design certification will use the site-specific probabilistic risk assessment to evaluate and identify improvements in the reliability of core and containment heat removal systems as specified by 10 CFR 50.34(f)(1)(i).	19.2
COL Item 19.2-3:	A COL applicant that references the NuScale Power Plant design certification will evaluate severe accident mitigation design alternatives screened as "not required for design certification application."	19.2
COL Item 19.3-1:	A COL applicant that references the NuScale Power Plant design certification will identify site-specific regulatory treatment of nonsafety systems (RTNSS) structures, systems, and components and applicable RTNSS process controls.	19.3
COL Item 20.1-1:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific seismic hazard.~~	20.1
COL Item 20.1-2:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if a flood hazard is applicable at the site location. If a flood hazard is applicable, then the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific flood (including wave action) hazard.~~	20.1

Table 1.8-2: Combined License Information Items (Continued)

Item No.	Description of COL Information Item	Section
COL Item 20.1-3:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if high wind and applicable missile hazards are applicable at the site location. If high wind and applicable missile hazards are applicable, then the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific high wind and applicable missile hazards.~~	20.1
COL Item 20.1-4:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if snow, ice and extreme cold temperature hazards are applicable at the site location. If snow, ice and extreme cold hazards are applicable, the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific snow, ice or extreme cold temperature hazard.~~	20.1
COL Item 20.1-5:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if extreme high temperature hazard is applicable at the site location. If extreme high temperature hazard is applicable, the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific extreme high temperature hazard.~~	20.1
COL Item 20.1-6:	Not used.	20.1
COL Item 20.1-7:	Not used.	20.1
COL Item 20.1-8:	A COL applicant that references the NuScale Power Plant design certification will develop procedures, training, and a qualification program for operations, maintenance, testing, and calibration of ultimate heat sink level instrumentation to ensure the level instruments will be available when needed and personnel are knowledgeable in interpreting the information as addressed in Nuclear Energy Institute (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."	20.1
COL Item 20.2-1:	A COL applicant that references the NuScale Power Plant design certification will develop enhanced firefighting capabilities in accordance with 10 CFR 50.155(b)(2).~~by implementing the guidance in NRC guidance document "Developing Mitigating Strategies/Guidance for Nuclear Power Plants to Respond to Loss of Large Areas of the Plant in Accordance with B.5.b of the February 25, 2002, Order" dated February 25, 2005 (Reference 20.2-3).~~ The enhanced firefighting capabilities should address the expectation elements listed in Section 4.1.3 of the Technical Report TR-0816-50796 (Reference 20.2-1).	20.2
COL Item 20.2-2:	A COL applicant that references the NuScale Power Plant design certification will provide a means for water spray scrubbing using fog nozzles and the availability of water sources, and address runoff water containment issues (sandbags, portable dikes, etc.) as an attenuation measure for mitigating radiation releases outside containment.	20.2
COL Item 20.3-1:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will ensure that the severe accident management guidelines, diverse and flexible coping strategies support guidelines (FSGs), and extensive damage mitigation guidelines are integrated with the emergency operating procedures consistent with Recommendation 8.1 of SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan."~~	20.3
COL Item 20.4-1:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will perform an analysis that demonstrates the emergency response organization staff has the ability to implement the strategies of the emergency operating procedures, severe accident mitigation guidelines, diverse and flexible coping strategies support guidelines (FSGs), and extensive damage mitigation guidelines. The analysis will be performed with the offsite response organization access to onsite being impeded. The event shall be a loss of all onsite and offsite alternating current power and loss of normal access to the ultimate heat sink.~~	20.4
COL Item 20.4-2:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop a supporting emergency response organization structure with defined roles and responsibilities to implement the strategies of the emergency operating procedures, severe accident mitigation guidelines, diverse and flexible coping strategies support guidelines (FSGs), and extensive damage mitigation guidelines.~~	20.4

Table 1.8-2: Combined License Information Items (Continued)

Item No.	Description of COL Information Item	Section
COL Item 20.4-3:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop and describe at least one onsite and one offsite communications system capable of remaining functional during an extended loss of alternating current power including the effects of the loss of the local communications infrastructure.~~	20.4
COL Item 20.4-4:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop, implement, and maintain the training and qualification of personnel that perform activities in accordance with diverse and flexible coping strategies support guidelines (FSGs), severe accident mitigation guidelines, and extensive damage mitigation guidelines. The training and qualification on these activities will be developed using the systems approach to training as defined in 10 CFR 55.4 except for elements already covered under other NRC regulations.~~	20.4
COL Item 20.4-5:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop drills or exercises that demonstrate the ability to transition to one or more of the strategies and guidelines of the emergency operating procedures, diverse and flexible coping strategies support guidelines (FSGs), extensive damage mitigation guidelines, and severe accident mitigation guidelines using only the station communication equipment designed to be available following an extended loss of alternating current including effects of the loss of the local communications infrastructure.~~	20.4
COL Item 20.4-6:	Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop and describe the means to be used for determining the magnitude of, and for continually assessing the impact of, the release of radioactive materials to the environment including releases from reactor core and spent fuel pool sources.~~	20.4

