

Loss of Large Areas Due to Explosions and Fires Assessment

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Abstract

This report addresses the requirements and associated guidance of 10 CFR 50.54(hh)(2)¹ as related to the design of the NuScale Power Plant. The report describes the NuScale Power Plant's response to a loss of large area due to explosion and fire event. The report evaluates how the NuScale Power Plant maintains or restores core cooling, containment, and spent fuel pool (SFP) cooling capabilities in accordance with the applicable acceptance criteria in the Standard Review Plan, Section 19.4.

¹ Regulation 10 CFR 50.54(hh)(2) may be moved to new regulation 10 CFR 50.155, presently in rulemaking process (Federal Register notice Vol. 80, No. 219 pages 70610-701647)

Executive Summary

10 CFR 50.54(hh)(2)² requires each licensee to develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities under the circumstances associated with loss of large areas (LOLA) of the plant due to explosions or fire. Strategies developed by a licensee must address the following areas:

- (i) firefighting
- (ii) operations to mitigate fuel damage
- (iii) actions to minimize radiological release

The purpose of this report is to evaluate the NuScale Power Plant's design response to a LOLA event. This report is also intended to provide guidance for a licensee that utilizes the NuScale Power Plant design to develop the site-specific strategies prescribed by 10 CFR 50.54(hh)(2). The guidance contained in Nuclear Energy Institute (NEI) 06-12, "B.5.b Phase 2 & 3 Submittal Guideline" (Reference 6.1) was used to determine the NuScale Power Plant design response to a LOLA event. The NEI 12-06 guidance prescribes that a three phases approach be used to perform an evaluation for meeting 10 CFR 50.54(hh)(2). The phases and associated guidance for each phase are the following:

- Phase 1 – Enhanced firefighting capabilities
- Phase 2 – Measures to mitigate damage to fuel in the SFP
- Phase 3 – Measures to mitigate damage to fuel in the reactor vessel and to minimize radiological release

Phase 1

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.

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² Regulation 10 CFR 50.54(hh)(2) may be moved to new regulation 10 CFR 50.155, presently in rulemaking process (Federal Register notice Vol. 80, No. 219 pages 70610-701647).

The remainder of the Phase 1 requirements and guidance are Combined License (COL) applicant items.

Phase 2

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Phase 3

The generic pressurized water reactor (PWR) key safety functions identified in NEI 06-12 were developed based on a traditional PWR plant design. These key safety functions are applicable to the NuScale Power Plant design, and no new key safety functions were identified. The key safety functions that must be evaluated for a LOLA event are as follows:

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

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primary and alternate means to maintain these functions are separated per the guidance in NEI 06-12. }}^{SRI} The

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}}^{SRI} The remainder of the Phase 3 requirements and guidance are Combined License (COL) applicant items.

1.0 Introduction

1.1 Purpose

The purpose of this report is to evaluate the NuScale Power Plant design for requirements to respond to loss of large areas (LOLA) of the nuclear power plant due to fire or explosion. This report defines LOLA criteria and identifies the design features that meet these criteria, and expected Combined License (COL) applicant requirements. This report is intended to provide guidance for a licensee that utilizes the NuScale design to develop the site specific strategies prescribed by 10 CFR 50.54(hh)(2).

Nuclear Regulatory Commission (NRC) regulation 10 CFR 50.54(hh)(2)³ requires licensees to develop guidance and strategies for addressing a LOLA of the plant due to explosions or fires from a beyond design basis event through the use of readily available resources and by identifying potential practicable uses of beyond-readily-available resources. These strategies would address licensee response to events that are beyond the design basis of the facility.

1.2 Scope

The scope of this report includes an assessment of the NuScale Power Plant design against the criteria set forth in Nuclear Energy Institute (NEI) 06-12, "B.5.b Phase 2 & 3 Submittal Guideline," Revision 3 (Reference 6.1).

1.3 Abbreviations

Table 1-1 Abbreviations

Term	Definition
CFDS	containment flooding and drain system
CFR	Code of Federal Regulations
CIV	containment isolation valve
CNTS	containment system
CNV	containment vessel
COL	Combined License
CVCS	chemical and volume control system
DHRS	decay heat removal system
ECCS	emergency core cooling system
EDMG	extensive damage mitigation guideline
ERO	Emergency Response Organization
FPS	fire protection system

³ Regulation 10 CFR 50.54(hh)(2) may be moved to new regulation 10 CFR 50.155, presently in rulemaking process (Federal Register notice Vol. 80, No. 219 pages 70610-701647)

Term	Definition
LOLA	loss of large areas
MOU	Memorandums of Understanding
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NPM	NuScale Power Module
NRC	Nuclear Regulatory Commission
PWR	pressurized water reactor
RCS	reactor coolant system
RPV	reactor pressure vessel
RXB	reactor building
SFP	spent fuel pool
SG	steam generator
SFI	Safeguards Information
SRP	Standard Review Plan
UHS	ultimate heat sink

2.0 Background

10 CFR 50.54(hh)(2) focuses on ensuring that the nuclear power plant licensee will be able to implement effective mitigation measures for large fires and explosions including (but not explicitly limited to) those caused by the impact of a large, commercial aircraft. New plant design COL applications are required to meet this regulation.

