Loss of Large Area Analysis Report

Revision 1

Non-Security-Related Information

March 2017

REVISION HISTORY

Revision	Date	Page	Description
0	December 2014	All	First Issue
1	March 2017	1, 23, A1, and A14	• In response to RAI 201-8063(Question 19.04-1), to change SRP 19.4 to DC/COL-ISG-016. • In response to RAI 201-8063(Question 19.04-19), to add DCD as reference.
		6, 9, 10, A7, A8, and A9	• In response to RAI 201-8063(Question 19.04-19), to indicate that the standpipes for internal and external SFP strategies are a part of the DCD design, and that flexible hose and procedure/guidance for implementing SFP spray strategies will be a COL item.
		9, 10, A17, A26, and A27	• In response to RAI 201-8063(Question 19.04-22), to indicate that the COL applicant is to determine how the strategy will be implemented including necessary human actions, and develop procedures for manually using portable pump.
		9	• In response to RAI 201-8063(Question 19.04-3), to indicate that provision and procedure/guidance for implementing external SFP spray strategies will be a combined license (COL) item.
		10	• In response to RAI 201-8063(Question 19.04-4), to indicate that the portable pump specification will be a combined license (COL) item.
		13	• In response to RAI 201-8063(Question 19.04-9), to delete the detail number of nozzles. • In response to RAI 201-8063(Question 19.04-10), to describe the location of containment isolation valves.
		13-16	• In response to RAI 201-8063(Question 19.04-2), to provide the primary and alternate means to satisfy each key safety function. • In response to RAI 201-8063(Question 19.04-6), to correctly describe the design feature of containment isolation. • In response to RAI 201-8063(Question 19.04-7), to correctly describe the design feature of containment integrity. In response to RAI 201-8063(Question 19.04-8), to correctly describe the design feature of offsite release mitigation.

REVISION HISTORY

Revision	Date	Page	Description
		15	• To correctly describe the locations of CCW pumps which are located on EL.55'.
		16	• In response to RAI 201-8063(Question 19.04-11), to correctly provide reference DCD section.
		18	• In response to RAI 201-8063(Question 19.04-12), to indicate that the procedure/guidance for implementing the IRWST makeup strategy will be a combined license (COL) item. • Change "reactor" to "refueling".
		18-22	• In response to RAI 201-8063(Question 19.04-16), to revise Appendix A.3 to A.4.
		19-20	• In response to RAI 201-8063(Question 19.04-13), to indicate that the turbine steam isolation valves can be controlled manually. • In response to RAI 201-8063(Question 19.04-14), to describe that the turbine driven pumps can be operated manually without onsite AC or DC power. • In response to RAI 201-8063(Question 19.04-15), to indicate that the alternate AC, Mobile AC sources are part of the DCD design requirements and DC power will be a COL item.
		21	• Appendix C is not exist. Appendix B is correct.
		A2	• In response to RAI 201-8063(Question 19.04-17), to revise Table 19.4-1 to Table A.1-1, and to revise Tables 19.4-2 through 19.4-15 to Tables A.2-1 through A.4-7.
		A8	• In response to RAI 201-8063(Question 19.04-20), to indicate AFWST and CCW can be a backup source for SFP makeup.
		A31	• In response to RAI 201-8063(Question 19.04-21), to provide SFP makeup design feature.
		A39	• In response to RAI 201-8063(Question 19.04-17), to provide a description of manual operation of turbine-driven AFW pump.
		A2, A8, A30, A32	• To revise Table A.1-1 to Table 19.4-1, 3 and 4.

ABSTRACT

The purpose of this report is to evaluate the APR1400 design and requirements in support of the Design Certification Document (DCD) submittal for loss of large areas (LOLA) of the nuclear power plant due to explosion or fire. Initiating events classified as Loss of Large Areas (LOLA) are beyond the design basis for existing and proposed new nuclear power plants.

This report is based on a review of current regulatory guidance; experience gained from the existing nuclear fleet as they addressed B.5.b issues, the APR1400 standard plant design. No site specific design is included at this time.

In developing appropriate mitigative strategies, existing nuclear power plants often relied on providing a large volume of water from an alternate, independently powered system to help mitigate a LOLA event. This resulted in a critical review and implementation of procedures for utilizing the facility's fire protection system in various support configurations.

This report also includes two appendices; Licensee response templates, Example PWR EDMG.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AFW	Auxiliary Feedwater
AFWST	Auxiliary Feedwater Storage Tank
BAMP	Boric Acid Makeup Pump
BAST	Boric Acid Storage Tank
CCW	Component Cooling Water
CFR	Code of Federal Regulations
CFS	Cavity Flooding System
COL	Combined Operating License
CS	Containment Spray
CST	Condensate Storage Tank
DC	Direct Current
DCD	Design Certification Document
DWST	Demineralized Water Storage Tank
ECCS	Emergency Core Cooling System
ECSBS	Emergency Containment Spray Backup System
EDG	Emergency Diesel Generator
EDMGs	Extensive Damage Mitigation Guidelines
EOP	Emergency Operating Procedure
ERO	Emergency Response Organization
FW	Feed Water
GPM	Gallons per Minute
IRWST	In-containment Refueling Water Storage Tank
LOLA	Loss of Large Area
MOU	Memorandum of Understanding
MSADV	Main Steam Atmospheric Dump Valve
MST	Mitigative Strategy Template
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NRC	Nuclear Regulatory Commission
PIV	Post Indicating Valve

POSRV	Pilot Operated Safety Relief Valve
PSIA	Pounds per Square Inch, Absolute.
PWR	Pressurized Water Reactor
RCS	Reactor Coolant System
RG	Regulatory Guide
RMWT	Reactor Makeup Water Storage Tank
SAMG	Severe Accident Management Guidance
SC	Shutdown Cooling
SFP	Spent Fuel Pool
SG	Steam Generator
SGI	Safeguards Information
SIS	Safety Injection System
SOC	Statements of Consideration
TDAFW	Turbine-Driven Auxiliary Feedwater
USDA	United States Department of Agriculture

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1 PURPOSE

The purpose of this report is to evaluate the APR1400 design and requirements in support of the Design Certification Document (DCD) submittal for loss of large areas (LOLA) of the nuclear power plant due to explosion or fire. Initiating events classified as Loss of Large Areas (LOLA) are beyond the design basis for existing and proposed new nuclear power plants. Existing nuclear power plants have evaluated these beyond design basis events and implemented changes and operational programs to assist in coping with LOLA events. This report defines LOLA criteria and identifies the design features that meet these criteria, commitments for the Combined Operating License (COL) applicant, and DCD and COL submittal requirements.

The Nuclear Regulatory Commission (NRC) has issued 10 CFR 50.54(hh)(2) that requires licensees to develop guidance and strategies for addressing the loss of large areas 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 areas for the use of beyond-readily-available resources. These strategies would address licensee response to events that are beyond the design basis of the facility.

This report is based on a review of current regulatory guidance; experience gained from the existing nuclear fleet as they addressed B.5.b issues, the APR1400 standard plant design. No site specific design is included at this time. It is written using the guidance of DC/COL-ISG-016 [Reference 7] and NEI 06-12, Revision 3 [Reference 1]. The format and evaluations performed for the report are primarily based on NEI 06-12, Rev. 3, as the NRC has stated in the statements of consideration (SOC) related to the new 10 CFR 50.54(hh)(2) that NEI 06-12 provides an acceptable means for developing and implementing Phase 2 and Phase 3 mitigation strategies.

In developing appropriate mitigative strategies, existing nuclear power plants often relied on providing a large volume of water from an alternate, independently powered system to help mitigate a LOLA event. This resulted in a critical review and implementation of procedures for utilizing the facility's fire protection system in various support configurations. This approach, when combined with a portable independently powered pumping system, generally meets the requirements to help mitigate events following a LOLA. This same approach has been followed in developing this report. The design of the fire protection system for the APR1400 includes enhancements that could improve the capability of the system to be available and to provide sufficient water, if needed, to mitigate a LOLA event.

Appendix A summarizes the mitigative strategies. Tables in Appendix A include the response templates for the applicable mitigative strategies.

2 REGULATIONS AND SUFFICIENCY CRITERIA

2.1 Regulations

10 CFR 50.54(hh) focuses on ensuring that the nuclear power plant's 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.

10 CFR 50.54(hh)(2) requires that:

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

(i) Fire fighting;

(ii) Operations to mitigate fuel damage; and

(iii) Actions to minimize radiological release.

2.2 Sufficiency Criteria

The term “B.5.b” is taken from the Mitigating Strategies requirements from NRC Order EA-02-026, Section B.5.b. These orders, along with subsequent license conditions and 10 CFR 50.54(hh)(2), establish the rule. 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. The NRC considers that 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 1].

The requirements of the rule are consistent with the resolution of B.5.b for current US operating plants. B.5.b was divided into three phases for current plants and this evaluation follows this same approach:

Phase 1 – Enhanced fire fighting 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.