Table 1.9-4: Conformance with Interim Staff Guidance (ISG) (Continued)

ISG Section/ Title	AC	AC Title / Description	Conformance Status	Comments	Section
DC/COL-ISG-14: Assessing Ground Water Flow and Transport of Accidental Radionuclide Releases	All	Area of Review; Review Interfaces; Regulatory Requirements; Onsite Hydrogeological Characterization; Contamination Source and Receptor Location; Groundwater Modeling and Pathway Prediction; and Radioactive Consequence Analysis	Not Applicable	As a supplement to SRP Sections 2.4.12 and 2.4.13, this guidance governs site-specific hydrogeological data, site characteristics, and radiological analysis aspects that are the responsibility of the COL applicant referencing the certified design.	Not Applicable
ESP/DC/COL-ISG-15: Post-Combined License Commitments	No Num (p4-11)	New Section C.III.4.3 to Replace Section C.III.4.3 of RG 1.206	Not Applicable	This guidance is for COL applicants.	Not Applicable
ESP/DC/COL-ISG-15	No Num (p11-23)	Anticipated NRC Revisions of NUREG0800, SRP Chapter 1.0	Partially Conforms	The portions of this guidance that apply to the DCA include discussion concerning COL action items and COL information items and not using the term “COL holder item.” COL action items are identified throughout the FSAR.	Ch 1
DC/COL-ISG-16: Compliance with 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d)	All	-	Not Applicable	Requirements in 10 CFR 50.54(hh)(2) were moved to 10 CFR 50.155(b)(2). 10 CFR 50.54(hh)(2) is not applicable to design certification applicants; however 10 CFR 52.80(d) requires COL applicants to include a description ~~and plans for implementation~~ of the equipment upon which mitigating strategies rely to comply with 10 CFR 50.155(b)(2) ~~guide and strategies intended~~ to maintain or restore core cooling, containment, and SFP cooling capabilities. ~~under the circumstances associated with the LOLA of the plant due to explosions or fire as required by 10 CFR 50.54 (hh)(2).~~	Not Applicable
DC/COL-ISG-17: Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses	All	-	Not Applicable	This ISG is applicable to the review of seismic design information submitted to support combined license (COL) applications.	Not Applicable

CHAPTER 20 MITIGATION OF BEYOND-DESIGN-BASIS EVENTS

The NRC is expected to release the final mitigation of beyond-design-basis events (MBDBE) rule in 2019. The MBDBE rule revises requirements in 10 CFR 50 and 10 CFR 52 to require additional information, and adds new section 10 CFR 50.155 for nuclear power reactor licensees and applicants that addresses mitigation of beyond-design-basis events, including remotely-monitored spent fuel pool level instrumentation. In addition, the new rule moves requirements for licensees to develop and implement guidance and strategies to maintain or restore core cooling, containment, and spent fuel cooling under circumstances associated with loss of large areas (LOLA) of the plant due to fire or explosion from 10 CFR 50.34(hh) to 10 CFR 50.155(b)(2). Although the MBDBE rule will not apply to NuScale as a design certification applicant, certain provisions of the rule will apply to a COL applicant. Chapter 20 describes the response of the NuScale Power Plant and identifies provisions of the MBDBE rule that apply to COL applicants.~~Following the earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant, the NRC established a senior-level task force referred to as the Near-Term Task Force (NTTF). The NTTF conducted a systematic and methodical review of the NRC regulations and processes to determine if the agency should make safety improvements in light of the events in Japan. As a result of this review, the NRC issued SECY-11-0093 (Reference 20.1-1). SECY-11-0124 (Reference 20.1-2), and SECY-11-0137 (Reference 20.1-3) were issued to establish the NRC staff's recommendations and prioritization of the recommendations.~~

~~As a result of NRC's involvement with stakeholders and nuclear industry representatives, the following guidance documents were published:~~

- ~~NEI 12-01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities" (Reference 20.1-4)~~
- ~~NEI 12-02, "Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (Reference 20.1-5)~~
- ~~NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (Reference 20.1-6)~~
- ~~NEI 13-06, "Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents" (Reference 20.1-7)~~
- ~~NEI 14-01, "Emergency Response Procedures and Guidelines for Beyond Design Basis Events and Severe Accidents" (Reference 20.1-8)~~

RAI 20.01-13

~~Also as part of the NTTF recommendations, rulemaking is in progress (Reference 20.1-9). The proposed rule codifies the requirements in NRC orders for mitigating beyond-design-basis events and for having reliable SFP instrumentation for the licensed and operating fleet of nuclear power plants. In addition, the proposed rule establishes regulatory requirements for an integrated response capability and for enhanced on-site emergency response capabilities. This chapter describes the NuScale Power Plant response to the proposed rule.~~

RAI 20.01-13

No mitigation strategies are required for the NuScale Power Plant because installed plant features, described in this Chapter and the DCA, provide the only equipment necessary to satisfy the language and intent of the MBDBE rule. Section 20.1 addresses ~~strategies to~~

~~mitigate~~the NuScale design's response to beyond-design-basis events (BDBE~~E~~s), including having remotely-monitored spent fuel pool level instrumentation, and Section 20.2 addresses the NuScale design's loss of large area of the plant due to fire or explosion~~, Section 20.3 addresses procedure integration, and Section 20.4 addresses emergency response~~.