The LOLA regulation and guidance is derived from the “B.5.b” industry work. The term “B.5.b” is taken from the Mitigating Strategies requirements from NRC Order EA-02-026 (Reference 6.2), Section B.5.b. This order, along with subsequent license conditions and 10 CFR 50.54(hh)(2), establish the applicable requirements and guidance documents. The NRC issued guidance (safeguards information) to current reactor licensees on February 25, 2005, and additionally endorsed NEI 06-12, Revision 2, by letter dated December 22, 2006. Revision 3 was later endorsed in DC/COL-ISG-016 (Reference 6.3). These two sources of guidance provide an acceptable means for developing and implementing the required strategies. Note that Revision 3 is the most current revision of NEI 06-12 (Reference 6.1).

The requirements of the rule are consistent with the resolution of Section B.5.b of Order EA-02-026 for current U.S. operating plants. Implementation of Section B.5.b was divided into three phases for current operating plants. This evaluation follows the same approach and uses the following assessment guidance for each phase:

- Phase 1 – Enhanced firefighting capabilities
 - New plants should address Phase 1 as operating plants have done 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 6.4).
- Phase 2 – Measures to mitigate damage to fuel in the spent fuel pool (SFP)
 - Use of NEI 06-12 criteria
- Phase 3 – Measures to mitigate damage to fuel in the reactor vessel and to minimize radiological release
 - Use of NEI 06-12 criteria

2.1 Theory

NEI 06-12, Revision 3 is the current accepted guidance for assessment of the regulation for LOLA and has been endorsed by the NRC (Reference 6.3). The intent of the guidance was written towards current operating plants and traditional design plants. As such, the methodology is not always directly applicable or easily translated for the NuScale Power Plant design. Nonetheless, this report applies the NEI assessment guidance to the extent practicable. This methodology is intended for use by a licensee (COL) to develop the applicable site-specific strategies.

2.2 Regulatory Requirements

10 CFR 50.54(hh)(2) is not applicable for design certification applicants; however, 10 CFR 52.80(d) requires COL applications to include a description and plans for implementation of the guidance 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).

10 CFR 50.54(hh)(2) requires the following:

Each licensee shall develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and SFP cooling capabilities under the circumstances associated with LOLA of the plant due to explosions or fire, to include strategies in the following areas:

- (i) firefighting
- (ii) operations to mitigate fuel damage
- (iii) actions to minimize radiological release

This report describes how the NuScale Power Plant design satisfies 10 CFR 50.54(hh)(2) and the applicable guidance in Standard Review Plan (SRP), Section 19.4 (Reference 6.7), and the NRC endorsed guidance document, NEI 06-12. This report provides the basis and generic guidance for developing site-specific mitigation strategies or extensive damage mitigation guidelines (EDMG) for a COL application licensee.

3.0 Methodology

The methodology for performing the LOLA assessment is taken from NEI 06-12. This reference is applicable to COL applications. Specifically, Section 4 of NEI 06-12 includes additional guidance for new plant COL applications. Each of the three phases of the B.5.b requirements and their applicability to new plant designs are addressed in the following sections.

3.1 Approach

3.1.1 Phase 1 - Enhanced Fire Fighting Capabilities

New plants should address Phase 1 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 6.4).

The COL applicant needs to meet the guidance of DC/COL-ISG-016.

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

Section 2.0 of NEI 06-12 is used to determine strategies to mitigate damage to fuel in the SFPs. Guidance for implementing the mitigation strategy shall be developed, documented, and available for NRC inspection to meet the requirements of 10 CFR 50.54(hh)(2) by the COL applicant. All of the boundary conditions, objectives, performance attributes, response elements, submittal guidance and additional considerations of NEI 06-12, Section 2.0, apply with the exception of the following elements for new plants:

- **DIVERSE SFP MAKEUP SOURCE (INTERNAL STRATEGY)**

For the internal strategy, there are no additional potential makeup sources resulting from industry and NRC site-specific reviews. New plants should identify additional strategies to provide makeup to the SFP beyond the minimum 500 gpm flow required by Section 2.0 of NEI 06-12.

- **EXTERNAL MAKEUP AND EXTERNAL SPRAY STRATEGY**

For the external makeup and external spray strategy, the use of fire hoses to provide water to the SFP from an external, ground-level pump is not permitted. Instead, new plant designs should employ two standpipes located on opposite sides of the SFP to reduce the chances of losing both standpipes from a fire or explosion. The external standpipes should employ a standard hose connection at ground level and connections at the SFP floor to a monitor nozzle for the spray strategy and to a fire hose connection for the SFP makeup strategy.

