Rulemaking for Station Blackout Mitigation Strategies

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Regulatory Basis Document

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Table of Contents

Acronyms

10 CFR	Title 10 of the *Code of Federal Regulations*
AEC	Atomic Energy Commission
ac	Alternating current
ADAMS	Agencywide Documents Access and Management System
ANPR	Advance notice of proposed rulemaking
COL	Combined License
CP	Construction permit
DBA	Design basis accident
DC	Design certification
dc	Direct current
ELAP	Extended loss of ac power
EOP	Emergency operating procedures
FLEX	Diverse and flexible coping strategies
GDC	General design criterion
ISG	Interim Staff Guidance
LOOP	Loss of offsite power
ML	Manufacturing license
NEI	Nuclear Energy Institute
NTTF	Near-Term Task Force
NRC	Nuclear Regulatory Commission
NUMARC	Nuclear Management and Resources Council
OMB	Office of Management and Budget
OL	Operating license
PDC	Principal design criteria
PRM	Petition for rulemaking
RCS	Reactor coolant system
RG	Regulatory Guide
SBO	Station blackout
SDA	Standard design approval
SFP	Spent fuel pool
SRM	Staff requirements memorandum
SSC	Structure, system, and component

1. Executive Summary

The Nuclear Regulatory Commission (NRC), in the staff requirements memorandum (SRM) on SECY-11-0124, dated October 18, 2011, approved the NRC staff's proposed actions to implement without delay the development of a regulatory basis, proposed rule, and implementing guidance to enhance the capability of nuclear power plants to maintain safety through a prolonged station blackout (SBO) (Ref. 1). The anticipated regulatory actions originate in large measure from Recommendations 4 and 7 of *The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident* (NTTF report), Enclosure (1) to SECY-11-0093, *The Near-Term Report and Recommendations for Agency Actions Following the Events in Japan*, dated July 12, 2011 (Ref. 2). In SRM-SECY-2011-0124, the Commission directed the NRC staff to: initiate a rulemaking for recommendation 4.1, *Station blackout regulatory actions*, as an advance notice of proposed rulemaking (ANPR); designate the SBO rulemaking associated with Near-Term Task Force(NTTF) Recommendation 4.1 as a high-priority rulemaking; craft recommendations that continue to realize the strengths of a performance-based system as a guiding principle and consider approaches that are flexible and able to accommodate a diverse range of circumstances and conditions.

In SRM-COMSECY-13-002, dated March 4, 2013, the Commissioners instructed the NRC staff to consolidate rulemaking activities associated with NTTF Recommendation 4 (strengthening station blackout mitigation capability at all operating and new reactors for design-basis and beyond-design-basis external events) and NTTF Recommendation 7 (enhancing spent fuel pool (SFP) makeup capability and instrumentation for the spent fuel pool) into one rulemaking, entitled the *Station Blackout Mitigation Strategies Rulemaking* (Ref. 3).

This regulatory basis document concludes that there is sufficient basis to fulfill the Commission's explicit direction, as documented in SRM-SECY-11-0124 and SRM-COMSECY-13-002, to address station blackout mitigation strategies in a rulemaking.

2. Introduction

The alternating current (ac) electric power for essential and nonessential service in a nuclear power plant is supplied primarily by offsite power. Redundant onsite emergency ac power systems also are provided in the event that all offsite power sources are lost. These systems provide power for various safety systems, including reactor core decay heat removal and containment heat removal systems that are important for preserving the integrity of the reactor core and the containment building, respectively. The reactor core decay heat also can be removed for a limited time period by safety systems that are independent of ac power.

Under the current regulatory framework, the term "station blackout" means the loss of offsite ac power to the essential and nonessential electrical buses concurrent with a turbine trip and the unavailability of the redundant onsite emergency ac power system (e.g., as a result of units out of service for maintenance or repair, failure to start on demand, or failure to continue to run after start) except for available ac power to buses fed by station batteries through inverters or by alternate ac sources as defined in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.2 (Ref. 4). If an SBO persists for longer than the ac-independent systems are capable of removing decay heat, core melt and containment failure could result. Current regulations require nuclear power plants to be able to withstand, and recover from, an SBO of a duration determined in accordance with 10 CFR 50.63 (Ref. 4), "Loss of all alternating current power" (sometimes referred to as the SBO rule) and to ensure core cooling and appropriate containment integrity for the specified duration. For a multiunit site, station blackout was assumed to occur only at one unit.

The events that occurred at the Fukushima Dai-ichi Nuclear Power Plant site, however, highlight the possibility that extreme natural phenomena could challenge the prevention, mitigation, and emergency preparedness defense-in-depth layers that are currently in place under the NRC's regulatory framework. On March 11, 2011, a magnitude 9.0 earthquake struck off the coast of the Japanese island of Honshu. The earthquake resulted in a large tsunami which inundated the Fukushima Dai-ichi site. The earthquake and tsunami produced widespread devastation across northeastern Japan and significantly affected the infrastructure and industry in the northeastern coastal areas of Japan. When the earthquake occurred, Fukushima Dai-ichi Units 1, 2, and 3 were in operation; and Units 4, 5, and 6 were shut down for routine refueling and maintenance activities. The Unit 4 reactor fuel had been offloaded into the Unit 4 spent fuel pool to facilitate maintenance activities in the reactor pressure vessel.

Shortly after the earthquake, the three operating units automatically shut down, and offsite power was lost to the entire facility. The emergency diesel generators started at all six units, providing ac electrical power to critical systems at each unit. Approximately 40 minutes after the earthquake and shutdown of the operating units, the first large tsunami wave inundated the site, followed by additional waves. The tsunami caused extensive damage to site facilities and resulted in a complete loss of all ac electrical power at Units 1 through 5 (i.e., an SBO). In addition, all direct current (dc) electrical power was lost early in the event at Units 1 and 2, and after some period of time at Units 3 through 6. Unit 6 retained the function of one air-cooled emergency diesel generator. Despite their actions, the operators lost the ability to cool the fuel in the Unit 1 reactor after several hours, in the Unit 3 reactor after about 36 hours, and in the Unit 2 reactor after about 70 hours, resulting in damage to the nuclear fuel shortly after the loss of cooling capabilities.

The limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure.

As discussed in this regulatory basis, the NRC's assessment of insights from the events at Fukushima Dai-ichi leads the NRC ----staff to conclude that requirements are necessary for all licensees and applicants (both current and new reactor licensees and applicants including design certifications) to mitigate an extended loss of all ac power condition, including the loss of normal access to the ultimate heat sink resulting from beyond-design-basis external events. Regarding loss of access to the ultimate heat sink, it should be noted that the NRC required passive new reactor designs that have the atmosphere as the ultimate heat sink to take a different approach. The NRC staff plans to issue a proposed rule amending NRC regulations to address these scenarios.

2.1 NRC's Response to Fukushima

In the days following the Fukushima Dai-ichi nuclear accident in Japan, the NRC Chairman directed the NRC staff to establish a senior-level agency task force to conduct a methodical and systematic review of the NRC's processes and regulations to determine whether the agency should make additional improvements to its regulatory system and to offer recommendations to the Commission for its policy direction. This direction was provided in a tasking memorandum (COMGBJ-11-0002), dated March 23, 2011, from the NRC Chairman to the NRC Executive Director for Operations (Ref. 32). In response to this tasking memorandum, the NRC chartered the NTTF.

In SECY-11-0093, the NTTF provided a number of recommendations, including a specific proposal for long term station blackout mitigation to the Commission. The recommendation regarding SBO and the need for revising 10 CFR 50.63, sometimes referred to as the SBO rule (Ref. 2), was subsequently endorsed by the Natural Resources Defense Council in a petition for rulemaking (PRM), PRM-50-101 (Ref. 5). The NTTF suggested enhanced station blackout mitigation strategies, within NTTF Recommendation 4.1, as follows:

> Initiate rulemaking to revise 10 CFR 50.63 to require each operating and new reactor licensee to: (1) establish a minimum coping time of 8 hours for a loss of all ac power,[1] (2) establish the equipment, procedures, and training necessary to implement an "extended loss of all ac" coping time of 72 hours for core and spent fuel pool cooling and for reactor coolant system and primary containment integrity as needed, and (3) preplan and prestage offsite resources to support uninterrupted core and spent fuel pool cooling, and reactor coolant system and containment integrity as needed, including the ability to deliver the equipment to the site in the time period allowed for extended coping, under conditions involving significant degradation of offsite transportation infrastructure associated with significant natural disasters.