RAI 20.01-13

20.1 Mitigating Strategies for Beyond-Design-Basis ~~External~~ Events

RAI 20.01-13

This section ~~discusses~~describes the ~~mitigating strategies that address~~response of the Nuscale design to the assumed damage state of a beyond-design-basis event in 10 CFR 50.155(b)(1), an extended loss of alternating current power (ELAP) and loss of normal access to the ~~ultimate~~normal heat sink (LUHS). The NuScale design features two functional heat sinks, as described in FSAR Section 9.2.5 and summarized here. During normal operation, the normal heat sink is via the power conversion system, where the condenser transfers heat to the circulating water system. The safety-related sink is the ultimate heat sink (UHS), which is used only if the power conversion system is not available. For the NuScale design, the UHS becomes the heat sink in an ELAP with LUHS ~~resulting from a BDBEE~~. The purpose of the discussion is to address compliance with provisions of 10 CFR 50.155. ~~JLD-ISG-2012-01, Revision 1 endorsed the approach of NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, Revision 2 (Reference 20.1-6) as an acceptable method for COL applicants and licensees to define and deploy strategies to enhance their ability to cope with conditions resulting from BDBEEs. The NuScale design is inherently different from the assumptions or design features considered in the development of the strategies detailed in NEI 12-06. NuScale is providing an alternative method to NEI 12-06 for determining compliance with the proposed MBDBE rule in this section and TR-0816-50797.~~

20.1.1 Not Used~~Determining Applicable Extreme External Hazards~~

~~FLEX equipment credited in the mitigation strategies is required to be available following a BDBEE. The extreme external hazards required to be considered for a BDBEE are seismic, flooding, high winds (including applicable missiles), snow, ice, and extreme (cold and high) temperatures. Descriptions of the external hazards design criteria are provided in the following sections.~~

20.1.1.1 ~~Seismic~~

~~The seismic design criteria are identified in Section 3.7.1.~~

COL Item 20.1-1: Not used.~~A COL applicant that references the NuScale Power Plant design certification will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific seismic hazard.~~

20.1.1.2 ~~External Flooding~~

~~The external flood design criteria are identified in Section 3.4.2.~~

COL Item 20.1-2: Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if a flood hazard is applicable at the site location. If a flood hazard is applicable, then the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific flood (including wave action) hazard.~~

20.1.1.3 ~~High Winds / Missile Protection~~

~~The high winds (hurricane and tornado) and applicable missile design criteria are identified in Section 3.3 and Section 3.5.~~

COL Item 20.1-3: Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if high wind and applicable missile hazards are applicable at the site location. If high wind and applicable missile hazards are applicable, then the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific high wind and applicable missile hazards.~~

20.1.1.4 ~~Snow, Ice, and Extreme Cold~~

RAI 02.03.01-6

~~The snow and ice design criteria are identified in Section 3.8.4. The zero percent exceedance minimum outdoor design dry bulb temperature (i.e., extreme cold) is identified in Table 2.0-1.~~

COL Item 20.1-4: Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if snow, ice and extreme cold temperature hazards are applicable at the site location. If snow, ice and extreme cold hazards are applicable, the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific snow, ice or extreme cold temperature hazard.~~

20.1.1.5 ~~High Temperatures~~

RAI 02.03.01-6

~~The zero percent exceedance maximum outdoor design dry bulb temperature (i.e. high temperature) is identified in Table 2.0-1.~~

COL Item 20.1-5: Not used.~~A COL applicant that references the NuScale Power Plant design certification will determine if extreme high temperature hazard is applicable at the site location. If extreme high temperature hazard is applicable, the COL applicant will ensure equipment and structures credited for diverse and flexible coping strategies are designed to be available following a site-specific extreme high temperature hazard.~~

20.1.2 Not Used~~Extended Loss of AC Power and Loss of Ultimate Heat Sink Design Assessment~~

RAI 20.01-13

~~This section discusses the inherent coping capability of the NuScale Power Plant design to maintain the key safety functions following a loss of normal access to the ultimate heat sink (ELAP and an LUHS) event. The key safety functions are maintaining core cooling, containment, and spent fuel pool (SFP) cooling.~~

20.1.2.1 Not Used~~Definitions~~

~~An ELAP event is defined as a loss of all alternating current (AC) electric power to the essential and nonessential switchgear buses except for those fed by qualified DC batteries through inverters.~~

RAI 20.01-13

~~NEI 12-06 (Reference 20.1-6) defines an LUHS as the loss of motive force for UHS flow, i.e., service water or circulating water pumps, with no prospect for recovery. The MBDBEE proposed rule (Reference 20.1-9) further defines an LUHS for passive reactor designs, such as the NuScale design, as a loss of normal access to the normal heat sink. The LUHS event assumes the water inventory in the UHS remains available following the event, and the piping connecting the UHS to plant systems, which are qualified to survive the applicable external hazards, remains intact.~~