The Phase 2 SFP strategies are not required for sites that have SFPs that are below grade and cannot be drained. These existing sites were previously notified by the NRC.⁴

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

Several steps are taken to evaluate the need for employing the mitigative strategies of Phase 3. These steps are discussed in Section 4.2.3 of NEI 06-12. A key element identified in this section of NEI 06-12 is that new designs may employ passive features that might be less susceptible to damage from the effects of large fires and explosions. This section also specifies that new plant designs may not need all of the mitigation strategies. This guidance is applicable to the NuScale Power Plant design, in that mitigation strategies are not needed as design features for installed plant systems render some of the strategies for maintaining the generic safety functions as not applicable.

The generic key safety functions that are applicable to the NuScale Power Plant design are described in this report. Due to the unique design of the NuScale Power Plant, a description of the functional attributes of the systems that perform the safety functions is provided. Equipment location is also discussed. These design features of the installed systems are described in how they perform the function as well as their susceptibility to a large fire or explosion. This report discusses how the success criteria for meeting the key safety function are satisfied by installed plant systems.

For any key safety function that is not satisfied with design features of installed systems, mitigation strategies are identified in this report. The mitigation strategies are site-specific and will be developed and implemented by the COL applicant. Guidance for implementing the mitigation strategy shall be developed, documented, and available for NRC inspection to meet the requirements of 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d) by the COL applicant.

3.2 Assumptions

The following assumptions, limitations, and clarifications are applicable to this report:

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⁴ The statement in NEI 06-12 Section 2.1 regarding notification to sites that have spent fuel pools that are below grade and cannot be drained having been notified by the NRC was directed towards existing plants at the time NEI 06-12 Revision 3 was published.

4.0 Assessment

4.1 Phase 1 – Enhanced Fire Fighting Capabilities

New plant designs must address Phase 1 by implementing the guidance in NRC 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. This guidance document is classified as Safeguards Information (SGI). This section provides a non-SGI description of the NuScale Power Plant strategy for meeting this guidance.

4.1.1 Areas of Consideration

The NRC guidance document (Reference 6.3) contains four areas of consideration, with each area containing several expectation elements. The areas of consideration are as follows:

- Part 1 – Firefighting response strategies
 - coordinated response strategy
 - assessment of mutual aid
 - establishing staging
 - command and control
 - training
- Part 2 – Plant operations to mitigate fuel damage
 - personnel
 - communications
 - rapid spread of fire
 - procedures
 - equipment
 - training
 - SFP mitigating measures
- Part 3 – Actions to minimize release of radioactive materials
 - water spray scrubbing
 - emergency responders
- Part 4 – Industry best practices

Each area of consideration has several expectation elements that must be addressed in the appropriate regulatory submittal (i.e., design certification applicant or COL applicant).

Site-specific equipment, design features, and procedures or program documents are developed by a COL applicant.

4.1.2 Applicability

Part 1 (Firefighting) of the NRC guidance document is addressed in this section. Much of the Part 1 response to the NRC guidance document will be specified by the COL applicant. Parts 2, 3, and 4 are addressed by the COL applicant. The few areas in the NRC guidance document applicable to the design certification applicant are presented in this report in a non-SGI format.

4.1.3 Response to Expectation Elements

The Part 1 (Firefighting) specific expectation elements are addressed in Table 4-1.

Table 4-1 Expectation elements

Item No.	Expectation Element	Response
a	Establish a staging area for pre-positioned equipment and materials.	This expectation element will be addressed by the COL applicant.
b	Pre-event notification staging to maximize survivability.	This expectation element will be addressed by the COL applicant.
c	Identify airlifted resources for fire fighting.	This expectation element will be addressed by the COL applicant.
d	Evaluate command and control functions needed.	This expectation element will be addressed by the COL applicant.
e	Identify outside organizations to support response actions.	This expectation element will be addressed by the COL applicant.
f	Revisit and/or establish new Memorandums of Understandings (MOUs).	This expectation element will be addressed by the COL applicant.
g	Use local offsite facilities as staging areas.	This expectation element will be addressed by the COL applicant.
h	Control of emergency response vehicles.	This expectation element will be addressed by the COL applicant.
i	Communication enhancements.	This expectation element will be addressed by the COL applicant.
j	Provisions for treatment of casualties.	This expectation element will be addressed by the COL applicant.
k	Establish an alternate site assembly area.	This expectation element will be addressed by the COL applicant.
l	Provide fire training.	This expectation element will be addressed by the COL applicant.

Item No.	Expectation Element	Response
m	Establish a means to supply the fire protection yard fire main loop using offsite resources and a staged onsite portable diesel-driven pump.	<p data-bbox="846 321 873 359">{{</p> <p data-bbox="1019 1161 1076 1197">}}SRI</p>

Only expectation element (m) of Table 4-1 is applicable to the design certification applicant for Phase 1.