In the same section of the report, the NTTF made another key recommendation that significantly impacts this rulemaking activity, identified as Recommendation 4.2:

[1] Recommendation 4.1 also called for protecting coping systems and equipment from damage from all design-basis events and extended beyond-design-basis events by either locating the equipment one level (i.e., 5 to 6 meters (15 to 20 feet)) above the plant design-basis flooding level or in water-tight enclosures. This issue is under consideration as part of the NRC's response to NTTF Recommendation 2.1, the re-evaluation of the design-basis flood levels.

> Order licensees to provide reasonable protection for equipment currently provided pursuant to 10 CFR 50.54(hh)(2) from the effects of design-basis external events and to add equipment as needed to address multiunit events while other requirements are being revised and implemented.

The SRM- SECY-11-0093, dated August 19, 2011, directed the NRC staff to identify and "make recommendations regarding any Task Force recommendations that can, and in the staff's judgment, should be implemented, in part or in whole, without unnecessary delay" (Ref. 6). Accordingly, in SECY-11-0124, dated September 9, 2011, and SECY-11-0137 dated October 3, 2011, (Ref. 7 and Ref. 8, respectively), with regard to NTTF Recommendation 4, the staff recommended that the Commission undertake the following as near-term actions:

> Engage stakeholders in support of rulemaking activities to enhance the capability to maintain safety through a prolonged SBO. These activities will include the development of the regulatory basis, a proposed rule, and implementing guidance [related to NTTF Recommendation 4.1].
>
> Develop and issue Orders to licensees to provide reasonable protection of the equipment used to satisfy the requirements of 10 CFR 50.54(hh)(2) from the effects of external events, and to establish and maintain sufficient capacity to mitigate multi-unit events. This would include stakeholder interactions to define acceptance criteria for reasonable protection of 10 CFR 50.54(hh)(2) equipment from design basis external hazards [related to NTTF Recommendation 4.2].

In SRM-SECY-11-0124 (Ref. 1), the Commission approved the NRC staff's proposed actions to implement without delay the NTTF recommendations as described in SECY-11-0124 (Ref. 7). The Commission approved the NRC staff's proposed prioritization of the NTTF recommendations, including the staff's proposals for addressing the NTTF recommendations. With regard to the portions of the SRM having relevance to this regulatory action, the Commission directed the staff to:

- Initiate a rulemaking for recommendation 4.1, Station blackout regulatory actions, as an ANPR rather than as a proposed rule.

- Designate the SBO rulemaking associated with NTTF Recommendation 4.1 as a high-priority rulemaking with a goal of completion within 24 to 30 months.

- Craft recommendations that continue to realize the strengths of a performance-based system as a guiding principle. In developing these recommendations, the Commission directed the NRC staff to consider approaches that are flexible and able to accommodate a diverse range of circumstances and conditions. The Commission noted that "[i]n consideration of events beyond the design basis, a regulatory approach founded on performance-based requirements will foster development of the most effective and efficient, site-specific mitigation strategies, similar to how the agency approached the approval of licensee response strategies for the "loss of large area" event under its B.5.b program (Ref. 1)."

- Monitor nuclear industry efforts underway to strengthen SBO coping times and consider whether any interim regulatory controls (e.g., commitment letters or confirmatory action

letters) for coping strategies for SBO events would be appropriate while rulemaking activities are in progress.

- For NTTF Recommendations 4.2 and 5.1, provide the Commission with notation vote papers for its approval of the Orders once the NRC staff has engaged stakeholders and established the requisite technical bases and acceptance criteria.

Order EA-12-049

In accordance with SRM-SECY-11-0124, the NRC staff provided SECY-12-0025, *Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami*, to the Commission on February 17, 2012 (Ref. 9), including the proposed Order to implement enhanced mitigation strategies. As directed by SRM-SECY-12-0025, the NRC staff issued Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, on March 12, 2012 (Refs. 31 and 10). Order EA-12-049 imposed new requirements to implement mitigating strategies for beyond-design-basis external events as defense-in-depth measures to address the uncertainties associated with such events. The Order significantly expanded the regulatory scope under NTTF Recommendation 4.2 in SECY-11-0124, as discussed below in the section entitled, *Consolidation of Recommendation 4 and 7 Regulatory Activities*.

The Order requires a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment, and spent fuel pool cooling. The transition phase requires provision of sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from offsite. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. The Commission concluded that the EA-12-049 requirements were necessary for ensuring continued adequate protection of public health and safety.

On March 30, 2012, the Commission issued Memorandum and Order CLI-12-09, *In the Matter of South Carolina Electric & Gas Co. and South Carolina Public Service Authority (Also Referred to as Santee Cooper; Virgil C. Summer Nuclear Station, Units 2 and 3),* which includes requirements for mitigation strategies as a license condition for Virgil C. Summer Nuclear Station, Units 2 and 3 (Ref. 11).

In response to Order EA-12-049, the Nuclear Energy Institute (NEI) developed an industry implementation guidance document for NRC's review. NEI 12-06 Rev. 0, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide* provides one approach for complying with the mitigating strategies order (Ref. 12). The NRC staff endorsed the industry guidance in Interim Staff Guidance (ISG), JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events* (Ref. 13).

Advanced Notice for Proposed Rulemaking

To gather information for the SBO rulemaking, the NRC published an ANPR in the *Federal Register* on March 20, 2012. This ANPR began the process for considering amendments to the NRC's regulations that address SBO (Ref. 14). The ANPR provided background on the Fukushima Dai-ichi event and the NRC response, as well as background information on the

current requirements related to SBO. The ANPR sought public comment on specific questions and issues with respect to possible revisions of the NRC's requirements addressing SBO conditions and this regulatory basis. The NRC considered the ANPR comments as part of the effort to formulate this regulatory basis.

August 2012 Commission Direction

Following a Commission briefing on August 7, 2012, the NRC staff received further direction from the Commission's SRM on the briefing (Ref. 15). The Commission directed that:

> In developing the proposed rule on mitigating strategies, the staff should ensure that potential failures or challenges to the implementation of these strategies are identified and resolved appropriately.

Consolidation of NTTF Recommendation 4 and 7 Regulatory Activities

COMSECY-13-0002, *Consolidation of Japan Lessons-Learned Near-Term Task Force Recommendations 4 and 7 Regulatory Activities*, dated January 25, 2013, requested approval to consolidate regulatory activities associated with NTTF Recommendations 4 and 7 into a single rulemaking (Ref. 16). The request included a schedule adjustment to enable the rulemaking activity to be informed by the implementation of the mitigating strategies Order EA-12-049. The request was approved by the Commission in an SRM dated March 4, 2013 (Ref. 3).

Order EA-12-049 imposed new requirements to implement mitigating strategies as defense-in-depth measures to address the uncertainties associated with beyond-design-basis external events (Ref. 10). The Order was a significant expansion of the regulatory action envisioned in NTTF Recommendation 4.2, and as recommended by the NRC staff in SECY-11-0124, because the scope of the Order goes beyond augmenting the equipment required by 10 CFR 50.54(hh)(2) and protecting it from external events. External stakeholder feedback collected from public meetings held in December 2011 and January 2012 helped shape the regulatory scope of the Order. As a result of this feedback, the Order's scope includes the following requirements:

- Develop, implement, and maintain mitigating strategies designed to maintain or restore the key functional capabilities following beyond-design-basis external events (i.e., core cooling, containment, and spent fuel pool cooling);
- Implement strategies capable of mitigating a simultaneous loss of all ac power and loss of normal access to the ultimate heat sink;
- Assume that ac power sources will not be restored;
- Implement strategies that have adequate capacity to address challenges to core cooling, containment, and spent fuel pool cooling at all units on site;
- Reasonably protect equipment relied upon for mitigation of external events;
- Establish the ability to implement mitigation strategies in any mode;

- Implement a three-phase approach that enables mitigation for an indefinite time period: the first phase uses installed equipment, the second phase uses portable and onsite equipment, and the final phase allows for offsite assistance.

The above requirements exceed the initial regulatory concept of procuring additional portable equipment and using existing Section 50.54(hh)(2) strategies, in part because Section 50.54(hh)(2) strategies are not designed to handle a site-wide external event for which offsite ac power is lost indefinitely (Ref. 4). As explained below, the broad scope of the order largely encompasses all of NTTF Recommendation 4, including NTTF Recommendations 4.1 and 4.2.