~~NEI 12-06 defines the following three phases for developing FLEX strategies (Reference 20.1-6):~~

- ~~Phase 1 (initial): cope relying on plant equipment~~
- ~~Phase 2 (transition): augment or transition from plant equipment to on-site FLEX equipment and consumables to maintain or restore key functions~~
- ~~Phase 3 (final): obtain additional capability and redundancy from off-site equipment until power, water, and coolant injection systems are restored or commissioned~~

20.1.2.2 Not Used~~Applicable Systems, Structures, and Components~~

~~RAI 20.01-13~~

~~The UHS is a large pool of water consisting of the combined water volumes of the reactor pool, refueling pool (RFP) and SFP, as described in Section 9.2.5. Each NuScale Power Module (NPM) is partially immersed in the UHS. Since the NPMs are partially immersed and in direct contact with the UHS, there is no need for UHS piping or motive force such as service water or circulating water pumps to provide cooling functions following BDBEE. Therefore, the loss of the UHS, as defined in NEI 12-06 (Reference 20.1-6), is not plausible. No other heat sink is credited for maintaining the key safety functions.~~

~~The NPM is a self-contained nuclear steam supply system composed of a reactor core, a pressurizer, and two steam generators integrated within the reactor pressure vessel (RPV) and housed in a compact steel containment vessel (CNV). The plant design relies on passive systems for core cooling during a loss of AC power or DC power.~~

~~The reactor coolant system (RCS) design does not require inventory makeup following an ELAP event, but instead relies on maintaining the coolant inventory contained in the RPV and CNV, as described below.~~

~~The containment isolation valves (CIVs), which isolate the CNV, fail-safe to their closed position using stored energy. A discussion of the design and function of the CIVs is described in Section 6.2.4.~~

~~The decay heat removal system (DHRS) actuation valves fail-safe to the open position, and the main steam isolation valves (MSIVs) and feedwater isolation valves (FWIVs) fail-safe to the closed position to place the DHRS passive condensers in service. These valves fail-safe using stored energy and do not require operator actions or electric power to perform this function. Once a DHRS passive condenser is in service, a closed natural circulation loop is established transferring core decay heat and sensible heat to the UHS. DHRS is further described in Section 5.4.3.~~

~~Emergency Core Cooling System (ECCS) valves are also designed fail-safe to their open position. The ECCS valves fail-safe using the differential pressure between the RPV and CNV and do not require operator actions or electric power to perform this function. The function of the ECCS is further described in Section 6.3. With the ECCS valves open and the CIVs closed, a closed natural circulation loop is established in which decay heat is transferred from the core to the UHS. The containment heat removal capability of the CNV is described in Section 6.2.2, and the natural circulation process after ECCS initiation is described in Section 6.3. Once natural circulation is established, core cooling and containment integrity are assured by maintaining sufficient inventory in the UHS. Sufficient inventory to maintain core cooling and containment integrity is available in the UHS for greater than 30 days (Reference 20.1-10) without the need for operator actions.~~

~~Instrumentation and its associated indications remain available as needed to confirm proper CIV positions and verify that the natural circulation passive cooling is established. Once the valve positions are verified to be in the proper position and key parameters indicate that passive natural circulation is occurring, the only key parameters that require monitoring for the duration of the event are the UHS and SFP level when below the weir.~~

~~The UHS and SFP are monitored using four reliable independent level instruments that are designed to the augmented quality requirements specified in NEI 12-02 (Reference 20.1-5). Two level instruments are positioned in the SFP area, one level instrument in the RFP area, and one level instrument is positioned in the reactor pool area. All four instruments monitor the UHS level until the UHS level decreases below the SFP weir when the RFP and reactor pool inventory is separate from the inventory in the SFP.~~

~~A robust makeup line with an external connection point for providing inventory to the SFP is available to support SFP makeup following a BDBEE. The makeup to the SFP will overflow into the UHS when level reaches the weir. The makeup line is sized to provide at least 100 gpm of gravity-fed makeup inventory to the SFP. The 100 gpm makeup is greater than the UHS boil off rate. The SFP makeup line is discussed in Section 9.2.5.~~

~~During hot shutdown, safe shutdown, transition, and refueling conditions the NPM remains partially immersed in the UHS. The DHRS and ECCS are available or are in service to support core cooling.~~

~~Prior to entering the transition mode, the CNV is flooded and the ECCS valves are opened. The NPM remains partially immersed in the UHS while being transported to the RFP. In the RFP the upper module, lower module, and RPV are disassembled while immersed in the UHS.~~

~~The reactor core is submerged in water either via the CNV being flooded or directly in the UHS, while in refueling, through the duration of the event. Therefore, passive core cooling remains available in shutdown and refueling conditions.~~

~~The SFP will not begin to boil sooner than five days after the start of the ELAP event. The UHS is sized such that sufficient inventory is available to provide spent fuel cooling for greater than 30 days (Section 9.2.5).~~