Phase 2 – Measures to mitigate damage to fuel in the spent fuel pool

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

3 ASSUMPTIONS

The following assumptions are appropriate for this report:

- None

4 PHASE 1 – ENHANCED FIRE FIGHTING CAPABILITIES

Phase 1 of the B.5.b assessments focused on enhancement of a plant's fire-fighting response capability to respond to losses of large areas of the plant due to fire or explosions. The NRC issued guidance for meeting the different expectations of Phase 1 of B.5.b in a document titled, “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 5]. That guidance document identified numerous items to be assessed on an individual plant site basis, such as onsite fire fighting capability, off-site fire fighting resources, accelerant-fed fire fighting capabilities, hoses and self-contained pumps for moving water for fire fighting and core cooling, etc. Most of these items involve assessments, evaluations, action plans and the development of procedures that cannot be accomplished until the facility is near the completion of construction. These items are nonetheless Phase 1 expectations listed in the Mitigative Strategies Table (MST) with a description on how the APR1400 meets each expectation.

4.1 Areas of Consideration

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

Part 1 – Fire fighting response strategies

a) Coordinated response strategy

b) Assessment of mutual aid

c) Establishing staging

d) Command and control

e) Training

Part 2 – Plant operations to mitigate fuel damage

a) Personnel

b) Communications

c) Rapid spread of fire

d) Procedures

e) Equipment

f) Training

g) Spent Fuel Pool mitigating measures

Part 3 – Actions to minimize release of radioactive materials

a) Water spray scrubbing

b) Emergency responders

Part 4 – Industry best practices

Each area of consideration has several expectation elements which must be addressed in the regulatory submittal

4.2 Applicability

Part 1 (Fire fighting) 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 DCD applicant are presented herein in a non-SGI format.

4.3 Response to Expectation Elements

The Part 1 (Fire fighting) specific expectation elements are addressed below.

4.3.1 Expectation Element: Staging Area

The COL applicant is to establish a staging area for pre-positioned equipment and materials at an appropriate location (onsite or nearby offsite) that would not be expected to be affected by the event itself.

4.3.2 Expectation Element: Notifications

The COL applicant is to establish procedures for pre-event notification which may allow for staging personnel in alternative areas to maximize survivability of onsite personnel. Evacuation of target buildings should be considered.

4.3.3 Expectation Element: Airlifted Resources

The COL applicant is to identify airlifted resources (personnel and equipment) for fire fighting. Resources should arrive within two hours (door-to-door).

4.3.4 Expectation Element: Command and Control

The COL applicant is to, as part of a coordinated fire fighting response strategy, provide for the plant coordination with offsite local fire departments to support plant recovery efforts, including using these facilities as a staging area for specialized equipment and material; and coordination of large, nearby municipal fire departments (i.e., if not already in a mutual aid agreement), specialized fire fighting equipment at nearby industrial facilities, nearby airports and military bases, national fire fighting assets (e.g., USDA Forest Service), and private fire fighting companies.

4.3.5 Expectation Element: Outside Organizations

The COL applicant is to identify outside organizations that may have the required knowledge, skills, and abilities to support response actions.

4.3.6 Expectation Element: Establishment of Memorandums of Understanding

The COL applicant is to provide in either MOUs/agreements already established, or new agreements that are to be put in place as a result of newly evaluated measures, those arrangements established to address the roles and responsibilities of the responders and their integration into the overall fire fighting strategy. Ground-based regional support should arrive within two hours (door-to-door).

4.3.7 Expectation Element: Use of Local Offsite Facilities

The COL applicant is to provide in either MOUs/agreements already established, or new agreements that are to be put in place as a result of newly evaluated measures, those arrangements established to address the roles and responsibilities of the responders and their integration into the overall fire fighting strategy. Ground-based regional support should arrive within two hours (door-to-door).

4.3.8 Expectation Element: Control of Emergency Response Vehicles

The COL applicant is to establish provisions for controlling the large number of emergency response vehicles that may arrive at the plant in response to the event, such as, arrangements for establishing a staging area. Pre-event coordination should include local law enforcement agencies to ensure that responding fire fighting assets are not restricted from the staging areas or locations directed by plant operators. Provisions for security and radiological protection should be maintained.

4.3.9 Expectation Element: Communications Enhancements

The COL applicant is to establish the following communications enhancements: (1) providing pagers for potential responders to receive dispatch notices both on and off shift; (2) checking for interoperability of radios to ensure that fire and rescue organizations have compatible equipment; and (3) availability of batteries/chargers to support the use of radios during an event of extended duration.

4.3.10 Expectation Element: Treatment of Casualties

The COL applicant is to provide for the treatment of casualties. Triage areas should be established at least 91.44 m (100 yards) from target areas (e.g., auxiliary building).

4.3.11 Expectation Element: Alternate Site Assembly Area

The COL applicant is to establish alternate site assembly areas for personnel.

4.3.12 Expectation Element: Fire Training

The COL applicant is to provide plant personnel responsible for fire fighting with general training knowledge about an accelerant fed fire and appropriate training to ensure effective implementation of actions that are part of the coordinated response strategy. Event responders that are part of the mutual aid considerations should, as a minimum, receive site familiarity training, and planning for a site exercise with their involvement should be considered. When site exercise training is not feasible for identified mutual aid organizations, use of table top exercise training (preferably provided at the site as part of site familiarity training) is to be considered.

4.3.13 Expectation Element: Feeding Fire Protection Ring Header

A portable diesel-driven pump will be provided and staged onsite by the COL applicant. This portable pump may be connected to the fire protection ring header using portable hoses and connectors, which will also be staged with the pump. There are several connections in the yard to the fire protection ring header and several valves in the ring header that could isolate any broken sections of the ring header. The fire protection drawing (Reference 4) shows yard hydrants attached to the ring header on all four sides of the power block and several valves in the ring header. The APR1400 design which includes diverse locations and number of yard hydrants as well as numerous ring header isolation valves can successfully support supplying the fire protection ring header using a portable diesel-driven onsite pump. The external water sources include the fire water tanks, the demineralized water tank, the raw water tank, and the ultimate heat sink (e.g., cooling tower basin, lake, and river). The COL applicant is to will establish procedures that will address the actions necessary to provide staged on-site water sources and

an alternate off-site feed path to the ring header.

4.4 Submittal Requirements

The DCD submittal requirements for Phase 1 include the completed Appendix B template of the NRC guidance document (SGI). It is expected that the response would be a SGI document. Only expectation element 4.3.13 of Part 1 requires a response from the DCD applicant for Phase 1. Expectation elements 4.3.1 through 4.3.12 and Parts 2, 3, and 4 will be completely addressed by the COL applicant.

5 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 spent fuel pool (SFP) through the use of diverse internal and external SFP makeup and spray strategies.

5.1 Diverse SFP Makeup Source (Internal Strategy)

SRI

NEI 06-12 Table A.2-1 is included in Appendix A of this report and will be included as part of the submittal by COL applicant.

5.2 SFP Makeup Capability (External Strategy)

SRI

SRI

The COL applicant is to provide flexible hose(s) with connection provision and procedure/guidance for implementing external SFP makeup strategy.

5.3 SFP Spray Capability (External Strategy)

SRI

The COL applicant is to provide flexible hose(s) with connection provision and procedure/guidance for implementing external SFP spray strategies, including the minimum pump discharge pressure required to

support the minimum flow requirements.

5.4 Additional Site-Specific SFP Makeup Strategies

Additional site-specific strategies were evaluated during a review of Attachment A to the NEI Letter from Marvin Fertel to Luis Reyes on Closure of Phase 2, January 24, 2006 [Reference 3]. The following site-specific strategies were applicable to this plant design:

SRI

The COL applicant is to determine the portable pump specification to deliver the required flow at the required discharge pressure considering head loss of piping, hoses, elevation, and fittings based on site conditions.

5.5 Leakage Control Strategies

Leakage control strategies are not required for the DCD. They will be addressed by the COL applicant.

5.6 Submittal Requirements

The DCD submittal requirements for Phase 2 include NEI 06-12 Tables A.2-1 through A.2-6, which are included in Appendix A of this report and will be included as part of the submittal by COL applicant.

6 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.

6.1 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 condition. Extensive Damage Mitigation Guidelines (EDMGs) is the generic term used by the industry.

6.1.1 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 for the COL phase and there is no input required for the DCD. The template provided in NEI 06-12 Table A.3-1 (included in Appendix A herein) will be used to documented the capabilities in the COL applicant submittal.

6.1.2 Notifications/ERO Activation

The purpose of this strategy is to provide an enhanced level of assurance that the proper notifications of the utility ERO occur and the ERO callout is initiated in a timely manner, despite the postulated condition. A response is required for the COL phase and there is no input required for the DCD. The template provided in NEI 06-12 Table A.3-1 (included in Appendix A herein) will be used to documented the capabilities in the COL applicant submittal.

6.1.3 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.

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 Room. 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 AFW running, and subsequent starting of a turbine-driven auxiliary feedwater (TDAFW) pump with no AC/DC power available. Procedures and/or guidance and training will be developed by the COL applicant for the initial operational response under the postulated conditions.

The PWR EDMG 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.