4.2 Phase 2 – Measures to Mitigate Damage to Fuel in the Spent Fuel Pool

Phase 2 consists of measures to mitigate damage to fuel in the SFP through the use of diverse internal and external SFP makeup and spray strategies. Phase 2 also includes additional SFP mitigation measures as referenced in NEI 06-12 Section 2.1 and Appendix D. These include actions such as the following:

- strategically dispersing higher decay power fuel amongst the older low decay power fuel by symmetrically surrounding the highest decay power fuel (from the most recent offload) by four assemblies of low decay power

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- highest decay power assemblies should not be located in rack cells positioned above the rack feet
- maintenance of an empty space area in the SFP (e.g., the shipping cask lay down area) to provide for a downcomer effect (size of empty space to be determined based upon conditions at each SFP)
- enhancing natural circulation air cooling of spent fuel in the pool by promoting passive ventilation of the bulk air space above the pool with the environs (e.g., opening doorways or blowout panels after an event)

As stated in NEI 06-12 Section 2.1, the SFP mitigation strategies are not required for sites that have SFPs that are below grade and cannot be drained (existing sites have been notified by NRC). {{

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4.3 Phase 3 – Measures to Mitigate Damage to Fuel in the Reactor Vessel and to Minimize Radiological Release

Phase 3 consists of measures to enhance command and control aimed at improving initial site operation response before the Emergency Response Organization (ERO) is fully activated, and implement a specific set of mitigation strategies for PWRs based on diverse methods to ensure PWR safety functions.

4.3.1 Command and Control Enhancements

The purpose of command and control enhancements is to establish guidelines for initial site operational response in a beyond design basis event. Extensive damage mitigation guidelines is the generic term used by the industry.

4.3.1.1 Offsite and Onsite Communications

The purpose of this strategy is to improve the initial response of the available plant operational resources and enhance the capability for those resources to communicate

with off-site resources. A response is required by the COL applicant, and there is no input required for the design certification application. The template provided in NEI 06-12 Table A.3-1, which is included in Appendix A of this report, should be used by a future licensee to document the capabilities.

4.3.1.2 Notifications/Emergency Response Organization Activation

The purpose of this strategy is to provide an enhanced level of assurance that the proper notifications of the licensee ERO occur and the ERO callout is initiated in a timely manner, despite the postulated condition. A response is required by the COL applicant, and no input is required for the design certification application. The template provided in NEI 06-12 Table A.3-1, which is included in Appendix A of this report, should be used to document the capabilities in the COL applicant.

4.3.1.3 Initial Operational Response Actions

The purpose of this strategy is to enhance focus on the key actions that may be able to prevent or delay a release as well as be reasonably accomplished in adverse conditions.

A response is required by the COL applicant, and there is no input required for the design certification application.

The PWR extensive damage mitigation guidelines template from NEI 06-12 is included in Appendix B of this report and represents an example of the initial operational response procedure/guidelines to be developed by the COL applicant.

NEI 06-12 Table A.3-1 is included in Appendix A of this report and should be included as part of the COL application.

4.3.1.4 Initial Damage Assessment

The purpose of this aspect of the initial response EDMGs is to utilize the available onsite resources to perform an assessment of the plant and equipment conditions in order to assist the arriving ERO personnel in decision-making and development of specific strategies.

A response is required by the COL applicant, and no input is required for the design certification application.

The PWR EDMG template, including the initial plant damage assessment, from NEI 06-12 is included in Appendix B of this report and represents an example of the plant damage assessment to be developed by the COL applicant.

NEI 06-12 Table A.3-1 is included in Appendix A of this report.

4.3.2 Determination of Need for Mitigation Strategies

4.3.2.1 Key Safety Functions

The generic PWR key safety functions identified in NEI 06-12 were developed based on a traditional PWR plant design. Although the NuScale Power Plant is a small modular reactor with numerous passive features, these key safety functions are applicable to the NuScale Power Plant design, and no new key safety functions were identified. These key safety functions are as follows:

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

The purpose of each key safety function is discussed in this report in order to demonstrate how the NuScale Power Plant is designed to perform that key safety function. Each of the following key safety functions and an assessment of how the NuScale Power Plant is designed to perform these safety functions is described in Section 4.3.2.3.

- RCS inventory control – The purpose of this key safety function is to ensure that the core is covered with water. If the core remains covered with water, core damage will be precluded.
- RCS heat removal – The purpose of this key safety function is to remove the decay heat from the core and transfer it to the ultimate heat sink (UHS).
- containment isolation – The purpose of this key safety function is to ensure no leakage paths exist that would allow gaseous and particulate radiation to escape containment.
- containment integrity – The purpose of this key safety function is to ensure the containment fission product barrier is maintained to minimize or prevent radiological release outside containment.
- release mitigation – The purpose of this key safety function is to minimize a radiological release assuming severe core damage has occurred and a radiological release is imminent or in progress.

4.3.2.2 NuScale Power Plant Design

The NuScale Power Plant design is a small modular reactor and has many unique features that differentiate the design from a standard PWR. This design, as it pertains to development of mitigation strategies for a LOLA event, are described in this section.