~~The two level instruments located in the SFP meet the guidance in accordance with NEI 12-02 (Reference 20.1-5). See Section 20.1.4 for more detail on the SFP level instruments.~~

20.1.3 Mitigating Strategies for an Extended Loss of AC Power Event

Following an ELAP concurrent with a LUHS, automatic responses of safety-related equipment establish and maintain the key safety functions of core cooling, containment, and SFP cooling by placing the reactor modules into a safe, stable, shutdown state with passive core and containment cooling. Following the initial, automatic response of safety-related equipment—which requires no operator action and no electrical power (AC or DC)—the reactor modules and the spent fuel pool rely only on the large inventory of the reactor, refueling, and spent fuel pools, which comprise the ultimate heat sink (UHS), to maintain uninterrupted and long-term heat removal.~~A summary of the three phases as defined above for NuScale's FLEX strategies is provided in the following sections. The key parameters that are monitored for the FLEX strategies are summarized in Table 20.1-1, Table 20.1-2 and Table 20.1-3.~~

20.1.3.1 Not Used~~Phase 1~~

~~As described in Section 20.1.2, the key safety functions are maintained for greater than 30 days with installed plant equipment. No operator actions or supplemental equipment are necessary to perform these functions.~~

Core Cooling

The core cooling function is automatically established and passively maintained by safety-related equipment, as follows:

- During an ELAP, reactor coolant system inventory is preserved by containment isolation that occurs within the first minute of the event.~~Decay heat removal system (DHRS) actuation valves open to establish natural circulation flow and commence the transfer of reactor coolant system (RCS) heat to the fluid contained in the passive condenser loops.~~
- If DC power is available, the decay heat removal system (DHRS) passively removes decay heat for the first 24 hours following an ELAP. If DC power is not available or is lost earlier than 24 hours, emergency core cooling system (ECCS) valves automatically open to remove decay heat.~~The DHRS passive condensers are submerged in the ultimate heat sink (UHS), and transfer their heat to the UHS.~~
- The ECCS cools the core for the remainder of an ELAP. Reactor coolant water accumulates in the containment vessel (CNV) and passively returns to the reactor vessel by natural circulation after ECCS valves open.~~The containment isolation valves close to maintain RCS inventory.~~
- The reactor modules are submerged in the reactor pool, which is part of the UHS. Passive heat removal to the UHS using DHRS and ECCS maintains core cooling for more than 50 days without pool inventory makeup or operator action.~~Emergency core cooling system (ECCS) valves open to establish natural circulation flow of reactor coolant between the reactor pressure vessel and the CNV. The CNV is partially immersed in the UHS, and transfers heat passively to the UHS.~~

Maintain Containment

The containment function is automatically established and passively maintained by safety-related equipment as follows:

- Containment isolation valves (CIVs) and the CNV provide the passive containment function. Without operator action or electrical power, the safety-related CIVs close to isolate the CNV.~~The containment isolation valves close to establish containment of the RCS.~~
- Heat removal to the UHS passively controls temperature and pressure to ensure containment integrity. Peak pressure and temperature conditions for the CNV occur early in the event when the ECCS valves open, and do not challenge containment integrity.~~Containment temperature and pressure control are provided by partial immersion of the CNV in the UHS.~~

Spent Fuel Pool Cooling

The spent fuel pool cooling function is maintained by submergence of the spent fuel in the UHS.

- The spent fuel pool (SFP), as part of the UHS, communicates with the refueling pool and reactor pool above the SFP weir wall. As such, the pools respond as a single volume during an ELAP, until UHS level lowers below the weir wall.

- The UHS inventory maintains passive cooling of the spent fuel in the SFP for more than 150 days following initiation of an ELAP without pool inventory makeup or operator action.

Monitoring

- No operator action is required to establish or maintain the required safety functions for at least 50 days following the onset of an ELAP. Therefore, no instrumentation is necessary to support operator actions.
- Although not necessary because of the fail-safe and passive design, monitoring instrumentation (safety display and indication system, SDIS) is maintained in the main control room for at least 72 hours to provide additional assurance that systems have responded as designed.
- Although sufficient UHS level exists for at least 50 days, UHS level monitoring, which includes SFP level, is assured for at least 72 hours using installed equipment alone.

20.1.3.2 Not Used~~Phase 2~~

~~A FLEX strategy for a transition phase is not needed for the NuScale Power Plant design. The coping time utilizing installed plant equipment is greater than 72 hours. The initial phase is of sufficient duration to transition directly to the final phase.~~

20.1.3.3 Not Used~~Phase 3~~

RAI 20.01-13

The coping duration ensured by installed SSC with no operator actions exceeds 14 days. The installed equipment relied on to ensure core cooling, containment, and SFP cooling has sufficient capacity and capability to perform those functions for at least 50 days. Monitoring is not relied on for the mitigation strategies and guidelines, but installed instrumentation provides at least 72 hours of module and UHS monitoring as a supplementary capability. No offsite resources are required for a NuScale Power Plant to respond to an ELAP.~~The baseline coping capability utilizing installed plant equipment is greater than 30 days, and therefore, immediate actions after 72 hours are not necessary. Sufficient time is available for detailed planning and procurement of offsite equipment, if necessary to maintain the key safety functions. Due to this extended baseline coping capability, the Phase 3 FLEX strategy is to monitor UHS pool level, using the level instruments described in Section 20.1.4, and add inventory to the UHS via the SFP assured makeup line if necessary.~~

RAI 20.01-13

COL Item 20.1-6: Not used.