With regard to recommendation 7 and its consolidation within this rulemaking effort, the NTTF recommended that the Commission direct the NRC staff to: [2]

7.1 Order licensees to provide sufficient safety-related instrumentation, able to withstand design-basis natural phenomena, to monitor key spent fuel pool parameters (i.e., water level, temperature, and area radiation levels) from the control room.

7.2 Order licensees to provide safety-related ac electrical power for the spent fuel pool makeup system.

7.3 Order licensees to revise their technical specifications to address requirements to have one train of onsite emergency electrical power operable for spent fuel pool makeup and spent fuel pool instrumentation when there is irradiated fuel in the spent fuel pool, regardless of the operational mode of the reactor.

7.4 Order licensees to have an installed seismically qualified means to spray water into the spent fuel pools, including an easily accessible connection to supply the water (e.g., using a portable pump or pumper truck) at grade outside the building.

7.5 Initiate rulemaking or licensing activities or both to require the actions related to the spent fuel pool described in detailed recommendations 7.1–7.4.

The NRC staff, in SECY-11-0137, recommended the following regulatory activities to address the Recommendation 7 concerns (Ref. 8):

- The NRC, as a near-term action, should undertake regulatory activities to engage stakeholders to inform the determination of (1) what constitutes reliable (potentially

[2] On July 26, 2011, the Natural Resources Defense Council submitted PRM-50-100, "Require Licensees To Improve Spent Nuclear Fuel Pool Safety," requesting that the NRC institute a rulemaking to require licensees to (1) provide sufficient safety-related instrumentation, able to withstand design-basis natural phenomena, to monitor key spent fuel pool parameters (i.e., water level, temperature, and area radiation levels) from the control room; (2) provide safety-related ac electrical power for the spent fuel pool makeup system; (3) revise their technical specifications to address requirements to have one train of onsite emergency electrical power operable for spent fuel pool makeup and spent fuel pool instrumentation when there is irradiated fuel in the spent fuel pool, regardless of the operational mode of the reactor; and (4) have an installed seismically qualified means to spray water into the spent fuel pools, including an easily accessible connection to supply the water (e.g., using a portable pump or pumper truck) at grade outside the building (Ref. 17). This PRM is related to the actions called for under Recommendation 7.

safety-related) SFP instrumentation, (2) what conditions the instrumentation must withstand to fulfill its intended function, (3) which SFP parameters should be monitored (e.g., water level, temperature, and area radiation levels), (4) what makeup strategies could be implemented, and (5) where indications are needed (e.g., control room and/or remote location) (associated with NTTF recommendation 7.1).

- Develop and issue order to licensees to provide reliable SFP instrumentation (associated with NTTF recommendation 7.1).

- Once sufficient technical information is available, the staff recommends that the NRC undertake regulatory activities to engage stakeholders in support of rulemaking activities to provide reliable SFP instrumentation and makeup capabilities. These activities will include the development of the regulatory basis, a proposed rule, and implementing guidance consistent with the rulemaking process established in SECY-11-0032 .

The NRC issued EA-12-051, *Order Modifying Licenses With Regard to Reliable Spent Fuel Pool Instrumentation* on March 12, 2012, to address the regulatory issues stemming from NTTF Recommendation 7.1 (Ref. 18). Regarding the remaining regulatory issues stemming from NTTF Recommendation 7, the expansive scope of the mitigating strategies Order also resulted in the NRC addressing a majority of the actions related to the spent fuel pool in NTTF Recommendation 7. Specifically, the Order requires mitigating strategies that maintain or restore spent fuel pool cooling capabilities. The resulting mitigating strategies provide increased capability to maintain or restore spent fuel pool cooling, independent of ac power. The spent fuel pool strategies include the use of self-powered, portable pumps through multiple connection points, including connections diverse from the spent fuel pool deck to provide makeup to the pool. These strategies make use of spent fuel pool level instrumentation required by EA-12-051. Accordingly, the NRC staff concluded that it was most efficient to address Recommendation 7 within the Recommendation 4 rulemaking activities (i.e., the Station Blackout Mitigation Strategies rulemaking that is the subject of this regulatory basis).

Table 1 attached to COMSECY-13-0002 describes how NTTF Recommendation 4 and Recommendation 7 are being addressed through implementation of the mitigating strategies Order and through a rulemaking of similar regulatory scope (Ref. 16). The rulemaking (for which this regulatory basis is developed) would make the Order requirements generically applicable and would consider external stakeholder feedback and lessons learned from implementation of the mitigating strategies Order, including whether there are any potential failures or challenges associated with the implementation of the mitigating strategies per direction in the August 2012 SRM (Ref.15).

2.2 Current SBO-Related Regulatory Requirements

This section discusses the NRC's current SBO-related regulatory requirements and guidance. Current NRC licensees, construction permits (CP) holders, and Combined License (COL) holders authorized to operate or construct nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and 10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities* (Ref. 4), and Part 52, *Licenses, Certifications, and Approvals for Nuclear Power Plants* (Ref. 19), are required to comply with a variety of regulatory requirements related to station blackout mitigation. (Any new rulemaking addressing SBO mitigating strategies also would affect these same entities.)

General Design Criteria [3,4]

The general design criteria relevant to a potential SBO rulemaking are general design criterion (GDC) 2, which governs consideration of natural phenomena, and GDC 17, which governs electrical system design.[5]

General Design Criterion 2 requires nuclear power plants designed in accordance with appendix A to 10 CFR Part 50 to be protected against natural phenomena. Specifically, GDC-2 requires:

> *Criterion 2—Design bases for protection against natural phenomena.* Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena and (3) the importance of the safety functions to be performed.

General Design Criterion 17 governs electric power systems for nuclear power plants designed in accordance with appendix A to 10 CFR Part 50. GDC 17 states:

> An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor

[3] As defined in 10 CFR 50.2, "design basis" means that information that identifies (1) the specific functions to be performed by a facility structure, system, or component (SSC), and (2) the specific values or ranges of values chosen for controlling parameters as reference bounds for design. The actual detailed design of facility SSCs must reflect the assigned design basis functions and assure performance of those functions within the reference bounds for design. An applicant for a construction permit or combined license for a facility is required, pursuant to 10 CFR 50.34(a)(3) or 52.79(a)(4)(i), respectively, to describe the principal design criteria (PDC) for the proposed facility. The PDC generally identify facility SSCs and their functions, which are part of the design bases described above. U.S. facilities for which construction permits were issued before 1971 had plant-specific PDC because the Atomic Energy Commission (AEC), the regulatory divisions of which was the predecessor to the NRC, had yet to develop generic requirements for facility design criteria at that time.

[4] On February 20, 1971, the AEC published the final GDC and added appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR part 50 (36 FR 3255) (Ref. 20). The GDC provide minimum requirements for facility PDC and form part of the facility design basis because they identify SSCs and their required functions at a high level. NRC regulations, including the GDC and plant-specific PDC, set general minimum standards for the values or ranges of values chosen for controlling parameters as reference bounds for design, which is the second element of the design bases defined in 10 CFR 50.2. As a practical matter, these values or ranges of values are normally determined in accordance with detailed NRC guidance applicable to the particular SSCs found in nuclear power facilities.

[5] For facilities with construction permits issued before 1971, plant-specific PDC, which differ in certain respects from GDC 2 and 17, identify facility SSCs and their functions. A significant fraction of currently operating nuclear power facilities were licensed in accordance with plant-specific PDC rather than the GDC.

> coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.
>
> The onsite electric power sources, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure.
>
> Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable. Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies and the other offsite electric power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.
>
> Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.

GDC 17 (and its predecessor plant-specific, principle design criterion) establishes requirements for the design of onsite and offsite electric power systems that are intended to reduce the probability of losing all ac power to an acceptable level. GDC 17 establishes the design basis for the ac electric systems and does not address events beyond the design basis.

In the 1970s and 1980s, as operating experience accumulated, the NRC staff developed concerns over the reliability of both the onsite and offsite emergency ac power systems. The NRC staff learned of many events in which operating plants experienced a total loss of offsite power (LOOP), which is a design basis event under GDC 17. Some events involved failure of diesel generators. A few events involved a complete loss of both the offsite and the onsite ac power systems. Since the design basis in GDC 17 accounts for a single failure in the onsite ac power system, the complete failure of the onsite ac power system concurrent with a loss of offsite power is a beyond-design-basis event. Although ac power was restored in a short time without any serious consequences in those few events, the NRC staff identified a need for an SBO rulemaking to require operating plants to cope with such events, as discussed in the next section.