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4.3.2.3 Assessment of Key Safety Functions

RCS Inventory Control

The purpose of this key safety function is to ensure that the core is covered with water. If the core remains covered with water, core damage will be precluded. Traditional PWR designs accomplish this function by injecting water into the RPV using systems such as safety injection. {{

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RCS Heat Removal

The purpose of this key safety function is to remove the decay heat from the core and transfer it to the UHS. Traditional PWR designs accomplish this function via heat removal through the SGs or feed and bleed operation. {{

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Containment Isolation

The purpose of this key safety function is to ensure no leakage paths exist that would allow gaseous and particulate radiation to escape containment. Traditional PWR designs accomplish this function by using CIVs. {{

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Containment Integrity

The purpose of this key safety function is to ensure the containment fission product barrier is maintained to minimize or prevent radiological release outside containment. Traditional PWR designs accomplish this function through the use of containment sprays to control containment pressure and temperature below applicable limits as well as quenching debris that has relocated outside of the RPV during a severe accident.

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Release Mitigation

The purpose of this key safety function is to minimize a radiological release assuming severe core damage has occurred and a radiological release is imminent or in progress. Traditional PWRs perform this function by scrubbing the containment atmosphere using containment sprays. However, a release that is in progress may not be susceptible to the

scrubbing effects, and a release from containment or the reactor building may nonetheless occur.

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4.3.3 Mitigation Strategies

The NuScale Power Plant ensures that key safety functions are successfully performed with installed plant systems when subjected to a LOLA event. {{

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4.3.3.1 Portable Sprays

The objective of this strategy is to spray a release coming from a damaged or failed containment or release location (e.g., RXB). The intent of the strategy is to spray a release point, which may be located internal or external to the RXB. Guidance for performing spray scrubbing of radiological releases and containing associated runoff will be developed by the COL applicant. Ensuring the spray scrubbing equipment is located at least 100 yd from the RXB is a responsibility of the COL applicant.

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The mitigating strategy template in Appendix A of this report identifies how this strategy can be implemented by a COL applicant.

4.3.4 Submittal Requirements

The COL applicant requirements for Phase 3 include NEI 06-12 Tables A.2-6, A.3-1, and A.4-1 through A.4-7, which are included in Appendix A of this report. The COL applicant requirements for Phase 3 also include the NEI 06-12 PWR EDMG template, which is included in Appendix B of this report, and the NEI 06-12 PWR EDMG Plant Damage Assessment template, which is included in Appendix C of this report.

4.4 Maintenance and Testing

The COL applicant will describe how equipment relied upon to implement these strategies will be maintained and periodically tested to ensure it will operate when called upon.

Any equipment, such as fire pumps, hoses, or nozzles purchased for these strategies, will be maintained by licensees. An adequate program for equipment requiring maintenance, at a minimum, should include periodic surveillance checks, start and run checks, and pump flow tests. Other tools, adaptors, wrenches, jumpers, etc., that do not require maintenance or testing should, at a minimum, be stored in an accessible location greater than 100 yd from the building of interest, and periodically inventoried to ensure that the equipment is available when needed.

Equipment will be taken out of service for routine maintenance activities for varying periods of time. However, a program that allows equipment needed to implement the strategies required by 10 CFR 50.54(hh)(2) to be out of service for an indefinite period of time is considered to be inconsistent with the requirement to implement strategies. COL applicants should ensure that reasonable controls on the availability of equipment needed to implement the strategies are included in their site-specific procedures and guidance.

4.5 Design Enhancements

No design enhancements are required for the NuScale Power Plant in order to comply with 10 CFR 50.54(hh)(2) requirements.

6.0 References

- 6.1 Nuclear Energy Institute, "B.5.b Phase 2 & 3 Submittal Guideline," NEI 06-12, Revision 3, July 2009 Agencywide Document Access and Management System (ADAMS) Accession No. ML092890400.
- 6.2 U.S. Nuclear Regulatory Commission, Issuance of Order for Interim Safeguards and Security Compensatory Measures, EA-02-026, February 25, 2005.
- 6.3 U.S. Nuclear Regulatory Commission, "Interim Staff Guidance Compliance with 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d) Loss of Large Areas of the Plant due to Explosions or Fires from a Beyond-Design Basis Event," DC/COL-ISG-016, June 09, 2010.
- 6.4 U.S. Nuclear Regulatory Commission, "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," February 25, 2005.
- 6.5 National Fire Protection Association, "Standard for the Installation of Standpipe and Hose Systems," NFPA 14, 2016.
- 6.6 U.S. Nuclear Regulatory Commission, "Fire Protection for Nuclear Power Plants," Regulatory Guide 1.189, Revision 2, October 2009.
- 6.7 U.S. Nuclear Regulatory Commission, "Strategies and Guidance to Address Loss of Large Areas of the Plant Due to Explosions and Fires," NUREG-0800, Section 19.4, Revision 0, June 2015.