The APR1400 TDAFW pumps each can deliver a design flowrate of 650 gpm over the entire range of steam generator pressure of 6.3 through 87.2 kg/cm2A (90 through 1,240 psia) [Reference 2, Section 10.4.9]. The TDAFW modulating valves fail open on a loss of power, so the COL applicant will establish an alternative method of flow control to prevent underfeeding/overfill of the steam generators.

NEI 06-12 Table A.3-1 is included in Appendix A of this report and will be included as part of the submittal by COL applicant.

6.1.4 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.

Procedures and/or guidance and training will be developed by the COL applicant for the ERO damage assessment.

The PWR EDMG template, including the 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 and will be included as part of the submittal by COL applicant.

6.2 Determination of Need for Mitigation Strategies

NEI 06-12 recommends seven (7) PWR mitigations strategies based on PWR safety functions. Before the actual mitigation strategies are discussed, an evaluation must be performed to determine if each mitigation strategy is required.

6.2.1 Key Safety Functions

The generic PWR key safety functions identified in NEI 06-12 are all applicable to the APR1400. The PWR key safety functions are as follows:

- RCS inventory control
- RCS heat removal
- Containment isolation
- Containment integrity
- Release mitigation

No new key safety functions were identified for this plant design.

6.2.2 Functional Attributes

The minimal set of equipment for means of satisfying the key safety functions must be identified. The equipment for each key safety function is as follows:

- RCS inventory control
    - The Safety Injection System (SIS) is the primary means of RCS inventory control [Reference 2, Section 19.2.3.3.7.1]. A water source, pumps, and associated piping and 4.16 kV Class 1E AC electrical power are required for this system to meet the safety function. There are four trains of SIS, each located in a separate quadrant of the Auxiliary Building.

- Realignment of the Containment Spray (CS) or Shutdown Cooling (SC) system pumps to operate in an injection mode is possible, however they rely on the same electrical support systems as the SIS.

- RCS heat removal
  - The primary method for this safety function is the establishment of natural circulation in conjunction with heat removal via the secondary side using Auxiliary Feedwater [Reference 2, Section 19.2.3.3.7.1]. A water source, pumps, associated piping and valves, and electrical power are required for this system to meet the safety function.
  - An alternate method to perform this safety function is feed and bleed operation using the pressurizer pilot operated safety relief valves (POSRVs) and SIS. A water source, pumps, associated piping and valves, and electrical power are required for this safety function to be met.

- Containment isolation
  - There is no unique system that performs the containment isolation function. Isolation is achieved by closure of inboard and outboard containment isolation valves in each containment piping penetration.
  - Containment bypass events involve failure of the pressure boundary between the high pressure reactor coolant system and a low-pressure auxiliary system. For PWRs, this can also occur because of the failure of the steam generator tubes, either as an initiating event or as a result of severe accident conditions.
  - Successful closure of at least one isolation valve or check valve in each containment mechanical penetration flowpath is required. The valves and motive force to close the valves are required for this safety function to be met.
  - The piping system and related components penetrating containment are provided containment isolation capabilities with redundancy. Primary means is an isolation valve located inside containment. An alternate means is an isolation valve located outside containment. These valves are locked closed valves or automatic isolation valves. All automatic isolation valves are designed with a fail-safe position that provides the position of greater safety in the event of valve actuation signal failure or loss of motive power. [Reference 2, Section 6.2.4]

- Containment integrity
  - The containment pressure boundary is made up of the containment shell and several mechanical and electrical containment penetrations. These penetrations include one equipment hatch, two personnel air locks, containment piping penetration assemblies, electrical penetrations, and a fuel transfer tube. Heat removal from containment is required to prevent exceeding the design pressure and temperature requirements to maintain containment integrity. Containment Spray System (CSS) is used to control containment conditions. This system requires the In-containment Refueling Water Storage Tank (IRWST), CSS pumps, associated piping, and 4.16 kV Class 1E AC electrical power. The Shutdown Cooling pumps can act as backup for CS pumps. SC pumps are considered as only a primary means since they rely on the same electrical support systems with CSS.

- The Cavity Flooding System (CFS) is an alternate means to flood the reactor cavity during a severe accident. The water delivery from the IRWST to the reactor cavity is accomplished by means of active components [Reference 2, Section 19.2.3.3.3.1.2]. The CFS takes water from the IRWST and directs it to the reactor cavity.

- As an alternate method, the Emergency Containment Spray Backup System (ECSBS) provides an emergency containment spray flow path from external water sources. The ECSBS contains a separate spray ring header in containment with a connection located at ground level near the Auxiliary Building [Reference 2, Section 19.2.4.2.3]. An outboard manual isolation valve is included in the ECSBS piping, and it is manually operated and normally locked closed. The piping, valve, and nozzles are separate and unique from the rest of the CSS system.

• Release mitigation

- The CS and ECSBS systems described previously are used to minimize offsite releases during an accident [Reference 2, Section 19.2.5.1.4]. The CS system is a primary means to perform this function and the ECSBS is an alternate means to perform the function to mitigate offsite release.

6.2.3 Equipment Locations

SRI

SRI

SRI

6.2.4 Existing Design Features

SRI

SRI

6.2.5 Assessment of Key Safety Functions

SRI

SRI

6.2.6 Mitigation Strategies

6.3 Mitigation Strategies

There are seven PWR mitigation strategies that will be implemented for the APR1400 and they are listed as follows:

- Makeup to IRWST in order to supply ECCS long-term

- Manually depressurize SGs to reduce inventory loss
- Manual operation of Turbine-driven AFW pump
- Manually depressurize SGs and use portable pump
- Makeup to CST/AFWST
- Containment flooding with portable pump
- Portable sprays

6.3.1 Makeup to IRWST in order to supply ECCS long-term

SRI

The COL applicant is to provide procedure/guidance for implementing the IRWST makeup strategy.

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.3.2 Manually depressurize SGs to reduce inventory loss

SRI

SRI

Procedures/guidance to be developed by the COL applicant will be applicable to postulated conditions.

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.3.3 Manual operation of Turbine-driven pumps

SRI

SRI

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.3.4 Manually depressurize SGs and use portable pump

SRI

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.3.5 Makeup to CST/AFWST

SRI

SRI

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.3.6 Containment flooding with portable pump

SRI

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.3.7 Portable sprays

SRI

The mitigative strategy template (MST) in the Appendix A.4 of this report identifies how this strategy will be implemented.

6.4 Submittal Requirements

The DCD submittal 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 DCD submittal requirements for Phase 3 also include the NEI 06-12 PWR EDMG template and the NEI 06-12 PWR EDMG Plant Damage Assessment template, which is included in Appendix B of this report.

7 CONCLUSION

This report has identified the regulatory requirement and sufficiency criteria for meeting the regulation for LOLA for DCD. The requirements of NEI 06-12 and the Phase 1 LOLA template have been addressed and requirements have been specified based on the APR1400 design.

The design features of the APR1400 as assessed for LOLA for the DCD when combined with COL applicant commitments will meet the regulatory requirements.

This report concludes that the APR1400 meets the regulatory requirements for LOLA at the DCD stage of licensing.

8 REFERENCES

1. Nuclear Energy Institute report, NEI 06-12, Revision 3, prepared by ERIN Engineering & Research “B.5.b Phase 2 & 3 Submittal Guideline,” dated July 2009.

2. APR1400-K-X-FS-14002. "APR1400 Design Control Document", Tier 2, Rev.1, KEPCO and KHNP, March 2017.

3. NEI Letter from Marvin Fertel to Luis Reyes on Closure of Phase 2, January 24, 2006 (Reference 1 to NEI 06-12).

4. KEPCO E&C Drawing 1-691-M105-003, P&I Diagram Fire Protection System (FP) 3/15, Revision 0.

5. 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.

6. KEPCO Engineering & Construction, Inc., LOLA Design Enhancement Report (Draft), 1-037-N462-403, Revision A.

7. DC/COL-ISG-016, "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".

APPENDIX A

Licensee Response Templates

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A Mitigative Strategies Report

A.1 Introduction

The purpose of this Mitigative Strategies Report is to identify strategies that the APR1400 will implement in the event that a large area of the facility is lost due to explosions or fire. Initiating events classified as Loss of Large Areas (LOLA) are beyond the design basis for existing and proposed new nuclear power plants. Existing nuclear power plants have evaluated these beyond design basis events and implemented changes and operational programs to assist in coping with LOLA events. The operational and programmatic elements of responding to LOLA events will be addressed by the COL applicant prior to fuel load.

The LOLA mitigative strategies required by 10 CFR 50.54(hh)(2) (Reference 1) are summarized in this report and are submitted to the NRC in accordance with 10 CFR 52.80(d). The Statements of Consideration for 10 CFR 52.80(d) (Reference 2) states that the commission decided that the most appropriate and efficient process is to review the procedures and guidance for 10 CFR 50.54(hh)(2) strategies as part of the review of operations procedures and beyond design basis guidelines similar to operational programs. Therefore, this report is written at the programmatic level for licensing approval and the implementation details and documentation will be available for inspection prior to fuel load.