Station Blackout Rule (Section 50.63)

The term “station blackout” is defined in 10 CFR 50.2 as follows (Ref. 4):

> the complete loss of alternating current (ac) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., loss of offsite

electric power system concurrent with turbine trip and unavailability of the onsite emergency ac power system). Station blackout does not include the loss of available ac power to buses fed by station batteries through inverters or by alternate ac sources as defined in 10 CFR 50.2, nor does it assume a concurrent single failure or design basis accident [DBA]. At single unit sites, any emergency ac power source(s) in excess of the number required to meet minimum redundancy requirements (i.e., single failure) for safe shutdown (non-DBA) is assumed to be available and may be designated as an alternate power source(s) provided the applicable requirements are met. At multi-unit sites, where the combination of emergency ac power sources exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining emergency ac power sources may be used as alternate ac power sources provided they meet the applicable requirements. If these criteria are not met, station blackout must be assumed on all the units.

The SBO rule was developed based on insights gained from several plant-specific probabilistic safety studies; operating experience; and reliability, accident sequence, and consequence analyses completed between 1975 and 1988. The final rule containing SBO requirements was published on July 21, 1988 (Ref. 21). The Commission issued the SBO rule based on operating experience suggesting that both onsite emergency ac power systems and offsite power from the transmission network might be less reliable than originally anticipated, even for plants designed to meet GDC 17 of appendix A to 10 CFR part 50. The objective of the rule was to reduce the risk of severe accidents resulting from SBO by maintaining highly reliable ac electric power systems and, as additional defense-in-depth, assuring that plants can cope with an SBO for a specified duration. As indicated above, the SBO rule addresses an event involving a loss of offsite power (a design basis event) concurrent with the loss of all onsite ac power sources (a beyond-design-basis internal event). NRC guidance for implementing the SBO rule can be found in Regulatory Guide (RG) 1.155, *Station Blackout* (Ref. 22), which endorses Nuclear Management and Resources Council (NUMARC) 8700, *Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,* dated November 1987, with certain exceptions and clarifications (Ref. 23).

The SBO rule requires that nuclear power plants have the capability to withstand an SBO and maintain core cooling and containment integrity for a specified duration.[6] The specified SBO duration for a plant is determined based on (1) the redundancy of the onsite emergency ac power sources, (2) the reliability of the onsite emergency ac power sources, (3) the expected frequency for a loss of offsite power event at the particular site, and (4) the probable time needed to restore offsite power. The assumption used for a loss of offsite power event at a plant site was an initiating event resulting from a switchyard-related or grid-related event due to random faults or an external event, such as a grid disturbance, or weather events such as high winds, snow, and ice loading that affect the offsite power system either throughout the grid or at the plant.

During the development of the SBO rule, the NRC staff concluded that there was a sufficiently low likelihood of a loss of offsite power generated by a fire, flood, or seismic activity and that preexisting licensing requirements specified sufficient protective measures such that loss of

[6] The existing SBO rule does not address spent fuel pool cooling. Presumably, this was a result of the relative short duration of the maximum determined SBO event duration of 16 hours and the ability of the spent fuel pool inventory to continually cover the fuel for this duration.

offsite power events from such causes need not be considered under the SBO rule requirements. See NUREG-1032 (Ref. 24) for further detail.

In order to meet the requirements of the SBO rule, licensees modified some stations in order to cope with their specified duration for an SBO event, depending on the station's existing capability. For example, licensees added an alternate ac power source or increased the capacity of the station batteries, plant instrument air system, or condensate storage tank. The SBO rule allows licensees to rely on an alternate ac source to cope with an SBO. Alternate ac source is defined in Section 50.2 as follows (Ref. 4):

> Alternate ac source means an alternating current (ac) power source that is available to and located at or nearby a nuclear power plant and meets the following requirements:
>
> (1) Is connectable to but not normally connected to the offsite or onsite emergency ac power systems;
>
> (2) Has minimum potential for common mode failure with offsite power or the onsite emergency ac power sources;
>
> (3) Is available in a timely manner after the onset of station blackout; and
>
> (4) Has sufficient capacity and reliability for operation of all systems required for coping with station blackout and for the time required to bring and maintain the plant in safe shutdown (non-design basis accident).

The SBO rule also requires that alternate ac sources at multiunit sites where onsite emergency ac sources are shared between units (i.e., where there exists excess capacity of the non-SBO unit's emergency ac power system) have the capability to bring all units to, and maintain them in, safe shutdown (non-design basis accident (non-DBA)). Safe shutdown (non-DBA) is defined in Section 50.2 as follows (Ref. 4):

> *Safe shutdown* (non-design basis accident (non-DBA)) for station blackout means bringing the plant to those shutdown conditions specified in plant technical specifications as Hot Standby or Hot Shutdown, as appropriate (plants have the option of maintaining the [reactor coolant system] RCS at normal operating temperatures or at reduced temperatures).

In addition, licensees enhanced station procedures and training for restoring both offsite and onsite ac power sources. The NRC and licensees also increased their emphasis on establishing and maintaining high reliability of onsite emergency power sources. The SBO rule does not require systems and equipment used to cope with SBO to meet 10 CFR part 50 quality assurance requirements for safety-related equipment (Ref. 4); instead, Appendix A of RG 1.155 provides the applicable quality assurance guidance for non-safety systems and equipment used to meet the SBO rule requirements (Ref. 22).

After a licensee or applicant has submitted the information required by the SBO rule regarding the "specified duration" of an SBO for its facility and the NRC has determined that information adequate, the SBO rule does not require the licensee to update either the specified duration or the coping analysis. If the licensee, on its own volition, chooses to modify the facility, and that

significantly impacts how the plant mitigates the consequence of an SBO event, then NRC review and approval could be involved, and then this information would be updated as part of that review. Nonetheless, the parameters that were used for inputs into both the determination of the specified duration and the SBO coping analysis are subject to change over time. These parameters include the number of loss of offsite power events expected at a particular site, recovery time for offsite power, frequency of grid blackout events, and diesel generator reliability. Changes to these parameters may have a significant effect on the SBO duration and coping analyses, and these may differ from the original determination performed by a licensee.[7] If the NRC determines that a licensee's plans for coping with an SBO are no longer adequate, the NRC can require a licensee to modify its SBO plans or related equipment as necessary, so long as the NRC satisfies the requirements of the Backfit Rule in 10 CFR 50.109 (Ref. 4).

3. Technical Basis for Incorporating Mitigating Strategies Requirements into Regulations

The NRC's existing rules address many aspects related to SBO mitigating strategies that the NRC staff is considering in this potential rulemaking, as discussed in the previous section. However, the types of events addressed by the existing SBO regulations in 10 CFR 50.63 only include switchyard-related or grid-related events, due to random faults or other grid disturbance, or weather events, such as high winds, snow, and ice loading that affect the offsite power system either throughout the grid or at the plant. Typically, these events involve recovery of offsite or onsite power within a few hours. While the existing SBO rule does require consideration of a loss of offsite power and the probable time to restore offsite power in determining the specified duration, it does not require consideration of a loss of offsite power caused by a fire, flood, or seismic activity because the NRC concluded that the likelihood of such events was sufficiently low. The SBO rule also does not address maintaining or restoring SFP cooling. As such, NRC regulations do not currently contain requirements to address the mitigation of extended loss of all ac power, including loss of normal access to the ultimate heat sink due to beyond-design-basis external events of the type Order EA-12-049 was issued to address.

Section 50.63 also does not fully cover events that impact more than one unit at a site with two or more units. Based on its review of recent loss of offsite power data and the Fukushima event, the NRC staff has determined that loss of offsite power events can affect all nuclear power plants on a multiunit site. Understanding that the probability of all emergency power sources failing would generally be low, consideration must be given to those nuclear power plants with less robust electrical power system designs, including those with extended allowed outage times for performing online maintenance of the emergency power systems. The SBO rule was intended to require measures to cope with a loss of offsite power concurrent with the loss of all onsite ac power sources, which is a beyond-design-basis internal event, but not a beyond-design-basis external event such as occurred at Fukushima Dai-ichi.