RAI 20.01-13

COL Item 20.1-7: Not used.

20.1.4 Spent Fuel Pool ~~and Reactor Pool Level~~ Instrumentation

The purpose of the spent fuel pool instrumentation (SFPI) requirements at 10 CFR 50.155(e) is to ensure that information about the SFP is provided to decision makers to enable resource prioritization for event mitigation and recovery actions. The SFPI requirements are not intended to support mitigation action but rather, to provide information. Use of SFPI is not necessary for the NuScale design to respond to an event; however, the instrumentation is available for at least 72 hours following an event. The MBDBE SFPI requirements require licensees to provide reliable means to remotely monitor wide-range water level for each SFP at its site until five years have elapsed since all of the fuel within that SFP was last used in a reactor vessel for power generation.

20.1.4.1 Design Bases

The design of the four (4) UHS level instruments meets the guidance of NEI 12-02 (Reference 20.1-5). The design basis functions of the pool level instrumentation are to provide plant personnel with a reliable wide-range water level indication of the UHS level until the UHS level decreases below the SFP weir when the RFP and reactor pool inventory is separate from the inventory in the SFP and reactor pool relative to the following water levels:

RAI 20.01-6, RAI 20.01-7

- Level 1 - level that is adequate to support operation of the normal pool cooling systems (See Table 9.2.5-1, Relevant Ultimate Heat Sink Parameters, Minimum level for SFPCS and RPCS suction penetrations),

RAI 20.01-6, RAI 20.01-7

- Level 2 - level that is adequate to provide substantial radiation shielding for a person standing on the operating deck (See Table 9.2.5.1, Relevant Ultimate Heat Sink Parameters, Minimum level to support radiation shielding),

RAI 20.01-6, RAI 20.01-7

- Level 3 - level where stored fuel remains covered and actions to implement make-up water should no longer be deferred (See Table 9.2.5-1, Relevant Ultimate Heat Sink Parameters, Top of spent fuel rack).

During refueling, the NPM is disassembled in the RFP area to allow transferring of new and spent fuel to and from the reactor core. When an NPM is disassembled, the water level in the RFP area will be monitored to ensure the fuel in the reactor is covered during an ELAP event.

The UHS level instruments are designed to withstand external hazards; such as seismic, flooding, high winds (including applicable missiles) extreme temperatures, and snow and ice; without loss of capability to perform their monitoring function.

The UHS instruments are designed to withstand the effects of and to be compatible with the environmental conditions associated with the expected conditions in the Reactor Building during normal operations and an ELAP event.

The UHS level instruments and their power supplies are physically and electrically separated and independent.

- Radiological conditions existing from a normal refueling with a freshly discharged fuel batch that remains covered with SFP water (Level 3).

Independence

The four (4) UHS level instruments are both physically and electrically independent.

Power Supplies

RAI 20.01-6, RAI 20.01-7

The power to the four (4) UHS level instruments is supplied by the highly reliable DC power system (EDSS) with interface through the plant protection system (PPS). Power to the redundant level instruments is from separate bus sources such that the loss of one supply will not result in a loss of power supply function to both divisions of UHS level instrumentation. Additionally, a replaceable battery that is isolated from faults on the normal power supply provides an alternate source of power independent from the plant AC and DC power systems. Batteries are designed for easy replacement to power UHS monitoring level instruments indefinitely.

Accuracy

The instrument channels are designed to maintain the minimum accuracy following a power interruption or change in power source without recalibration.

Testing

The permanently installed UHS level instruments are designed such that testing and calibration can be performed in-situ.

Display

The four (4) UHS level instruments transmit signals to the main control room and the remote shutdown panel, and are immediately available to the operators following an event. The instrument signals also initiate high or low level alarms, both locally and in the main control room.

Programs

COL Item 20.1-8: A COL applicant that references the NuScale Power Plant design certification will develop procedures, training, and a qualification program for operations, maintenance, testing, and calibration of ultimate heat sink level instrumentation to ensure the level instruments will be available when needed and personnel are knowledgeable in interpreting the information as addressed in Nuclear Energy Institute (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.”

Safety Evaluation

The four (4) UHS level instruments are designed to withstand and be protected from natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunamis and seiches without loss of function.

These instruments are also designed to accommodate or be protected from the effects of the postulated environmental conditions, including missiles, pipe whipping, and jet impingement.

The instruments and associated cabling is protected by both physical and electrical separation such that a failure in one channel will leave the other channel functional.