Appendix A. Licensee Response Templates

- Table A.2-1 through Table A.2-6 from NEI 06-12
- Table A.3-1 from NEI 06-12
- Table A.4-1 through A.4-7 from NEI 06-12

Table A.2-1 Spent fuel pool makeup – internal strategy

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Table A.2-2 Spent fuel pool makeup - external strategy

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Table A.2-3 Spent fuel pool spray – external strategy

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Table A.2-4 Viable site-specific spent fuel pool mitigation strategies

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Table A.2-5 Spent fuel pool leakage control strategies

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Table A.2-6 Fire system management strategies

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Table A.3-1 Command and control enhancements

<p>ONSITE & OFFSITE COMMUNICATIONS:</p> <p><i>To be included in the COL application.</i></p> <ul style="list-style-type: none"> • <i>Provide a general description of the diverse methods available to communicate with offsite personnel that could be effective for the conditions assumed</i> • <i>Provide a general description of the approach for mustering the available plant resources in the event the control room/staff are substantially affected</i> • <i>Provide a general description of Operations/Security pre-plans for re-establishment of communications immediately following a large fire or explosion</i> • <i>Provide a general description of how operations and security personnel will coordinate activities immediately following a large fire or explosion</i>
<p>NOTIFICATIONS OF THE UTILITY ERO:</p> <p><i>To be included in the COL application.</i></p> <ul style="list-style-type: none"> • <i>Provide a general description of the command and control structure that will be established prior to arrival of offsite resources, in the event the control room/staff are substantially affected</i> • <i>Provide a general description of the approach(es) for making the appropriate off-site notifications of the utility ERO and ERO callout in the event the control room/staff are substantially affected</i> • <i>Confirm that a procedure/guidance and training exists or will be developed for ERO and offsite notifications of the utility ERO for the postulated conditions.</i>
<p>INITIAL OPERATIONAL RESPONSE ACTIONS:</p> <p><i>Entry conditions for the procedure/guidance on initial operation response actions are from other procedures after it has been determined that control of plant equipment cannot be established from the control room or the remote shutdown station. These entry conditions will be confirmed by the COL applicant. Initial operational response actions will include verifying communications, notifications and ERO callout, verification of reactor trip and ECCS and/or DHRS operation. Procedures and/or guidance and training will be developed by the COL applicant for the initial operational response under the postulated conditions.</i></p>
<p>EQUIPMENT LOCATIONS:</p> <p><i>To be included in the COL applicant.</i></p> <ul style="list-style-type: none"> • <i>Describe the general locations of the primary equipment involved in the initial operational response actions</i>

<p align="center"><u>EQUIPMENT</u> <i>To be determined by COL applicant.</i></p>	<p align="center"><u>LOCATION</u></p>

NOTIFICATIONS OF THE UTILITY ERO:

The damage assessment provided to the ERO will be specified by the COL applicant. An example is provided in Appendix B of this report and is taken from NEI 06-12. Procedures and/or guidance and training will be developed by the COL applicant for the ERO damage assessment.

Note to Table A.3-1:

Onsite and Offsite Communications are not required for the design certification application but are required for the COL applicant. Notification of the Utility ERO is not required for the design certification application and is required for the COL applicant. Initial Operational Response Actions, if applicable, should be included in the COL application.

Table A.4-1 Pressurized water reactor enhancement strategy #1; makeup to refueling water
storage tank

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Table A.4-2 Pressurized water reactor enhancement strategy #2; manually depressurize the steam generators

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Table A.4-3 Pressurized water reactor enhancement strategy #3; manual operation of turbine-driven auxiliary feedwater pump

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Table A.4-4 Pressurized water reactor enhancement strategy #4; manually depressurize steam generators and use portable pump

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Table A.4-5 Pressurized water reactor enhancement strategy #5; makeup to condensate storage tank/auxiliary feedwater storage tank

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Table A.4-6 Pressurized water reactor enhancement strategy #6; containment flooding with portable pump

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Table A.4-7 Pressurized water reactor enhancement strategy #7; portable sprays

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Appendix B. Example Pressurized Water Reactor Extensive Damage Mitigation Guidelines

This appendix presents example EDMG procedure sections as provided in the NEI 06-12. The EDMGs will be developed on a site-specific basis. The example presented in this appendix is intended to demonstrate the type of steps and information commonly found in the EDMGs that could be used to develop site-specific EDMGs.

Guideline Usage:

- This document is a Guideline. This Guideline should not be used unless entry has been directed from PROCEDURE1.
- Verbatim compliance with the steps of this Guideline is not required.
- This Guideline should be used by the implementers to aid in making the necessary decisions to combat a severe accident involving beyond design basis conditions.
- Use of opposite unit personnel (as applicable) may be called for, depending on the situation at the affected unit.
- Steps, procedure limitations and precautions selected at the discretion of the User.

1. Purpose

- 1.1. The Guideline provides initial actions and alternative methods of plant operation for responding to an event that results in a total loss of unit power (AC and DC), or prevents operation from the control room or the remote shutdown station.