The APR1400 approached the LOLA event evaluations in a phased approach similar to the existing plants. Phase 1 LOLA event evaluations focus on 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. These items apply to programmatic aspects of a plant once it is operational and procedures are written and in-place to control processes. Many of the items addressed within the referenced guidance documents involve assessments, evaluations, action plans and procedural development that cannot be accomplished until a plant is near the completion of construction.

Phase 2 LOLA event evaluations focus on issues associated with mitigating an event involving the spent fuel pool (SFP). They include issues such as fuel configuration within the pool and focus on alternative sources of water that could be provided to the SFP for cooling, heat removal, and inventory makeup. The SFP for the APR1400 is located above grade in the auxiliary building and is subject to Phase 2. The APR1400 does not have diverse concurrent makeup capability beyond the normal SFP makeup system that exceeds 1,892.75 L/min (500 gpm).

Phase 3 LOLA event evaluations focus on methods to provide sources of alternative cooling water to critical systems as well as mitigating the impact of a radiological release. In addition, they focus on alternative methods to operate critical systems or components in a manner to assist with the mitigation of the event. Safety functions are identified and mitigative strategy is developed for each of those functions in order to maintain or restore core cooling, containment cooling, and spent fuel pool cooling capabilities.

This report is based on a review of current regulatory guidance; experience gained from the existing nuclear fleet as they addressed B.5.b issues, the APR1400 standard plant design. No site specific design is included at this time. It is written using the guidance of DC/COL-ISG-016 (Reference 7) and NEI 06-12, Revision 3 (Reference 4). The format and evaluations performed for the report are primarily based on NEI 06-12, Rev. 3, as the NRC has stated in the statements of consideration (SOC) related to the new 10 CFR 50.54(hh)(2) that NEI 06-12 provides an acceptable means for developing and implementing Phase 2 and Phase 3 mitigation strategies.

In developing appropriate mitigative strategies, existing nuclear power plants often relied on providing a large volume of water from an alternate, independently powered system to help mitigate a LOLA event. This resulted in a critical review and implementation of procedures for utilizing the facility's fire protection

system in various support configurations. This approach, when combined with a portable independently powered pumping system, generally meets the requirements to help mitigate events following a LOLA. This same approach has been followed in developing this report. The design of the fire protection system for the APR1400 includes enhancements that could improve the capability of the system to be available and to provide sufficient water, if needed, to mitigate a LOLA event.

Table A.1-1 summarizes the mitigative strategies. Tables A.2-1 through A.4-7 include the response templates for the applicable mitigative strategies.

A.2 Phase 1 Mitigative Strategies

Phase 1 of the B.5.b assessments focused on enhancement of a plant's fire-fighting response capability to respond to losses of large areas of the plant due to fire or explosions. The NRC issued guidance for meeting the different expectations of Phase 1 of B.5.b in a document titled, “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.” That guidance document identified numerous items to be assessed on an individual plant site basis, such as onsite fire fighting capability, off-site fire fighting resources, accelerant-fed fire fighting capabilities, hoses and self-contained pumps for moving water for fire fighting and core cooling, etc. Most of these items involve assessments, evaluations, action plans and the development of procedures that cannot be accomplished until the facility is near the completion of construction. These items are nonetheless Phase 1 expectations listed in the enclosed Mitigative Strategies Table (MST) with a description on how the APR1400 meets each expectation. Table A1-1 summarizes the strategies.

A.2.1 Staging Area

The COL applicant is to establish a staging area for pre-positioned equipment and materials at an appropriate location (onsite or nearby offsite) that would not be expected to be affected by the event itself.

A.2.2 Notifications

The COL applicant is to establish procedures for pre-event notification which may allow for staging personnel in alternative areas to maximize survivability of onsite personnel. Evacuation of target buildings should be considered.

A.2.3 Airlifted Resources

The COL applicant is to identify airlifted resources (personnel and equipment) for fire fighting. Resources should arrive within two hours (door-to-door).

A.2.4 Command and Control

The COL applicant is to, as part of a coordinated fire fighting response strategy, provide for the plant coordination with offsite local fire departments to support plant recovery efforts, including using these facilities as a staging area for specialized equipment and material; and coordination of large, nearby municipal fire departments (i.e., if not already in a mutual aid agreement), specialized fire fighting equipment at nearby industrial facilities, nearby airports and military bases, national fire fighting assets (e.g., USDA Forest Service), and private fire fighting companies.

A.2.5 Outside Organizations

The COL applicant is to identify outside organizations that may have the required knowledge, skills, and abilities to support response actions.

A.2.6 Establishment of Memorandums of Understanding

The COL applicant is to identify outside organizations that may have the required knowledge, skills, and abilities to support response actions.

A.2.7 Roles and Responsibilities

The COL applicant is to provide in either MOUs/agreements already established, or new agreements that are to be put in place as a result of newly evaluated measures, those arrangements established to address the roles and responsibilities of the responders and their integration into the overall fire fighting strategy. Ground-based regional support should arrive within two hours (door-to-door).

A.2.8 Use of Local Offsite Facilities

The COL applicant is to provide in either MOUs/agreements already established, or new agreements that are to be put in place as a result of newly evaluated measures, those arrangements established to address the roles and responsibilities of the responders and their integration into the overall fire fighting strategy. Ground-based regional support should arrive within two hours (door-to-door).

A.2.9 Control of Emergency Response Vehicles

The COL applicant is to establish provisions for controlling the large number of emergency response vehicles that may arrive at the plant in response to the event, such as, arrangements for establishing a staging area. Pre-event coordination should include local law enforcement agencies to ensure that responding fire fighting assets are not restricted from the staging areas or locations directed by plant operators. Provisions for security and radiological protection should be maintained.

A.2.10 Communications Enhancements

The COL applicant is to establish the following communications enhancements: (1) providing pagers for potential responders to receive dispatch notices both on and off shift; (2) checking for interoperability of radios to ensure that fire and rescue organizations have compatible equipment; and (3) availability of batteries/chargers to support the use of radios during an event of extended duration.

A.2.11 Treatment of Casualties

The COL applicant is to provide for the treatment of casualties. Triage areas should be established at least 91.44 m (100 yards) from target areas (e.g., auxiliary building).

A.2.12 Alternate Site Assembly Area

The COL applicant is to establish alternate site assembly areas for personnel.

A.2.13 Fire Training

The COL applicant is to provide plant personnel responsible for fire fighting with general training knowledge about an accelerant fed fire and appropriate training to ensure effective implementation of actions that are part of the coordinated response strategy. Event responders that are part of the mutual aid considerations should, as a minimum, receive site familiarity training, and planning for a site exercise with their involvement should be considered. When site exercise training is not feasible for identified mutual aid organizations, use of table top exercise training (preferably provided at the site as part of site familiarity training) is to be considered.

A.2.14 Feeding Fire Protection Ring Header

One of the Phase 1 fire-fighting mitigative strategies is to develop a means to supply an alternate water source feed for the fire protection yard main loop in the event that the normal supply source (typically a fire water storage tank) is lost. To facilitate and support this enhancement, the underground yard ring header is designed to provide a minimum of two (2) external connections that can be used to connect an external water source and pumping capability. The external water sources include the fire water tanks, raw water storage tank, fresh water storage tank, demineralized water storage tank, reactor makeup water storage tank, and the ultimate heat sink (e.g., cooling tower basin, lake, river). Procedures will address the actions necessary to provide staged on-site water sources and an alternate off-site feed path to the ring header. Several yard hydrants are attached to the ring header on all four sides of the power block and several valves are located in the ring header. The APR1400 design which includes diverse locations and number of yard hydrants as well as numerous ring header isolation valves can successfully support supplying the fire protection ring header from an external water source. The COL applicant is to will establish procedural requirements.

A.2.15 Communication Enhancements

Another Phase 1 Mitigative Measure is to provide communication equipment, such as radios, cell phones, etc., to facilitate the response to a LOLA event. The radios are used for effective command and control of responses during a LOLA event. The mitigative action of providing and maintaining additional radios, cell phones, etc. is a programmatic issue to be addressed as each unit is nearing operational status. Through operating experience, several current plants have identified that radios are often inoperable or not as functional once an individual enters a robust building during a beyond design basis LOLA event involving a loss of all alternating current (AC) and direct current (DC) power. Radios associated with fire fighting will be stored at least 91.44 m (100 yards) from the auxiliary building. Operations personnel should use a separate set of radios to avoid confusion with the fire fighting response. The radios used by operations personnel shall be distributed at a location greater than 91.44 m (100 yards) from the auxiliary building. The COL applicant is to establish these requirements.

Nuclear plant sites have a range of communication systems, including a plant radio system with portable hand-held radios and an independent power supply system, for non-portable communications equipment. The detailed design of the internal communication systems considered these beyond design basis conditions with the intent of improving communications within the structures for portable equipment. This includes the addition of items that would support the internal communication system[s] such as repeaters, antennas, back-up power sources, leaky coax cables, etc.