Table 1 provides a comparison of the requirements and corresponding guidance for the existing SBO rule (10 CFR 50.63) and Order EA-12-049 (and corresponding license conditions for

[7] Current operating reactor licensees without alternate ac power sources were required to perform coping analyses to determine the SBO durations, typically resulting in 4 hours. Coping analyses performed using more recent information and assumptions based on current operating experience would result in longer specified durations, typically up to 16 hours.

subsequent COLs granted, hereinafter referred to collectively as EA-12-049). The table shows that the Order requirements cover scenarios that Section 50.63 was not intended to cover.

Table 1. Comparison of Section 50.63 and Order EA-12-049

	10 CFR 50.63	EA-12-049
Regulatory guidance	RG 1.155 and NUMARC 87-00	JLD-ISG-2012-01and NEI-12-06
Initiating event	LOOP due to grid-centered, switchyard-centered, and severe weather events	Beyond-design-basis external events
Initial plant condition	Loss of all ac power (not including the loss of ac power from buses fed by batteries through inverters, or as supplied by alternate ac power sources)	Loss of all ac power and loss of normal access to the ultimate heat sink (not including the loss of ac power from buses fed by batteries through inverters)
General requirement	Ability to withstand and recover from a loss of all ac power for a specified duration (determined in accordance with supporting guidance) based on plant characteristics and local grid reliability	Ability to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities for all of a licensee's units at the site following a loss of all ac power for an indefinite period of time from all modes of operation
Analysis requirement	Determine a specified duration (coping time) based on: • Onsite ac system configuration • Average diesel reliability • Expected frequency of LOOP • Probable restoration time for offsite power (This was a single determination accomplished at the time of implementation.) Evaluate the plant's actual ability to cope with loss of all ac power	Engineering analysis sufficient to provide a technical basis for equipment capability/capacity and identification of time constraints Demonstrate ability to transition between phases of strategies

	10 CFR 50.63	EA-12-049
Requirements on plant procedures and equipment	-Highly reliable ac power system -Procedures and training to restore offsite and onsite power -Plant capability to cope with an SBO for a specified duration -Maintain diesel generator reliability	Development of a three-phased strategy: -Phase 1: installed equipment -Phase 2: onsite portable equipment and supplies -Phase 3: offsite portable equipment and supplies Implementation guidance builds on the coping procedures already developed for 10 CFR 50.63 (e.g., loss of all heating, ventilation, and air conditioning) and extends these to an indefinite time period
Acceptable options	-Enhancements to plant equipment and procedures to meet the specified duration (ac-independent heat removal systems, battery capacity, water sources) -New and enhanced plant procedures and training -Alternate ac power sources that can be connected within 10 minutes were allowed to eliminate the need to demonstrate the ability to withstand and recover from the loss of all ac power for an evaluated specified duration	Use of installed equipment that is safety-related is assumed for the initial phase. Use of reasonably protected equipment is assumed for the second phase. Replenishing and supplementing equipment from offsite sources is provided in the third phase.
Hardening of onsite ac to prevent loss of power	No specific requirements for alternate ac power sources to be protected from external design basis events except for severe weather. However, NUMARC-8700 includes a discussion of the need to protect SBO equipment (including alternate ac power sources) from known environmental hazards.	Existing emergency ac power sources could not be credited for compliance with EA-12-049 - specifically the EA-12-049 requirement that Class 1E onsite emergency ac power sources and alternate ac power sources (per 10 CFR 50.63) be assumed unavailable.
Postulated loss of equipment required for coping	10 CFR 50.63 does not require consideration of single failures beyond the assumed failure of the redundant onsite emergency ac power sources.	Licensees must provide reasonable protection for mitigation equipment from external events. Guidance in step 2 of NEI-12-06 approach

	10 CFR 50.63	EA-12-049
Characteristics of coping equipment	Detailed guidance on system characteristics and regulatory treatment for dedicated SBO equipment in RG 1.155, Appendix B	Detailed guidance on equipment/system characteristics and regulatory treatment in NEI 12-06, Section 11.
Maintenance and testing requirements	Guidance on maintenance and testing for dedicated SBO equipment in RG 1.155, Appendix B; no change in required testing for existing safety-related equipment such as station batteries to demonstrate SBO load profiles.	Guidance on maintenance and testing in NEI 12-06, Section 11.
Single implementation or continuing configuration control requirement	-One-time coping assessment unless a licensee revises the means by which they mitigate an SBO (e.g., plant modifications). -There are requirements to maintain diesel generator reliability	-One time modifications to plant equipment -One-time addition of onsite and offsite portables -Continuing configuration/design control requirements -Possible ongoing commitments

To protect public health and safety from the inadvertent release of radioactive materials, the NRC's defense-in-depth strategy includes multiple layers of protection: (1) prevention of accidents by virtue of the design, construction, and operation of the plant; (2) mitigation features to prevent radioactive releases should an accident occur; and (3) emergency preparedness programs that include measures such as sheltering and evacuation. The defense-in-depth strategy also provides for multiple physical barriers to contain the radioactive materials in the event of an accident. The barriers are the fuel cladding, the reactor coolant pressure boundary, and the containment. These defense-in-depth features are embodied in the existing regulatory requirements and thereby provide adequate protection of the public health and safety.

As previously discussed in this document, the strategies implemented to meet 10 CFR 50.54(hh)(2) are potentially useful to mitigate the effects of prolonged station blackout events; however, these were not intended to address beyond-design-basis external events such as the event that occurred at Fukushima. These strategies, for loss of large areas of the plant due to explosions and fires, are not designed to address events that: (1) impact more than one unit at a site with two or more units, (2) involve multiple safety functions at each of several units located on the same site, and (3) can last for much longer periods of time.

The events at Fukushima further highlight the possibility that extreme natural phenomena could challenge the prevention, mitigation, and emergency preparedness defense-in-depth layers. To address the uncertainties associated with beyond-design-basis external events, the NRC imposed by Order EA-12-049 (Ref. 10) new requirements that require additional defense-in-depth measures at licensed nuclear power reactors so that the NRC can continue to have reasonable assurance of adequate protection of public health and safety in mitigating the consequences of a beyond-design-basis external event.

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The NRC concluded that the strategies and guidance developed and implemented in response to the EA-12-049 requirements provide the necessary capabilities to supplement those of the

permanently installed plant structures, systems, and components that could become unavailable following beyond-design-basis external events. The NRC concluded that the strategies and guidance enhance the safety and preparedness capabilities established following September 11, 2001, and made generically-applicable in 10 CFR 50.54(hh)(2). In order to address the potential for more widespread effects of beyond-design-basis external events, EA-12-049 requires strategies with increased capacity to implement protective actions concurrently at multiple units at a site. The strategies (currently being implemented) are intended to add multiple ways to maintain or restore core cooling, containment, and SFP cooling capabilities in order to improve the defense-in-depth of licensed nuclear power reactors. Hence, this provides the context for the Commission's direction to the NRC staff to initiate rulemaking activities to incorporate these requirements into the NRC regulations to ensure that these requirements are applied to future nuclear power plant designs and licensing applications.

3.1 Regulatory Objectives

As discussed above, the current regulations do not incorporate sufficient defense-in-depth requirements to address the uncertainties associated with beyond-design-basis external events and the adverse effects that such events could have on the safety-related SSCs at nuclear power reactors. A rulemaking would apply the requirements of Order EA-12-049 to all existing and proposed nuclear power plants. The regulatory objectives of the rulemaking would be as follows:

- Make the EA-12-049 requirements generically applicable. The principle objective of a rulemaking would be to place into the NRC's regulations requirements that reflect the EA-12-049 Order requirements (Ref. 10), which are already issued and imposed on licensees, giving consideration to stakeholder feedback and lessons-learned obtained through the implementation of the Order requirements (i.e., make the Order requirements "generically applicable"). In doing so, the NRC would give consideration to whether there are potential failures or challenges associated with the implementation of the mitigating strategies per the Commission direction in the August 2012 SRM (Ref. 15). Making the EA-12-049 requirements generically applicable, in addition to improving the regulatory framework, might allow future relaxation of the Order requirements imposed on current licensees.

- Establish a regulatory framework linking the SBO strategies in 10 CFR 50.63, the loss of large area strategies in 10 CFR 50.54(hh)(2), and the beyond-design-basis external event strategies of the new rule. The guidance and strategies originally implemented in response to the SBO rule in 10 CFR 50.63 and Order EA-02-026, *Order for Interim Safeguards and Security Compensatory Measures*, Section B.5.b, made generically applicable as 10 CFR 50.54(hh)(2), are similar or closely related to the strategies being implemented for EA-12-049. It therefore makes sense to evaluate a regulatory framework with these relationships in mind. With regard to station blackout mitigation, the mitigating strategies required by EA-12-049 fit into the plant station blackout emergency operating procedures (EOPs) and are implemented when ac power cannot be recovered from either offsite or onsite sources. As such, the station blackout requirements and the mitigating strategies requirements are directly related at the implementation level.