2. Entry Conditions

- 2.1. This guideline is entered from PROCEDURE1 after it has been determined that control of plant equipment cannot be established from the control room or the remote shutdown station.
- 2.2. Declaration of 50.54(x) is required.

3. Scope

- 3.1. Communications (Attachment A)
- 3.2. Notifications/ERO Callout
- 3.3. Immediate local actions should be taken to verify reactor tripped (if power available) and ECCS and/or DHRS has actuated, if verification from the control room is not possible.

4. Instructions

Note: Continue action steps begun in the emergency operating procedure network unless specifically stopped by a recommendation from the technical support center.

- 4.1 Assess Plant Damage Condition
 - 4.1.1. Determine if control room is accessible and useable
 - 4.1.2. Determine primary area of damage
- 4.2 Invoke Appropriate Regulatory Requirements
 - 4.2.1. Refer to *PROCEDURE2*, "Control Room Emergency Operation," and determine applicability of 10 CFR 50.54(x) invocation.
 - 4.2.2. Refer to *PROCEDURE3*, "Classification and PARs," and request unaffected unit personnel complete the required NRC notifications.
- 4.3 Determine Communication Options
 - 4.3.1. Use Attachment A to determine potential communication options if normal communication methods are affected.
- 4.4 Perform Local Immediate Actions

Conditions Necessary to Perform Local Immediate Actions		
Conditions	Requirement	Special Tools/Equipment
Access to Reactor Building and Turbine Building	Confirm it is safe to access	Portable lighting may be required

- 4.4.1. Verify Reactor Trip

a) Locally check reactor trip breakers – OPEN

1) IF reactor trip breakers are NOT OPEN, THEN manually trip breakers.

2) IF reactor trip breakers do NOT manually open, THEN open both output contactors locally.

4.5. Check Plant Status

4.5.1. Complete Attachment B

4.6. Implement Actions as Directed by Technical Support Center

Desired lineups

Imposed limitations

Special parameter monitoring

References:

PROCEDURE1 – Procedure directing entry into this guideline

PROCEDURE2 – Procedure for invoking 50.54(x)

PROCEDURE3 – Procedure for Event Classification

Attachment A of PWR EDMG
Communications Options

Structure Affected	Plant Radios	Plant Pagers	Plant Telephones	Plant Pager	Plant Process Computer	Satellite Phone
Turbine	Operable May be affected in damage zone due to loss of antennas.	Operable May be affected in damage zone due to loss of antennas.	Operable for calls within the station until batteries deplete.	Operable except in affected areas.	Not Available	Operable
Control	Not Operable	Not Operable	Not Operable	Operable except in affected areas.	Not Operable	Operable
Intake Structure	Operable May be affected in damage zone due to loss of antennas	Operable May be affected in damage zone due to loss of antennas.	Operable except in affected areas.	Operable except in affected areas.	Operable except in affected areas.	Operable
RXB	Operable May be affected in damage zone due to loss of antennas	Operable May be affected in damage zone due to loss of antennas.	Operable except in affected areas.	Operable except in affected areas.	Operable except in affected areas.	Operable
Etc.						

Attachment B of PWR EDMG
Plant Damage Assessment

Building	Elevation	Visible Damage	Accessibility	Equipment Status/System Integrity
NPM	N/A			
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Turbine Building				

Appendix C. Action Items for the Combined License Applicant

The following operational enhancements must be tracked as action items for the COL applicant in order to comply with the SRP Section 19.4 (Reference 6.7). The SRP is not a substitute for NRC regulations, and compliance with it is not required. However, a design certification applicant is required per 10 CFR 52.47(a)(9) to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives provide acceptable methods of compliance.

Table C.1-1 Additional COL applicant commitments

SRP Item Number*	Title	COL Applicant Commitment	Status/Comment	Report Section
1	License Conditions and Implementation Schedule	Include a license condition related to 10 CFR 50.54(hh)(2) that addresses (1) implementation of specified programs and (2) submitting schedules to support planning for and conduct of NRC inspections.	This is a COL applicant item.	-
2	Licensee Commitments	Include a commitment for the licensee to verify the adequacy of the procedures, training and engineering bases for each mitigating strategy by performing a walkthrough or other type of exercise of the strategy.	This is a COL applicant item.	-
3	SG Level	For applicants utilizing a nuclear power plant design similar to current operating PWRs that have adopted strategies in Section 3.3.2, 3.3.3, or 3.3.4 of NEI 06-12, Revision 3, or similar strategies, should determine whether or not a portable means of measuring SG level is necessary for the strategy to be successful.	{{ }} ^{SRI}	4.3.2.3
4	Staging of Fire Equipment	Stage fire equipment greater than 100 yd from target areas; or harden location; or credit present intervening structure(s); or store the necessary equipment in diverse locations.	The discussion of enhanced firefighting strategies states that fire equipment will be stored greater than 100 yd from all target areas.	4.1.3