A.2.16 Positioning Personnel and Staff Augmentation

The COL applicant is to provide for the pre-defined positioning and dispersal of personnel at the site to support fire fighting and recovery operations, in addition considerations for staff augmentation is to include:

(1) planning to share personnel at multi- unit facilities;

(2) verifying that existing callout plans provide rapid response by teams of personnel in the areas of operations, fire fighting, maintenance and engineering, and their reliefs

(3) arranging for receiving facilities at the site should the deployment of a rapid response team be necessary, including identifying nearby landing zones for helicopters.

The COL applicant is to establish these requirements, including applicable procedures.

A.2.17 Communication Capabilities

The COL applicant is to provide communication capabilities that ensure that established communications

can facilitate the focus of fire/response teams on those plant operations necessary to mitigate fuel damage.

A.2.18 Fire Fighting and Recovery Operations

The COL applicant is to evaluate the need to establish other procedures or SAMGs like format documents that would be used to document the details of the strategies and guidance for fire fighting and recovery operations. Included within these documents should be ways to refill coolant makeup tanks and the identification of penetrations communicating with the reactor coolant system that could be isolated remotely from the control room and/or remote locations to minimize coolant loss.

For the APR1400, SAMG-like guidance is to be available to operators and the Emergency Response Organization (ERO) to implement the mitigative strategies that are discussed in this report. That guidance addresses equipment locations, hoses, connection points and other necessary details for implementing the strategy. The COL applicant is to develop this guidance.

A.2.19 Evaluation of Buildings and Equipment

Vulnerable buildings and equipment were evaluated to determine if core cooling could be maintained or restored using existing or newly developed procedures and existing and staged equipment. The auxiliary building contains equipment required for core cooling. Portable equipment and water sources is to be located an adequate distance from the auxiliary building (i.e., at least 91.44 m (100 yards) away).

A.2.20 Additional Operational Contingency Action Guidance

The COL applicant is to develop an additional “Operational Contingency Action Guidance” to be considered for compensatory functions in the event of loss of normal and emergency plant systems (e.g., directions to mechanically start a turbine-driven AFW pump upon loss of all power, and directions on use of other Unit 2 divisional batteries to supply Unit 1 divisional DC buses).

A.2.21 EDG Blackstart Capability

The COL applicant is to establish procedures for starting an EDG without DC power, and use of a portable pump as an alternate supply of low pressure water for supporting core cooling functions and providing a supply of water to the SFP. A portable diesel-driven pump and a mobile AC generator are to be provided.

A.2.22 Compartmentalization

The COL applicant is to provide for compartmentalization of areas of the plant by securing access pathways during normal operations to minimize the spread of combustible liquids. Compartmentalization is considered in the APR1400 design by implementing several design enhancements as recommended by the aircraft impact analysis (Section 19.5). These design enhancements include blast door and fast-acting blast dampers, which serve to increase the plant compartmentalization in response to rapid fire spread.

A.2.23 Equipment Survivability and Accessibility

The COL applicant is to consider equipment survivability and personnel accessibility within plant areas potentially affected by the fire or explosion.

A.2.24 Portable and Offsite Equipment

The COL applicant is to implement strategies for relying on portable and offsite equipment (some onsite

and some offsite).

A.2.25 Supplemental Methods

The COL applicant is to consider supplemental methods for responding to events. For example, the COL applicant may establish contracts with drilling companies to drill a well and pump water to the ultimate heat sink if needed.

A.2.26 Contract Water Supply

The COL applicant is to provide a contract water supply within 12 hours to cool the component cooling water heat exchanger upon loss of normal cooling water.

A.2.27 Additional SFP Mitigative Measures

The COL applicant is to provide for the following measures:

a. 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;

b. Highest decay power assemblies should not be located in rack cells positioned above the rack feet;

c. 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);

d. 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); and

e. Providing for emergency pool water makeup, and pool leakage reduction and/or emergency repair measures, as well as implementing actions to address adverse radiological conditions.

A.2.28 Training to Prevent Fuel Damage

The COL applicant is to provide appropriate training consistent with the actions necessary to accomplish the mitigation strategies developed for preventing fuel damage. Training material on mitigation strategies to prevent fuel damage is to be designed, developed, and conducted. Training on mitigation strategies is to be incorporated into initial and requalification licensed operator training programs.

A.2.29 Mitigating Radiation Releases Outside Containment

The COL applicant is to 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) as an attenuation measure for mitigating radiation releases outside containment.

A.2.30 Water Spray Scrubbing Equipment

The COL applicant is to provide for the pre-staging of water spray scrubbing equipment. This equipment is to be stored at least 91.44 m (100 yards) from the auxiliary building.

A.2.31 Evaluation of Dose Projection Models

The COL applicant is to evaluate dose projection models for their adequacy in projecting doses to event responders onsite under the conditions envisioned for this event.

A.3 Fire Protection System (FPS) Features to Facilitate Phase 2 and Phase 3 Mitigative Strategies

For the APR1400, the FPS, which includes the fire pumps, fire water storage tanks, and the underground yard main loop, provides the water delivery for the fire protection system.

For the APR1400 the FPS is designed to facilitate Phase 1, 2, and 3 mitigative strategies. The FPS is sized such that it contains sufficient water for two-hour operation of the largest sprinkler system plus a 1,892.75 L/min (500 gpm) manual hose stream allowance to support fire suppression activities. Design features include three 50 percent capacity fire pumps (one electric and two diesel), redundant fire water storage tanks (minimum total capacity of 1,135.62m^3 (300,000 gallons) each), refill capability for one fire water storage tank, an underground fire water yard main loop supply piping with post indicator valves that provide sectionalized control and isolation of portions of the loop, standpipe and hose stations with minimum length of hose to meet the applications, and manual and automatic suppression systems(Reference 8, Section 9.5.1.2).

A.3.1 Fire Protection System (FPS)

A.3.1.1 Physical Location of Equipment

The FPS water supply pumps and water storage tanks are physically located a minimum of 91.44 m (100 yards) from the key plant target areas, e.g., the auxiliary buildings and containments. This positioning assists with meeting various aspects associated with LOLA. Spatial separation improves the possibility that the diesel fire pump and a water source will be available when needed. This distance from key plant areas locates the equipment outside of the anticipated damage zone as discussed in NEI 06-12, Rev. 3. The design of the fire protection system has isolation valves for each branch header from the yard main loop. These are post indicating valves (PIV) located outside that will isolate the FPS as it enters into each building. A building may have more than one feeder header from the yard loop based on the size and demand for the building. The remaining yard main loop header system is provided with additional isolation valves to permit isolation of portions of the yard main loop for maintenance and repair. The COL applicant is to ensure these requirements are met.

A.3.1.2 Pump Redundancy

The fire pump house contains one electric pump and two diesel-driven pumps. The diesel-driven fire pumps can be used for supplying water during a LOLA event assuming loss of AC and DC conditions. The diesel-driven fire water pumps have a fuel supply sufficient to operate for a minimum of 12 hours. The COL applicant is to ensure this requirement is met.

The APR1400 also retains an independently powered portable pump to provide an alternative means of moving water under various conditions, including use during a LOLA event. This portable pump is for emergency use only and, as such, provides defense-in-depth to make water available if the diesel-driven fire pump is lost. This portable pump has a fuel tank capacity for 12 hours of operation. The water source for the portable pump may be the FPS, if available, or alternate water sources, such as the raw water storage tank, fresh water storage tank, demineralized water storage tank, reactor makeup water storage tank, and the ultimate heat sink (e.g., cooling tower basin, lake, river). The COL applicant is to establish these requirements, including applicable procedures.

A.3.1.3 Fire Water Storage Tank Refill Station

For the APR1400 the design basis refill capability is to be provided specifically for the fire water storage tanks and location of the refill capability is to be specified by the COL applicant. Fire water storage tanks refill capability is necessary to meet fire protection design basis guidance in Regulatory Guide (RG) 1.189. Based on this guidance, the fire water storage tanks require the refill of one tank (with a minimum of 1,135.62m^3 (300,000 gallons) capacity) within eight hours after a design basis fire event. This requires a refilling capacity of approximately 2,365.94 L/min (625 gpm). The water source for the refill station is to be specified by the COL applicant. Refill capability under conditions of loss of normal AC power is to be provided and described by the COL applicant. This provides defense in depth for responding to a LOLA event by making more fire protection water available.

The COL applicant is to establish these requirements, including applicable procedures.

A.3.1.4 Fire Protection System Management

The fire protection system at many sites is the most flexible system that can be employed to mitigate many of the elements associated with LOLA events. Since portions of the fire protection system are relied on for implementation of event strategies, the management of the system is outlined in procedures/guidelines to be developed by the COL applicant. In implementing LOLA strategies, the fire protection system may be used as a water source provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and supporting the LOLA strategy. Guidance developed to manage the FPS includes methods to isolate potentially damaged headers and if possible ring header sectionalization. The fire system management strategy addresses isolation of fire headers inside structures that may be target areas. The pump[s] used to charge the ring header is located more than approximately 91.44 m (100 yards) from the target areas to assure it is available after a LOLA event.

The COL applicant is to establish these requirements, including applicable procedures.