Based on the information presented in this regulatory basis document, the NRC staff concludes that rulemaking is warranted to potentially amend 10 CFR Parts 50 and 52 by adding defense-

in-depth requirements to account for the uncertainties associated with beyond-design-basis external events, similar to those put forth in Order EA-12-049. Implementation of EA-12-049 (for the extended loss of all ac and loss of normal access to the ultimate heat sink from a beyond-design-basis external event) requirements may adequately address SBO sequences stemming from grid-centered, switchyard centered, and severe weather events. This would enhance the plant capabilities for addressing such events.

Appendix A provides a discussion of rule language concepts that the NRC staff is considering for the potential rulemaking. In addition, Appendix A contains a set of questions soliciting stakeholder feedback in areas that would support the NRC staff in developing a proposed rule.

3.2 NRC Guidance, Policy, and Implementation Issues

This section describes the NRC guidance that would need to be revised, as well as the relevant policy, implementation, and legal issues associated with a proposed rulemaking.

NRC Guidance

The following NRC guidance documents would need revision based on the content of a proposed rule.

- RG 1.155 (Ref. 22): This RG provides one acceptable method for complying with 10 CFR 50.63. The NRC staff expects that this RG might need to be revised to add statements linking RG 1.155 with the new mitigating strategies requirements and supporting guidance. The NRC expects that these changes would note that licensees are required to deploy mitigating strategies as required by the new rule in part 50 when the time required to recover from an SBO event exceeds the existing specified duration.

- JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events*, which endorses NEI 12-06 Rev. 0, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide* (Ref. 13): These guidance documents provide one acceptable approach to complying with Order EA-12-049. The NRC staff expects that a new regulatory guide might be developed to specify the criteria for defining an acceptable mitigation strategy or strategies. A new RG would reflect much of the detail in the ISG and would maintain the endorsement of NEI 12-06. If there are any substantive differences between the Order and the rule, then the new RG may need to include additional guidance by including regulatory positions on these differences.

Policy Issues

The NRC's approach for applicability to new reactor applicants and licensees, including COLs, design certifications (DCs), standard design approvals (SDAs), and manufacturing licenses (MLs), might be handled in a manner similar to that of the aircraft impact assessment rule, published June 12, 2009 (Ref. 26). Under this approach, issued DCs and SDAs would not be required to comply until renewal; issued COLs would be treated like an issued operating license (OL) or CP; DCs and COLs currently under NRC review would need to comply prior to issuing the certification or license; and any future DC, SDA, COL, or ML applicant would need to comply in its application. Further, the NRC would ensure that the permanent equipment and connection

requirements are included in the scope of a DC, SDA, or ML application, whereas the portable equipment requirements and mitigating strategies (operational requirements) are included in the scope of a COL application. This separation of permanent and portable equipment and mitigating strategies would implement the Commission's direction but place the requirements under the appropriate licensing application where those requirements would be best addressed.

Implementation Issues

Implementation challenges associated with the initial schedule set for this rulemaking have been significantly reduced as a result of the Commission approval of the revised schedule in SRM-COMSECY-13-0002 (Ref. 3).

- The mitigating strategies Order required each licensee to submit an overall integrated plan to the Commission by February 28, 2013. This licensee plan describes how compliance with the Order requirements will be achieved. Initial review of these plans indicates a number of open items. Under the revised rulemaking schedule approved in SRM-COMSECY-13-0002, the revised proposed rule schedule (due June 2014) is currently viewed as being sufficient to enable lessons learned from the NRC review of these plans to be considered.

- The NRC staff plans to inspect and audit licensee implementation of the SBO mitigating strategies Order during outages that occur in late 2014 and spring 2015. Under the revised rulemaking schedule approved in SRM-COMSECY-13-0002, the proposed rule will be able to partially account for lessons learned from the NRC reviews of the plans and any other interactions with licensees to support their implementation plans.

- The industry and the NRC currently are considering an augmented approach for the treatment of seismic issues to address NTTF Recommendation 2.1. Feedback from NTTF 2.1 regulatory activities could result in changes to the facility regarding protection of SSCs from the effects of external events; this could impact both the installed mitigating strategies equipment and the protection of the portable equipment. The approach to enhance seismic capacity in the short term would be applied to the installed mitigating strategies equipment, and therefore there is some potential that such an activity could impact this rulemaking.

- There is ongoing consideration regarding the use of the mitigating strategies equipment after core damage (under severe accident conditions). If such an approach is used, it could result in changes to the facility and the portable equipment (to allow this to be accomplished), and as such directly impact this rulemaking.

- With the revised final rule schedule approved in SRM-COMSECY-13-0002, the NRC staff anticipates that potential issues arising from implementation of EA-12-049 may largely be eliminated as challenges for a rulemaking.

- The NRC staff will follow its cumulative effects of regulations procedures throughout this rulemaking and, during the final rulemaking phase, expects to explore with external stakeholders whether there remain any implementation challenges that can be accommodated in the final rule's implementation requirements.

4. Impacts of the Rulemaking

The impacts of this rulemaking, for both current reactor licensees and new reactors, are not known at this time. The NRC staff considers it to be reasonable to assume as a starting point that the impacts of a potential rule would largely be the same as those currently being incurred as a result of the implementation of Order EA-12-049. In the appendix of this document, the NRC staff is asking for stakeholder feedback concerning the rulemaking impacts.

Impact on Operating Reactor Licensees

Based on stakeholder feedback, the impact on operating reactor licensees are would be site specific and would include:

- development, implementation, and maintenance of the mitigation strategies (referred to by industry as the "Flex Support Guidelines," see reference 12);
- modification of safety and non-safety related structures, systems, and components to enable ready connection of mitigating strategies equipment;
- engineering evaluations to support the key assumptions in the mitigating strategies that include time sensitive actions and key actions associated with maintaining or restoring core cooling, containment, and spent fuel pool cooling;
- procedural changes that support the mitigation strategies and use of the portable equipment, including the associated training on the changes;
- additional testing, drills, maintenance, or surveillance requirements; and
- other types of impacts to resources, such as coordinating with offsite response organizations (e.g., for the final phase of the mitigation strategy).

Some stakeholders have provided the NRC staff with compliance cost estimates associated with Order EA-12-049. One dual-unit site estimated that the Order may cost approximately $25 million, while a second dual-unit site estimated the cost at $43 million.

The NRC staff expects that a rulemaking would not impose additional adverse impacts on safety, security, or emergency preparedness, relative to the requirements of the Order. However, currently the NRC staff considers that a change control process may be required to control the long term configuration of the mitigation strategies and the equipment relied upon. This provision may have some additional impact; however, as a practical matter, licensees would be required to continue to meet the new provisions, including changes to equipment and strategies (as recognized in the industry guideline, NEI 12-06), so a change control provision should not represent significant additional impact.

If a proposed rule is an adequate protection regulatory action, the NRC staff nevertheless would need to ensure that the requirements achieve their objectives in an efficient and cost-effective manner. The NRC staff believes that a performance-based approach would provide sufficient flexibility for licensees to implement the most efficient and cost-effective approach given site-specific conditions. In addition, the NRC staff believes that there could be ancillary benefits of a proposed rulemaking. For example, the NRC staff expects that the strategies adopted by licensees could improve their ability to effectively carry out the strategies used to comply with Sections 50.63 and 50.54(hh)(2).

The NRC staff expects that a rulemaking would impose additional information collection requirements. Because Order EA-12-049 requires licensees to report on mitigating strategies, a rulemaking would likely allow licensees to rely on previous submissions to comply with certain information collection rule requirements so long as licensees have received NRC staff approval of mitigation strategies prepared for the Order.

Impact on Licensees with Plants under Construction

There are currently 5 reactors under construction – Watts Bar Unit 2, V.C. Summer Units 2 and 3, and Vogtle Units 3 and 4. Watts Bar Unit 2 received the same Order as all other operating reactors, and thus the impact on Watts Bar Unit 2 would be the same as for operating reactors.