Table C.1-1 Additional COL applicant commitments

SRP Item Number*	Title	COL Applicant Commitment	Status/Comment	Report Section
5	Dispersal of Personnel	Develop procedures to evacuate target building(s) or maximize survivability.	This is a COL applicant item.	4.1.3
		Stage fire brigade members greater than 100 yd from target areas, or hardened/intervening structure(s) is/are present.	This is a COL applicant item.	4.1.3
		Direct that operations and support staff will be relocated greater than 100 yd from target areas, with a minimum number in the control room.	This is a COL applicant item.	4.1.3
6	Airlifted Resources	Ensure airlifted resources will arrive in less than two hours door-to-door.	This is a COL applicant item.	4.1.3
7	Command and Control	Develop protocols for command of LOLA events, including organizational references.	This is a COL applicant item.	4.3.1
8	Evaluating Capabilities of Offsite Resources	Evaluate the ability of local and regional "specialized capabilities" (cranes, fire and hazmat teams, etc.).	This is a COL applicant item.	4.1.3
9	Evaluation of MOUs for Offsite Resources	Establish appropriate MOUs with offsite response organization to ensure support in a LOLA scenario.	This is a COL applicant item.	4.1.3

Table C.1-1 Additional COL applicant commitments

SRP Item Number*	Title	COL Applicant Commitment	Status/Comment	Report Section
10	Coordination with Regional Resources	Ensure ground-based regional support will arrive in less than two hours door-to-door. Agreements with supporting organizations should be formally documented, preferably with MOUs.	This is a COL applicant item.	4.1.3
11	Controlling Emergency Response Vehicles and Dosimetry for Responders	Establish security provisions to stage many response vehicles easily onsite.	This is a COL applicant item.	4.1.3
		Prepare guidelines to distribute sufficient dosimetry to the appropriate responders.	This is a COL applicant item.	4.1.3
12	Communications Equipment	Provide enough compatible radio sets for fire fighters, stored greater than 100 yd from target areas.	This is a COL applicant item.	4.1.3
		Establish a radio scheme for plant operations to minimize confusion. The required equipment must be separate from that used for firefighting and distributed greater than 100 yd from the nuclear island and structures	This is a COL applicant item.	4.1.3
13	Mass Casualties	Prepare guidelines for mass casualty events, including expected aid from offsite medical responders.	This is a COL applicant item.	4.1.3
14	Triage Areas	Define appropriate triage area(s) greater than 100 yd from target areas.	This is a COL applicant item.	4.1.3

Table C.1-1 Additional COL applicant commitments

SRP Item Number*	Title	COL Applicant Commitment	Status/Comment	Report Section
15	Firefighting Training and Exercises	Provide training on accelerant-fed fires and onsite/offsite coordination to the fire brigade. Familiarize local offsite responders with the site and provide information on LOLA events, if possible.	This is a COL applicant item.	4.1.3
16	Means for Feeding the Yard Fire Main Loop	Establish a means to feed the yard fire main loop using alternate water supplies.	The discussion of enhanced firefighting strategies identifies the means to meet this requirement.	4.1.3
17	Boiling Water Reactor: Containment Venting and Vessel Flooding	Prepare guidance to vent primary containment to secondary (or atmosphere) in a no-power condition.	This item is not applicable to NuScale.	N/A
		Prepare condensate pumps to provide cooling water to RPV.	This item is not applicable to NuScale.	N/A
18	Use of Plant Equipment During Loss of Power Situations	Establish a procedure to start emergency diesel generators and non-AC pumps without DC power.	This item is not applicable to NuScale.	N/A
		Prepare guidelines for fire pumper to supply cooling water to RPV and SFP.	{{ }} ^{SRI}	4.2 4.3.3

Table C.1-1 Additional COL applicant commitments

SRP Item Number*	Title	COL Applicant Commitment	Status/Comment	Report Section
21	Training	Include LOLA event training for initial and re-qualified operator licensing. This should be directed at least as often as severe accident management guideline training.	This is a COL applicant item.	-
		Analyze training needs for emergency and non-licensed personnel.	This is a COL applicant item.	-
22	Water Spray Scrubbing and Runoff	Prepare guidance for performing spray scrubbing of radiological releases and containing associated runoff.	The need for a portable spray strategy has been identified. Procedures for implementation and runoff containment will be addressed by the COL applicant.	4.3.3
		Ensure water spray scrubbing equipment is stored greater than 100 yd from target areas. This requirement does not apply only offsite equipment is used.	This is a COL applicant item.	4.3.3
23	Maintenance and Testing	Describe how equipment relied upon to implement the strategies required by 10 CFR 50.54(hh)(2) will be maintained and periodically tested to ensure it will operate when called upon.	This is a COL applicant item.	4.4

Table C.1-1 Additional COL applicant commitments

SRP Item Number*	Title	COL Applicant Commitment	Status/Comment	Report Section
24	Extensive Damage Mitigation Guidelines	Development of EDMGs.	This is a COL applicant item.	4.3.1

*Note to Table C.1-1:
Item numbers refer to Section II, SRP Acceptance Criteria, of Reference 6.7.