A.4 Phase 2 Mitigative Strategies

Phase 2 of 10 CFR 50.54(hh)(2) mitigative strategies concerns spent fuel pool (SFP). NEI 06-12, Rev. 3, identifies different strategies to mitigate damage to fuel in the SFP for a LOLA event. The COL applicant is to develop mitigative strategies using guidance from NEI 06-12, Rev. 3, and the APR1400 has design enhancements to facilitate the implementation of these mitigative measures that eliminate or reduce reliance on operator actions. Table A.1-1 summarizes the strategies.

A.4.1 Diverse Spent Fuel Pool (SFP) Makeup Source (Internal Strategy)

SRI

SRI

The COL applicant is to establish these requirements, including applicable procedures.

A.4.2 Diverse Spent Fuel Pool (SFP) Makeup Source (External Strategy)

A.4.2.1 Establish A Flexible Means of SFP Makeup of At Least 1,892.75 L/min (500 gpm) Using an AC power-Independent Pumping Capability

SRI

The COL applicant is to establish these requirements, including applicable procedures.

A.4.2.2 Establish a Flexible Means of Providing at Least 757.1 L/min (200 gpm) Per Unit of Spray to The SFP Using an AC Power-Independent Pumping Capability

SRI

The COL applicant is to establish these requirements, including applicable procedures.

A.4.3 SFP Leakage Control Strategies

The SFP leakage control strategies provided in NEI 06-12, Rev. 3, are based on operational actions. The SFP for the APR1400 is designed to have thick, heavily reinforced concrete walls and floor. Nonetheless, appropriate SFP leakage control strategies and procedures are to be identified by the COL applicant.

A.5 Phase 3 Mitigative Strategies

Phase 3 of the LOLA mitigative strategies is intended to restore or maintain core and containment cooling in order to mitigate potential damage to fuel in the reactor coolant system and to mitigate potential radiological releases through the containment or other walls. The Phase 3 efforts for the industry identified changes based on reactor type, and NEI 06-12, Rev. 3 identified different mitigation strategies for PWRs and for BWRs.

The APR1400 has identified the key safety functions for their design. The Phase 3 evaluations performed for the APR1400 are based on the mitigative strategies identified for those functions in NEI 06-12, Rev. 3, other strategies that have been added based on the new plant design and key safety functions that were not covered by the listed NEI 06-12 strategies. For the APR1400 no new safety functions were identified.

The APR1400 standard plant design already includes design enhancements that address some of the LOLA mitigative measures in NEI 06-12, Rev. 3, and the evaluation below credits design enhancements

to better respond to the LOLA event. The operational and programmatic aspects for Phase 3 mitigative measures, including the principal human actions and command and control measures specified in Section 3.2 of NEI 06-12, Rev. 3, are to be addressed by the COL applicant. Table A.1-1 summarizes the strategies.

A.5.1 Command and Control

The industry has invested extensively in establishing command and control structures for emergency conditions. However, the extent and type of damage postulated for some beyond design basis security threats may create unique challenges. Normal command and control structures may be interrupted, thereby creating implementation issues associated with procedurally required actions, communications, and organizational factors that could further complicate mitigation response for these types of postulated LOLA events. A primary aspect of enhancing command and control for these beyond design basis conditions is providing guidance for use in such circumstances. Establishing guidelines for initial site operational response would allow utilities to plan their strategy if normal command and control is disrupted. Extensive Damage Mitigation Guidelines (EDMG) is the generic term used by the industry. These guidelines are, in fact, intended to be used when the normal command and control structure is disabled and use of EOPs is not feasible. The COL applicant is to identify how this strategy is implemented, including the necessary human actions.

A.5.2 Makeup to IRWST

SRI

A.5.3 Manually Depressurize Steam Generators to Reduce Inventory Loss

SRI

A.5.4 Manual Operation of Turbine-Driven Pumps

SRI

A.5.5 Manually Depressurize SGs and Use Portable Pump

SRI

SRI

The COL applicant is to identify how this strategy is implemented, including the necessary human actions.

A.5.6 Makeup to CST/AFWST

SRI

The COL applicant is to identify how this strategy is implemented, including the necessary human.

A.5.7 Containment Flooding with Portable Pump

SRI

The COL applicant is to identify how this strategy is implemented, including the necessary human actions.

A.5.8 Portable Sprays

SRI

The COL applicant is to identify how this strategy is implemented, including the necessary human actions.

A.6 Conclusion

The APR1400 design utilized the industry developed guidance in NEI 06-12, Rev. 3 to address LOLA events for this new reactor plant. Multiple design enhancements are identified, and will be implemented, with the objective of reducing the burden on plant personnel during a LOLA event. By adding these design features, the capabilities of the plant and emergency response personnel to respond to LOLA events have been enhanced. The strategies identified in NEI 06-12, Rev. 3 have been considered and those that apply are to be developed. The operational and programmatic aspects of responding to LOLA events are to be addressed in facility procedures prior to fuel load.

A.7 References

1. 10 CFR 50.54, “Conditions of Licenses,” U.S. Nuclear Regulatory Commission, June, 2013.

2. 10 CFR 52.80, “Contents of Applications; Additional Technical Information,” U.S. Nuclear Regulatory Commission, March, 2009.

3. Standard Review Plan 19.4, “Strategies and Guidance to address Loss of Large Areas of the Plant due to Explosions and Fires,” Revision 0, U.S. Nuclear Regulatory Commission, May, 2013.

4. NEI 06-12, “B.5.b Phase 2&3 Submittal Guideline,” Revision 3, Nuclear Energy Institute, July, 2009.

5. NFPA 14, “Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems,” 2000 Edition, National Fire Protection Association.

6. NRC RG 1.189, “Fire Protection for Nuclear Power Plants,” Revision 2, U.S. Nuclear Regulatory Commission, October, 2009.

7. DC/COL-ISG-016, "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".

8. APR1400-K-X-FS-14002. "APR1400 Design Control Document", Tier 2, Rev.1, KEPCO and KHNP, March 2017.

Table A.1-1 (1 of 14)

Mitigative Strategies

Item	Expectation/Safety Function	Commitment/Strategy
Phase 1		
FIRE FIGHTING RESPONSE STRATEGY		
1	Establishment of a staging area for pre-positioned equipment and materials at appropriate locations (onsite or nearby offsite) that would not be expected to be affected by the event itself.	This is to be addressed by the COL applicant.
2	Pre-event notification may allow for staging personnel in alternative areas to maximize survivability of onsite personnel.	This is to be addressed by the COL applicant.
3	Identifying airlifted resources (personnel and equipment) for fire fighting.	This is to be addressed by the COL applicant.
4	Evaluate the command and control functions needed to ensure that the responding assets follow the established preplanned strategies, and that the evaluation takes into account the necessary technical assistance aspects of the command and control functions.	This is to be addressed by the COL applicant.
5	Identifying outside organizations that may have the required knowledge, skills, and abilities to support response actions.	This is to be addressed by the COL applicant.
6	Establish memorandums of understanding (MOUs), or other agreements which have a limited cost impact, with mutual aid organizations that are within reasonable distance to the site for fire fighting capabilities including accelerant fed fires.	This is to be addressed by the COL applicant.
7	Provide in either MOUs/agreements already established, or new agreements that are to be put in place as a result of newly evaluated measures, those arrangements established to address the roles and responsibilities of the responders and their integration into the overall fire fighting strategy.	This is to be addressed by the COL applicant.

Table A.1-1 (2 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
8	As part of a coordinated fire fighting response strategy provide for the plant coordination with offsite local fire departments to support plant recovery efforts, including using these facilities as a staging area for specialized equipment and material; and coordination of large, nearby municipal fire departments (i.e., if not already in a mutual aid agreement), specialized fire fighting equipment at nearby industrial facilities, nearby airports and military bases, national fire fighting assets (e.g., USDA Forest Service), and private fire fighting companies.	This is to be addressed by the COL applicant.
9	Provisions for controlling the large number of emergency response vehicles that may arrive at the plant in response to the event, such as, arrangements for establishing a staging area. Pre-event coordination should include local law enforcement agencies to ensure that responding fire fighting assets are not restricted from the staging areas or locations directed by plant operators. Provisions for security and radiological protection should be maintained.	This is to be addressed by the COL applicant.
10	The following communications enhancements: (1) providing pagers for potential responders to receive dispatch notices both on and off shift; (2) checking for interoperability of radios to ensure that fire and rescue organizations have compatible equipment; and (3) availability of batteries/chargers to support the use of radios during an event of extended duration.	This is to l be addressed by the COL applicant.
11	Provisions for treatment of casualties.	This is to be addressed by the COL applicant.
12	Alternate site assembly areas for personnel.	This is to be addressed by the COL applicant.