20.1.5 References

20.1-1 Not used.~~U.S. Nuclear Regulatory Commission, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," Commission Paper SECY-11-0093, July 12, 2011.~~

20.1-2 Not used.~~U.S. Nuclear Regulatory Commission, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," Commission Paper SECY-11-0124, September 9, 2011.~~

20.1-3 Not used.~~U.S. Nuclear Regulatory Commission, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SECY-11-0137, October 3, 2011.~~

20.1-4 Not used.~~Nuclear Energy Institute, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," NEI 12-01, Rev. 0, May 2012.~~

20.1-5 Nuclear Energy Institute, Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," NEI 12-02 Rev. 1, August 2012.

20.1-6 Not used.~~Nuclear Energy Institute, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," NEI 12-06, Rev. 2, December 2015.~~

20.1-7 Not used.~~Nuclear Energy Institute, "Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents," NEI 13-06, Rev. 0, September 2014.~~

20.1-8 Not used.~~Nuclear Energy Institute, "Emergency Response Procedures and Guidelines for Beyond Design Basis Events and Severe Accidents," NEI 14-01, Rev. 0, September 2014.~~

20.1-9 U.S. Nuclear Regulatory Commission, "Mitigation of Beyond-Design-Basis Events," [Proposed Final Rule] ADAMS Accession No. ML19023A040.~~Federal Register, Vol. 80, No. 219, November 13, 2015, pp. 70610-701647.~~

20.1-10 NuScale Power LLC, "Mitigation Strategies for Extended Loss of AC Power Event," TR-0816-50797, Rev. ~~0, November 2016.~~

20.2 Loss of Large Areas of the Plant due to Explosions and Fires

NRC regulation 10 CFR 50.155(b)(2)~~54(hh)(2)~~[1] requires licensees to develop and implement guidance and strategies to maintain or restore core cooling, containment, and spent fuel cooling under the circumstance associated with the loss of large areas of the plant due to explosion or fire (LOLA). The strategies that are required to be addressed are: (i) fire fighting; (ii) operations to mitigate fuel damage; and (iii) actions to minimize the radiological release.

Technical Report TR-0816-50796 (Reference 20.2-1) documents an assessment evaluating the NuScale Power Plant response to a LOLA event using the guidance in Nuclear Energy Institute (NEI) 06-12 (Reference 20.2-2). The report defines LOLA criteria and identifies the design features that meet those criteria and expected combined license (COL) applicant requirements.

The analysis was performed using the three phases recommended in NEI 06-12 (Reference 20.2-2): Phase 1 - Enhanced Fire Fighting Capabilities; Phase 2 - Measures to Mitigate Damage to Fuel in the Spent Fuel Pool; and Phase 3 - Measures to Mitigate Damage to Fuel in the Reactor Vessel and to Minimize Radiological Release.

This section describes the results of the assessment with no Security Related Information.

20.2.1 Phase 1 - Enhanced Fire Fighting Capabilities

The firefighting response to a LOLA event includes the operational aspects of responding to explosions or fire including items such as prearranging for the involvement of outside organizations, planning and preparation activities (e.g., pre-positioning equipment, personnel, and materials to be used for mitigating the event), and developing procedures and training for the event.

The fire protection system includes an underground yard fire main loop. Hydrants are provided on the yard fire main loop in accordance with the National Fire Protection Association at intervals up to 250 feet and located on each side of the Reactor Building. The lateral to each hydrant is controlled by an isolation valve. There are several connections in the yard main that can support supplying the yard main using a portable diesel-driven pump and several valves that can isolate damaged section(s) when required. The fire protection system is described in more detail in Section 9.5.1.

COL Item 20.2-1: A COL applicant that references the NuScale Power Plant design certification will develop enhanced firefighting capabilities in accordance with 10 CFR 50.155(b)(2).~~by implementing the guidance in NRC guidance document "Developing Mitigating Strategies/Guidance for Nuclear Power Plants to Respond to Loss of Large Areas of the Plant in Accordance with B.5.b of the February 25, 2002, Order" dated February 25, 2005 (Reference 20.2-3).~~ The enhanced firefighting capabilities should address the expectation elements listed in Section 4.1.3 of the Technical Report TR-0816-50796 (Reference 20.2-1).

1. ~~Regulation 10 CFR 50.54(hh)(2) may be moved to new regulation 10 CFR 50.155, presently in rulemaking process reference Federal Register notice Vol. 80, No. 219 pages 70610-70647~~

20.2.2 Phase 2 - Measures to Mitigate Damage to Fuel in the Spent Fuel Pool

Additional spent fuel cooling strategies are not required, in accordance with the guidance in NEI 06-12 (Reference 20.2-2).