The Vogtle and Summer units reference the Westinghouse AP1000 design, which has passive design features that provide core cooling, containment, and spent fuel cooling capabilities for 72 hours without reliance on ac power. Further, the AP1000 design does not rely on external water sources because the containment vessel and the passive containment cooling system serve as the ultimate heat sink. It also includes equipment to maintain required safety functions beyond 72 hours to 7 days and connections for offsite equipment to back up installed equipment. The requirements to address mitigating strategies for the Vogtle plants were similarly provided in Order EA-12-049. Because the licenses for the Summer plants were issued after the Order was issued, the mitigating strategies requirements were instead issued as license conditions. Regardless, there is an equal impact on the Vogtle and Summer plants. However, because of the passive plant design and the previously-planned equipment connections, the impact of the order on the Vogtle and Summer plants will be less than that of the operating reactors.

Impact on Issued Design Certifications and Standard Design Approvals

The NRC has issued 4 design certifications through the rulemaking process, and those certifications were promulgated as Appendices A through D to 10 CFR Part 52 (Ref. 19). As described in SECY-12-0025 (Ref. 9), the NRC staff plans to ensure that Commission-approved Fukushima actions are addressed prior to certification or licensing. SECY-12-0025 also describes how the AP1000 design, referenced in the Vogtle and Summer COLs, includes many of the design capabilities being considered under a potential rulemaking. However, the SECY paper did not recommend whether the Commission should apply the order to any or all of the issued design certifications. The NRC believes that there is no immediate need to amend the issued design certifications to address the order for two reasons. First, the relevant requirements can be implemented by a future COL applicant or licensee through orders or license conditions as was done for the Vogtle and Summer COLs. Second, the necessary changes to the certified design can be made when the design certification is renewed. Therefore, there is no near-term impact on issued design certifications. Instead, the burden associated with implementing requirements from a potential rulemaking could be deferred until the design certification is renewed, should that occur. Whether accomplished through order or rulemaking, the magnitude of the impact would vary among the certified designs, with passive plant designs (AP600 and AP1000) incurring less burden than that of active plant designs (U.S. ABWR and System 80+), though in each of these 4 cases the burden would be less than the burden to an operating reactor licensee. As with issued design certifications, the NRC would not seek to amend any issued standard design approval until an applicant sought to renew the design certification (note: a design approval cannot be renewed, but a vendor could seek a new standard design approval in connection with an application to renew a design certification).

Impact on New Reactor Combined License and Design Certification Applications under NRC Review

There are several applications for combined licenses and design certifications currently under NRC review. As described in SECY-12-0025, the NRC staff plans to ensure that Commission-approved Fukushima actions are addressed prior to certification or licensing. As a result, all applicants for design certifications would need to address the potential rulemaking requirements as applicable to the scope of the design (i.e., as applicable to the SSCs within the scope of the certified design), and all applicants for combined licenses referencing a certified design would need to address the complement of the potential requirements. The NRC also notes here that, because of the difference in the designs, passive plants would have fewer requirements to address than active plants. Thus, the impact on AP1000 and ESBWR (passive) plants would be less than U.S. EPR and U.S. APWR (active) plants.

Impact on Future Applications for Combined Licenses, Design Certifications, Standard Design Approvals, and Manufacturing Licenses

As described in SECY-12-0025, the NRC staff plans to ensure that Commission-approved Fukushima actions are addressed prior to certification or licensing. To achieve this, the NRC currently intends to make the requirements under a potential rulemaking applicable to all future applications for COLs, DCs, standard design approvals, and manufacturing licenses. However, because the effect on such an application depends on the nature of the design, which is not now known, an assessment of impact is not necessary.

Impact on the NRC

Because an SBO mitigating strategies rulemaking likely would only refine the requirements under Order EA-12-049, there would be no significant increase or reduction in impacts on the NRC as a result of a rulemaking. The NRC already would have addressed all operating reactor licensees as part of the EA-12-049 implementation, and any NRC impacts for this rulemaking would be limited to future reactors.

Impact on Public Health and Safety

Because the SBO mitigating strategies rulemaking would only refine the requirements under Order EA-12-049, there would be no substantial increase or reduction in public health, safety, and security.

Impact on State, Local, or Tribal Governments

This rulemaking would have no incremental impact on State, local, or Tribal governments.

5. Stakeholder Involvement

The NRC staff held meetings with industry and other stakeholders related to enhancing mitigation strategies intended to maintain or restore core cooling, containment, and SFP cooling capabilities following beyond-design-basis external events.[8] At these meetings, the NRC staff

[8] Although many other meetings have taken place between NRC staff and site personnel, the NRC staff conducted public meetings related to SBO mitigating strategies at NRC headquarters on the following days: December 1,

discussed implementation of NTTF recommendations, Order EA-12-049 requirements, and the ISG. These meetings also provided current and prospective licensees, as well as other stakeholders, the opportunity to describe proposals for complying with Order EA-12-049. The stakeholder input has been important throughout this regulatory effort; and, in fact, stakeholder input in December 2011 and January 2012 influenced the NRC to issue a much more expansive regulatory action (in the form of EA-12-049) than envisioned in NTTF Recommendation 4.2, SECY-11-0124, and SECY-11-0137.

In addition to these public meetings, the NRC staff published an ANPR in the *Federal Register* on March 20, 2012, to gather public comment to inform the NRC effort to draft a proposed rule addressing SBO mitigatiion strategies for beyond-design-basis external events (Ref. 14). The NRC staff also held a public meeting on April 25, 2012, to (1) provide external stakeholders with the NRC staff's preliminary thoughts on station blackout mitigation as described in the ANPR, (2) afford external stakeholders an opportunity to ask the NRC staff clarifying questions about the ANPR, and (3) provide an opportunity for external stakeholders and NRC staff to exchange information on ANPR subject matter, thereby facilitating more accurate and complete understanding of the subject matter. The results of this public meeting are detailed in the meeting summary and transcript (Refs. 27 and 28, respectively). The public comment period for the ANPR closed on May 4, 2012, and the NRC received 45 comment submissions. The NRC staff considered the stakeholder feedback from the ANPR submissions in developing this regulatory basis.

6. Backfitting and Issue Finality, Regulatory Flexibility Analysis, Compliance with NEPA, Safety Goal Evaluation, and Peer Review of Regulatory Basis

Backfitting and Issue Finality

The NRC's backfit provisions for holders of operating licenses and CPs are found in the regulations at 10 CFR 50.109 (Ref. 4). Issue finality provisions, analogous to the provisions in 10 CFR 50.109, are in 10 CFR 52.63 and the Appendices to part 52 for design certification rules. Issue finality provisions are in 10 CFR 52.83 and 52.98 for combined licenses. At this time, the NRC staff expects that a proposed rulemaking would make the requirements in Order EA-12-049 generically applicable and would not impose mitigating strategies beyond those already imposed through Order EA-12-049. Currently, the NRC staff anticipates that feedback on a proposed rule would allow the staff to better define acceptable and unique approaches (which inform the meaning and underlying purpose of the rule language) and possibly to offer more engineering flexibility (i.e., less reliance on human action and more reliance on engineered features) to current and future licensees. To the extent that the requirements in a proposed rule are the same as those imposed by Order EA-12-049, the requirements would not represent a backfit because they would not impose new or changed requirements on existing 10 CFR part 50 or part 52 licensees. Further, the NRC would not be imposing these requirements on issued design certifications, and therefore there would be no backfitting considerations for those design

2011; December 8, 2011; January 13, 2012; January 18, 2012; March 28, 2012; April 24, 2012; May 9, 2012; May 15, 2012; May 30, 2012; July 26, 2012; September 27, 2012; November 16, 2012.

certifications. There are no backfit considerations in applying the requirements in this rulemaking to future applications for COLs, DCs, MLs, and SDAs.

If a proposed rule includes any requirements in addition to those of Order EA-12-049, then the NRC staff will address the applicable backfitting and issue finality provisions with respect to the added requirements.

Regulatory Flexibility Analysis

The Regulatory Flexibility Act, enacted in September 1980, requires agencies to consider the impact of their regulatory proposals on small entities, analyze alternatives that minimize small entity impacts, and make their analyses available for public comment (Ref. 29).

None of the licensees and CP holders fall within the definition of "small entities" set forth in the size standards established by the NRC in 10 CFR 2.810 (Ref. 30). Therefore, a proposed rulemaking would not have a significant economic impact on a substantial number of small entities.