Table A.1-1 (3 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
13	Provide plant personnel responsible for fire fighting with general training knowledge about an accelerant fed fire and appropriate training to ensure effective implementation of actions that are part of the coordinated response strategy. Event responders that are part of the mutual aid considerations should, as a minimum, receive site familiarity training, and planning for a site exercise with their involvement should be considered. When site exercise training is not feasible for identified mutual aid organizations, use of table top exercise training (preferably provided at the site as part of site familiarity training) should be considered.	This is to be addressed by the COL applicant.
14	Develop means to supply the fire protection ring header using off-site resources and a staged on-site licensee purchased portable diesel driven pump.	A portable diesel-driven pump is to be provided and staged onsite. This portable pump may be connected to the fire protection ring header using portable hoses and connectors, which will also be staged with the pump. There are several connections in the yard to the fire protection ring header and several valves in the ring header that could isolate any broken sections of the ring header. The APR1400 design which includes diverse locations and number of yard hydrants as well as numerous ring header isolation valves can successfully support supplying the fire protection ring header using a portable diesel-driven onsite pump. The external water sources include the fire water tanks, the demineralized water storage tank, the raw water storage tank, and the ultimate heat sink (e.g., cooling tower basin, lake, river). The COL applicant is to provide flexible hose(s) with connection provision and procedure/guidance for implementing this strategy with portable pump. If the site fire header is intended to be used for reactor mitigation strategies, the capability to isolate other structures is included.

Table A.1-1 (4 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
PLANT OPERATIONS TO MITIGATE FUEL DAMAGE		
1	Provide for the pre-defined positioning and dispersal of personnel at the site to support fire fighting and recovery operations, in addition considerations for staff augmentation should include: (1) planning to share personnel at multi- unit facilities; (2) verifying that existing callout plans provide rapid response by teams of personnel in the areas of operations, fire fighting, maintenance and engineering, and their reliefs (3) arranging for receiving facilities at the site should the deployment of a rapid response team be necessary, including identifying nearby landing zones for helicopters.	This is to be addressed by the COL applicant.
2	Providing communication capabilities that ensures that established communications can facilitate the focus of fire/response teams on those plant operations necessary to mitigate fuel damage.	This is to be addressed by the COL applicant.
3	Evaluate the adequacy of established plant procedures or the need to establish other procedures or SAMGs like format documents that would be used to document the details of the strategies and guidance for fire fighting and recovery operations. Included within these documents should be ways to refill coolant makeup tanks and the identification of penetrations communicating with the primary system that could be isolated remotely from the control room and/or remote locations to minimize coolant loss.	For new plant sites, SAMG-like guidance is available to operators and the Emergency Response Organization to implement the mitigative strategies that are discussed in this report. That guidance addresses equipment locations, hoses, connection points and other necessary details for implementing the strategy. This is to be addressed by the COL applicant.
4	Evaluate vulnerable buildings and equipment to determine if core cooling could be maintained or restored using existing or newly developed procedures and existing and staged equipment.	The auxiliary building contains equipment required for core cooling. Portable equipment and water sources are to be located an adequate distance from the auxiliary building.

Table A.1-1 (5 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
5	Develop a procedure to allow venting primary containment to secondary containment, without AC power, as an alternate method to remove heat from the primary containment, and providing the feed of the vessel by flooding the steam lines using condensate pumps when no reactor vessel level indication is available.	BWR strategy only. Not applicable to APR1400.
6	Develop an additional "Operational Contingency Action Guidance" to be considered for compensatory functions in the event of loss of normal and emergency plant systems (e.g., directions to mechanically start turbine-driven AFW pump upon loss of all power, and directions on use of other Unit 2 divisional batteries to supply Unit 1 divisional DC buses).	This is to be addressed by the COL applicant.
7	Modify procedures for starting an EDG without DC power, and use of the site fire pumper as an alternate supply of low pressure water for core cooling and providing a supply of water to the SFP. Provide a portable diesel and portable transformer.	This is to be addressed by the COL applicant. A portable diesel-driven pump and a mobile AC generator are to be provided.
8	Compartmentalization of areas of the plant by securing access pathways during normal operations to minimize the spread of combustible liquids.	This is to be addressed by the COL applicant.
9	Consider equipment survivability and personnel accessibility within plant areas potentially affected by the fire or explosion.	This is to be addressed by the COL applicant.
10	Implement strategies for relying on portable and offsite equipment (some onsite and some offsite).	For new plant sites, the Phase 2 and 3 strategies that utilize portable and/or offsite equipment are discussed as part of that strategy. This is to be addressed by the COL applicant.
11	Establish supplemental methods for responding to events. A good practice by one licensee involved establishing contracts with drilling companies to drill a well and pump water to the ultimate heat sink if needed.	For new plant sites, supplemental methods for adding water to the core, spent fuel pool, and ultimate heat sink (if applicable) are established and preplanned. This is to be addressed by the COL applicant.

Table A.1-1 (6 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
12	Provide a contract water supply within 12 hours to cool the component cooling water heat exchanger upon loss of normal cooling water.	For new plant sites, alternative water supplies are available and can be used to cool various plant heat loads. This is to be addressed by the COL applicant.
13	Spent Fuel Pool Mitigative Measures 1. 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; 2. Highest decay power assemblies should not be located in rack cells positioned above the rack feet; 3. 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); 4. 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); and 5. Providing for emergency pool water makeup, and pool leakage reduction and/or emergency repair measures, as well as implementing actions to address adverse radiological conditions.	This is to be addressed by the COL applicant.
14	Provide appropriate training consistent with the actions necessary to accomplish the mitigation strategy developed for preventing fuel damage.	For new plant sites training material on mitigation strategies to prevent fuel damage is to be designed, developed, and conducted. Training on mitigation strategies is to be incorporated into initial and requalification licensed operator training programs. Training material for operators is to be developed using the Systematic Approach to Training (SAT). This is to be addressed by the COL applicant.

Table A.1-1 (7 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
ACTIONS TO MINIMIZE RELEASES		
1	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) as an attenuation measure for mitigating radiation releases outside containment.	This is to be addressed by the COL applicant.
2	Provide for the pre-staging of water spray scrubbing equipment.	This is to be addressed by the COL applicant.
3	Evaluate existing dose projection models for their adequacy in projecting doses to event responders onsite under the conditions envisioned for this event.	This is to be addressed by the COL applicant.

Table A.1-1 (8 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
Phase 2		

SRI

Table A.1-1 (9 of 14)

Item	Expectation/Safety Function	Commitment/Strategy

SRI

Table A.1-1 (10 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
4	Leakage Control Strategies	This is to be addressed by the COL applicant.

SRI

Table A.1-1 (11 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
Phase 3		
1	Command and Control EDMG	For new plant sites, SAMG-like procedure/guidance is developed for command and control (initial response EDMG) and for accomplishing the following safety functions: reactor coolant system (RCS) inventory control, RCS heat removal, containment isolation, containment integrity, and release mitigation. This is to be addressed by the COL applicant.

SRI

Table A.1-1 (12 of 14)

Item	Expectation/Safety Function	Commitment/Strategy

SRI

Table A.1-1 (13 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
9	Manual Operation of RCIC or Isolation Condenser	BWR strategy only.

SRI

Item	Expectation/Safety Function	Commitment/Strategy
		Not applicable to APR1400.
10	DC Power to Depressurize RPV & Inject with Portable Pump	BWR strategy only. Not applicable to APR1400.
11	Utilize Feedwater and Condensate	BWR strategy only. Not applicable to APR1400.

Table A.1-1 (14 of 14)

Item	Expectation/Safety Function	Commitment/Strategy
12	Makeup to Hotwell	BWR strategy only. Not applicable to APR1400.
13	Maximize CRD Flow	BWR strategy only. Not applicable to APR1400.
14	Isolation of RWCU or Other Lines Outside Containment	BWR strategy only. Not applicable to APR1400.
15	Manually Open Containment Vent Lines	BWR strategy only. Not applicable to APR1400.
16	Inject Water into Drywell	BWR strategy only. Not applicable to APR1400.
17	New Strategy Not Covered	No new strategies identified.
18	New Plant Safety Function Mitigative Strategy	No new safety functions identified.
19	New Plant Safety Function Mitigative Strategy	No new safety functions identified.
20	New Plant Safety Function Mitigative Strategy	No new safety functions identified.