20.2.3 Phase 3 - Measures to Mitigate Damage to Fuel in the Reactor Vessel and to Minimize Radiological Release

The only mitigating strategy required for the NuScale Power Plant is release mitigation. Standpipes and hose connections are located in each stairway and exit corridor. Hydrants are located in yard areas at least 100 yards from the Reactor Building (RXB). Portable external pump and supporting equipment should be located more than 100 yards from the RXB. The NuScale design will successfully support supplying the underground fire water ring main using a portable diesel-driven pump. External water sources available for makeup to the yard fire main loop are the fire protection supply tank and the fire protection alternative supply tank, which contain at least 300,000 gallons of water. The portable pump and supporting equipment (e.g., diesel fuel), as well as flexible hoses and supporting equipment, should be located at least 100 yards from the RXB. The COL applicant will determine the estimated flow rate of the portable equipment. If the yard fire main loop is intended to be used for reactor mitigation strategies, the capability to isolate other structures is included due to several connections and valves that can ensure isolation of broken sections of the main.~~The generic pressurized water reactor key safety functions identified in NEI 06-12 (Reference 20.2-2) were developed based on a traditional pressurized water reactor plant design. These key safety functions are applicable to the NuScale Power Plant. The key safety functions that must be evaluated for a LOLA event are:~~

- ~~reactor coolant system (RCS) inventory control~~
- ~~RCS heat removal~~
- ~~containment isolation~~
- ~~containment integrity~~
- ~~release mitigation~~

~~A primary and alternate means for RCS inventory control, RCS heat removal, containment isolation, and containment integrity are maintained for the NuScale Power Plant with installed plant capabilities. An additional means or strategy of minimizing a potential radiological release from a LOLA event is needed to augment the NuScale Power Plant installed plant capabilities.~~

COL Item 20.2-2: A COL applicant that references the NuScale Power Plant design certification will provide a means for water spray scrubbing using fog nozzles and the availability of water sources, and address runoff water containment issues (sandbags, portable dikes, etc.) as an attenuation measure for mitigating radiation releases outside containment.

20.2.4 References

20.2-1 NuScale Power, LLC, "Loss of Large Areas Due to Explosions and Fires Assessment," TR-0816-50796 (Security Related Information).

20.3 Not Used~~Integration with Emergency Procedures~~

COL Item 20.3-1: Not used.~~A COL applicant that references the NuScale Power Plant design certification will ensure that the severe accident management guidelines, diverse and flexible coping strategies support guidelines (FSGs), and extensive damage mitigation guidelines are integrated with the emergency operating procedures consistent with Recommendation 8.1 of SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan."~~

20.4 Not Used~~Enhanced Emergency Response Capabilities for Beyond-Design-Basis Events~~

~~This section describes the provisions implemented to enhance the emergency response capabilities as they relate to emergency response staffing, communication, training, drills, exercises, and multi-source dose assessment capabilities for beyond-design-basis events.~~

~~A description of the emergency plan is provided in Section 13.3.~~

~~The beyond-design-basis event (BDBE) emergency response enhancements of Section 20.4.1, Section 20.4.2, and Section 20.4.3 are not required to be part of the plant's emergency plan, and therefore do not require the change control provisions of 10 CFR 50.54(q).~~

20.4.1 ~~Enhanced Emergency Plan Staffing~~

COL Item 20.4-1: Not used.~~A COL applicant that references the NuScale Power Plant design certification will perform an analysis that demonstrates the emergency response organization staff has the ability to implement the strategies of the emergency operating procedures, severe accident mitigation guidelines, diverse and flexible coping strategies support guidelines (FSGs), and extensive damage mitigation guidelines. The analysis will be performed with the offsite response organization access to onsite being impeded. The event shall be a loss of all onsite and offsite alternating current power and loss of normal access to the ultimate heat sink.~~

COL Item 20.4-2: Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop a supporting emergency response organization structure with defined roles and responsibilities to implement the strategies of the emergency operating procedures, severe accident mitigation guidelines, diverse and flexible coping strategies support guidelines (FSGs), and extensive damage mitigation guidelines.~~

20.4.2 ~~Enhanced Emergency Plan Communications~~

~~The installed plant communication capabilities are described in Section 9.5.2.~~

COL Item 20.4-3: Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop and describe at least one onsite and one offsite communications system capable of remaining functional during an extended loss of alternating current power including the effects of the loss of the local communications infrastructure.~~

20.4.3 ~~Enhanced Emergency Plan Training, Drills, and Exercises~~

COL Item 20.4-4: Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop, implement, and maintain the training and qualification of personnel that perform activities in accordance with diverse and flexible coping strategies support guidelines (FSGs), severe accident mitigation guidelines, and extensive damage mitigation guidelines. The training and qualification on these activities will be developed using the systems approach to training as defined in 10 CFR 55.4 except for elements already covered under other NRC regulations.~~

COL Item 20.4-5: Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop drills or exercises that demonstrate the ability to transition to one or more of the strategies and guidelines of the emergency operating procedures, diverse and flexible coping strategies support guidelines (FSGs), extensive damage mitigation guidelines, and severe accident mitigation guidelines using only the station communication equipment designed to be available following an extended loss of alternating current including effects of the loss of the local communications infrastructure.~~

20.4.4 ~~Multi-Unit Multi-Source Dose Assessment Capability~~

COL Item 20.4-6: Not used.~~A COL applicant that references the NuScale Power Plant design certification will develop and describe the means to be used for determining the magnitude of, and for continually assessing the impact of, the release of radioactive materials to the environment including releases from reactor core and spent fuel pool sources.~~