Table A.2-1

SFP Makeup – Internal Strategy

SRI

GENERAL DESCRIPTION:	
DIVERSITY OF MAKEUP:	
EQUIPMENT LOCATIONS:	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Flow Rate to SFP:	
Water Source & Capacity:	
PROCEDURE/GUIDANCE:	Procedures and guidance is to be developed by the COL applicant to support implementation, including guidance on decisions to makeup to the SFP versus spray to the SFP.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.2-2

SFP Makeup External Strategy

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Maximum Pump Flow Rate:	
Flow Rate to SFP:	
Water Source & Capacity:	
PROCEDURE/GUIDANCE:	Procedures and guidance is to be developed by the COL applicant to support implementation, including guidance on decisions to makeup to the SFP versus spray to the SFP.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.2-3

SFP Spray – External Strategy

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Maximum Pump Flow Rate:	
Number of Spray Nozzles:	
Capacity of Each Nozzle:	
Rate of Spray to SFP:	
Water Source & Capacity:	
BASIS FOR SPRAY ADEQUACY:	
PROCEDURE/GUIDANCE:	Procedures and guidance is to be developed by the COL applicant to support implementation, including guidance on decisions to makeup to the SFP versus spray to the SFP.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.2-4

Viable Site-Specific SFP Mitigation Strategies

Strategy	List/Implement
PROCEDURE/GUIDANCE:	Confirm that procedure/guidance is to be developed to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

SRI

Table A.2-5

SFP Leakage Control Strategies

GENERAL DESCRIPTION:	
• Provide a list of the types of leakage control capabilities currently available on site and their general location	
PROCEDURE/GUIDANCE:	To be developed by the COL applicant.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.2-6

Fire System Management Strategies

GENERAL DESCRIPTION:	
• A portable diesel-driven pump is to be provided and staged onsite. This portable pump may be connected to the fire protection ring header using portable hoses and connectors, which will also be staged with the pump. There are several connections in the yard to the fire protection ring header and several valves in the ring header that could isolate any broken sections of the ring header. The APR1400 design which includes diverse locations and number of yard hydrants as well as numerous ring header isolation valves can successfully support supplying the fire protection ring header using a portable diesel-driven onsite pump. The external water sources include the fire water tanks, the demineralized water storage tank, the raw water storage tank, and the ultimate heat sink (e.g., cooling tower basin, lake, river). • If the site fire header is intended to be used for reactor mitigation strategies, the capability to isolate other structures is included.	
PROCEDURE/GUIDANCE:	Procedure/guidance is to be developed to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.3-1

Command and Control Enhancements

ONSITE & OFFSITE COMMUNICATIONS:	
To be included in the COL applicant submittal. • Provide a general description of the diverse methods available to communicate with offsite personnel that could be effective for the conditions assumed • Provide a general description of the approach for mustering the available plant resources in the event the control room/staff are substantially affected • Provide a general description of Operations/Security pre-plans for re-establishment of communications immediately following a large fire or explosion • Provide a general description of how operations and security personnel will coordinate activities immediately following a large fire or explosion	
NOTIFICATIONS OF THE UTILITY ERO:	
To be included in the COL applicant submittal. • Provide a general description of the command and control structure that will be established prior to arrival offsite resources, in the event the control room/staff are substantially affected • 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 • 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.	
INITIAL OPERATIONAL RESPONSE ACTIONS:	
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 room. These entry conditions are to be confirmed by the COL applicant. Initial operational response actions will include verifying communications, notifications and ERO callout, verification of reactor trip and AFW running, and subsequent starting of a TDAFW pump with no AC/DC power available. Procedures and/or guidance and training are to be developed by the COL applicant for the initial operational response under the postulated conditions.	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved the initial operational response actions	
Equipment	Location
To be determined by COL applicant.	
NOTIFICATIONS OF THE UTILITY ERO:	
The damage assessment provided to the ERO is to be specified by the COL applicant. Procedures and/or guidance and training are to be developed by the COL applicant for the ERO damage assessment.	

NOTE : Onsite and offsite communications is not required for the DCD submittal and is required for the COL applicant submittal. Notification of the utility ERO is not required for the DCD submittal and is required for the COL applicant submittal. Initial operation response actions should be included in the DCD submittal and also included in the COL applicant submittal.

Table A.4-1

PWR Enhancement Strategy #1
IRWST Makeup

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
CAPACITIES & FLOWRATES:	
Flow Rate to RWST:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	Procedures/guidance is to be developed by the COL applicant to support implementation.
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.4-2

PWR Enhancement Strategy #2
Manually Depressurize SGs to Reduce RCS Inventory Loss

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
PROCEDURE/GUIDANCE:	Procedures/guidance is to developed by the COL applicant to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.4-3

PWR Enhancement Strategy #3
Manual Operation of Turbine-Driven AFW Pump

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
CAPACITIES & FLOWRATES:	
Flow Rate to SGs:	
Capacity of Water Source:	
INSTRUMENTATION/ OPERATOR AIDS:	
PROCEDURE/GUIDANCE:	Procedures/guidance is to be developed by the COL applicant to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.4-4

PWR Enhancement Strategy #4
Manually Depressurized SGs and Use Portable Pump

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
CAPACITIES & FLOWRATES:	
Flow Rate to SG(s):	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	Procedures/guidance is to be developed by the COL applicant to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.4-5

PWR Enhancement Strategy #5
Makeup to CST

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
CAPACITIES & FLOWRATES:	
Flow Rate to CST:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	Procedures/guidance is to be developed by the COL applicant to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.4-6

PWR Enhancement Strategy #6
Containment Flooding with Portable Pump

SRI

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
CAPACITIES & FLOWRATES:	
Flow Rate to Containment:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	Procedures/guidance is to be developed by the COL applicant to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

Table A.4-7

PWR Enhancement Strategy #7
Portable Sprays

GENERAL DESCRIPTION:	
EQUIPMENT LOCATIONS:	
Equipment	Location
CAPACITIES & FLOWRATES:	
Estimated Spray Flow Rate:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	Procedures/guidance is to be developed by the COL applicant to support implementation.
NOTES (INLUDE DEVIATIONS/JUSTIFICATIONS)	

SRI

ATTACHMENT A of EXAMPLE PWR EDMG
Communication Options

Example PWR EDMG

COMMUNICATION ASSESSMENT FOR DAMAGE TO KEY STRUCTURES
----- EXAMPLE ONLY ----

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
Auxiliary	Not Operable	Operable May be affected in damage zone due to loss of antennas.	Operable except in affected areas	Not Operable	Operable except in affected areas	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
Containment	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.						

APPENDIX B

Example PWR EDMG

Example PWR EDMG from NEI 06-12

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 are selected at the discretion of the User.

TABLE OF CONTENTS

B Example PWR EDMG

B.1 Purpose

B.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 Panel.

B.2 Entry Conditions

B.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 Panel.

B.2.2 Declaration of 50.54(x) is required.

B.3 Scope

B.3.1 Communications (Attachment A)

B.3.2 Notifications/ERO Callout

B.3.3 Immediate local actions should be taken to verify reactor tripped and an auxiliary feedwater pump running, if verification from the Control Room is not possible.

B.3.4 The TDAFW Pumps are the primary method for providing feed flow to SGs during a complete loss of power. Each pump has a design flow rate of 650 gpm, and can maintain some flow as long as steam supply pressure is greater than 75 psig.

B.3.5 *PROCEDURE2* provides the steps necessary to start the TDAFW Pump with no AC/DC power available.

B.3.6 The TDAFW flow control valves (i.e., modulating valves) fail open on loss of power, so it will be necessary to establish an alternate method of flow control to prevent underfeeding/overfill of the steam generators.

B.4 Instructions

NOTE

Continue action steps begun in the EOP network unless specifically stopped by a recommendation from the TSC.

B.4.1 Assess Plant Damage Condition

B.4.1.1 Determine if control room is accessible and useable

B.4.1.2 Determine primary area of damage

B.4.2 Invoke Appropriate Regulatory Requirements

B.4.2.1 Refer to *PROCEDURE3*, "Control Room Emergency Operation," and determine applicability of 10CFR50.54(x) invocation.

B.4.2.2 Refer to *PROCEDURE4*, "Classification and PARs," and request unaffected unit complete the required NRC notifications.

B.4.3 Determine Communication Options

B.4.3.1 Use Attachment A to determine potential communication options if normal communication methods are affected.

B.4.4 Perform Local Immediate Actions

Table 1 – Conditions Necessary to Perform Local Immediate Actions

Conditions	Requirement	Special Tools/Equipment
Access to Auxiliary Bldg and Turbine Bldg	Confirm it is safe to access	Portable lighting may be required

B.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 MG set output contactors locally.

B.4.5 Locally Start TDAFP

B.4.5.1 DETERMINE conditions necessary to operate TDAFW Pump.

Table 2 – Conditions Necessary to Operate TDAFW Pump		
Condition	**Required**	**Special Tools/Equipment**
Access to BUILDING1	Confirm that radiation levels and temperatures permit access	Portable lighting required mat be required
Steam supply from at least one SG	Steam supply pressure >*75* psig	N/A
Speed indication	If instrument power is lost, use local speed indication	Handheld strobe light tachometer
Cooling	Not Required	Block doors open to provide ventilation, if necessary
TDAFW Pump Available		**Yes/No**

B.4.5.2 Refer to *PROCEDURE2* and locally start TDAFP in manual.

B.4.6 Check Plant Status

B.4.6.1 Complete Attachment B

B.4.7 Implement Actions as Directed by TSC

- Desired lineups
- Imposed limitations
- Special parameter monitoring
- Tank refilling

B.5 References

PROCEDURE1 – Procedure directing entry into this guideline

PROCEDURE2 – Procedure for Operating TDAFW pump without power

PROCEDURE3 – Procedure for invoking 50.54(x)

PROCEDURE4 – Procedure for Event Classification

PROCEDURE5 – Procedure for standard lineup of AFW suction water source

PROCEDURE6 – Procedure for alternate supply to AFW suction water source

ATTACHMENT B of EXAMPLE PWR EDMG
Plant Damage Assessment

Building	Elevation	Visible Damage	Accessibility	Equipment Status/System Integriity
Containment	n/a			
Control	57’ 77’ 111’ 139’			
Auxiliary	21’ 57’ 77’ 111’ 139’			
Turbine	66’ 92’ 115’ 145’			
Intake Structure	All			