Environmental Analysis

A rulemaking to incorporate the requirements imposed by EA-12-049 would not be a major Federal action significantly affecting the quality of the human environment, and therefore, an environmental impact statement would not be required. An environmental assessment likely would conclude that there would not be a significant offsite impact to the public from this action because the station blackout mitigating strategies should reduce releases from beyond-design-basis events, and that in turn should reduce environmental impacts from such events.

Safety Goal Evaluation

Safety goal evaluations are applicable to regulatory initiatives considered to be generic safety enhancement backfits subject to the substantial additional protection standard in 10 CFR 50.109(a)(3). This regulatory basis describes potential regulatory changes that would not qualify as generic safety enhancements because the new requirements are expected to meet 10 CFR 50.109(a)(4)(ii), one of the exceptions in 10 CFR 50.109(a)(4)(i)–(iii), which states:

(ii) That regulatory action is necessary to ensure that the facility provides adequate protection to the health and safety of the public and is in accord with the common defense and security.

Because the NRC staff expects that an SBO mitigating strategies rulemaking would qualify as an adequate protection action, a safety goal evaluation would not be required.

Peer Review

The Office of Management and Budget's (OMB's) *Final Information Quality Bulletin for Peer Review* (Ref. 33) requires each Federal agency to subject "influential scientific information" to peer review prior to dissemination. The OMB defines "influential scientific information" as "scientific information the agency reasonably can determine will have or does have a clear and substantial impact on important public policies or private sector decisions." The regulatory basis

document does not contain “influential scientific information.” Therefore, there is no need for a peer review of the regulatory basis.

7. Conclusion

The staff finds that there is a sufficient regulatory basis to proceed with rulemaking. Specifically, the current regulations do not incorporate sufficient defense-in-depth requirements to account for the uncertainties associated with beyond-design-basis external events and the adverse effects that such events could have on the safety-related SSCs at nuclear power reactors. For example, during the development of the current SBO rule, it was concluded that there was a sufficiently low likelihood of a loss of offsite power event generated by a fire, flood, or seismic activity and that preexisting licensing requirements specified sufficient protective measures such that loss of offsite power events from such causes need not be considered under the SBO rule. Additionally, the SBO rule addresses maintaining or restoring SFP cooling. Section 50.63 also does not fully cover events that impact more than one unit at a site (i.e., sites with two or more units). A rulemaking would address the mitigation of beyond-design-basis external events involving SBO such as those for which Order EA-12-049 was issued to address. In addition, a rulemaking would implement requirements similar to those imposed by Order EA-12-049 on future designs and applications.

A rulemaking also would fulfill the Commission’s explicit direction to address station blackout mitigation in a rulemaking, as documented in SRM-SECY-11-0124 and SRM-COMSECY-13-0002.

8. References

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2. U.S. Nuclear Regulatory Commission, *The Near-Term Report and Recommendations for Agency Actions Following the Events in Japan*, Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

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8. U.S. Nuclear Regulatory Commission, *Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned*, Commission Paper SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11272A111.

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12. Nuclear Energy Institute document 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 2012, ADAMS Accession No. ML12242A378.

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14. U.S. Nuclear Regulatory Commission, "Station Blackout," Advanced Notice of Proposed Rulemaking, *Federal Register*, Vol. 77, No. 54, March 20, 2012, pp. 16175 - 16183.

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Appendix A
Station Blackout Mitigation Strategies Regulatory Basis
Draft Rule Concepts

The draft regulatory basis provides the justification to conclude that rulemaking is warranted. Central to this conclusion is the recognition that EA-12-049[9] requirements, imposed on current licensees and determined by the Commission to be necessary to ensure continued adequate protection of public health and safety, are not in the *Code of Federal Regulations*, and so rulemaking is needed to make requirements in EA-12-049 generically-applicable to current and future licensees.

This appendix is intended to solicit external feedback to support the NRC staff's efforts to complete the regulatory basis and draft the proposed rule. Accordingly, it provides the NRC staff's current thoughts regarding what requirements would be needed and asks additional questions, with the intent of using the feedback obtained to support development of the proposed rule or its supporting statement of considerations.

Stakeholders should recognize that these are draft rule concepts and expect further development of these concepts into proposed rule text as work progresses to develop the proposed rule. The NRC staff has focused its effort to the development of a performance-based framework that is similar to the requirements in EA-12-049 and 10 CFR 50.54(hh)(2). The questions and information provided in this appendix are intended to solicit additional feedback and information from external stakeholders to support further development of that framework.

<u>Title</u>

The NRC staff intends to title this new regulation such that it conveys the central focus of the requirements. Accordingly, the title should reflect that the new requirements are fundamentally addressing two situations:

1. Extended loss of all ac power conditions resulting from beyond-design-basis external events where it is unlikely ac power will be recovered in the short term.

2. Station blackout conditions that stem from loss of offsite power events with multiple onsite failures of emergency power sources that extend longer than the specified durations of 50.63.

The NRC staff could entitle this effort: Extended Loss of All Alternating Current Power Conditions from Station Blackout and Beyond-Design-Basis External Events.

<u>Applicability</u>

The NRC staff anticipates that the new provisions should apply to all power reactors, both from a design and operation perspective. The new regulation may reflect some of the following requirements:

[9] U.S. Nuclear Regulatory Commission, *Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, Order EA-12-049, March 12, 2012, ADAMS Accession No. ML12054A736.

1. The requirements to develop, implement, and maintain mitigation strategies would apply to all operating power reactor license and combined license holders (part 50 and part 52) because these requirements would need to reflect aspects of the detailed plant design, which might not be known until the later stages of construction.
2. Design requirements, including requirements that relate to the need to have connections for portable equipment, protection of portable equipment, and maintenance and testing of equipment would be directed to operating license applicants and licensees (Part 50).
3. Design requirements, including requirements that relate to protection of the equipment, could be addressed by design certification holders and applicants, or combined license holders or applicants, depending on the nature of the requirement and the equipment relied upon for mitigation. Requirements that relate to the need to have connections for portable equipment could be addressed by design certification holders and applicants. Requirements that involve the protection of portable equipment could be addressed by either the design certification holders or applicants or combined license holders or applicants. Lastly, requirements for maintenance and testing of equipment would be directed to the combined license holders or applicants.
4. Requirements for design certification holders and applicants in item 3 of this section would equally apply to standard design approval and manufacturing license holders and applicants.
5. Cessation of the requirements would be keyed to when a licensee decides to terminate operations (under 10 CFR 50.82 and 10 CFR 52.110) and provides the NRC with the applicable certifications. When a licensee certifies that it has permanently removed the fuel from the reactor vessel, the mitigation strategies requirements, with the exceptions of those applicable to maintaining or restoring spent fuel pool cooling, would end. The remainder of the requirements could be terminated when the fuel is removed from the spent fuel pool and is stored in dry conditions in accordance with Commission requirements under 10 CFR part 72 or when all nuclear fuel for the reactor unit is permanently removed from the site (10 CFR part 73).

Definitions

The NRC staff intends to define a new term that would apply to the new requirements: extended loss of all ac power (ELAP). The intent is for the defined term to support the establishment of clear requirements and also more clearly delineate the differences between the new requirements and those that currently reside in 10 CFR 50.63. The definition of ELAP as currently envisioned would include:

1. A complete loss of ac power to the essential and non-essential switchgear buses
2. Loss of offsite electric power system concurrent with turbine trip
3. Unavailability of the onsite emergency ac power sources and offsite ac power sources for a duration that is longer than the specified duration determined in accordance with 10 CFR 50.63
4. Unavailability and potential non-recoverability of the offsite power source and onsite emergency and alternate ac power sources (with the exception of supplemental ac power sources per number 7 of this “Definitions” section) for beyond-design-basis external events

5. Exception: Initially ac power from inverters fed by safety-related batteries could be assumed available to support development of the strategies, provided this equipment is reasonably protected including the portions of the distribution system that are used.
6. Exception: Supplemental ac power sources that meet the new requirements (which would be specified in the new section) would be allowed to restore ac power.
7. Exception: Portable equipment that meets the new requirements would be allowed to maintain or restore functions.

There is a significant challenge to establishing requirements for what are fundamentally unbounded events (i.e., beyond-design-basis external events). This definition would provide a sufficient description of a damage state that enables, from a practical standpoint, the development of strategies and guidance that in turn are intended to mitigate that condition through the use of an approach that uses both installed and portable equipment to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities. An ELAP differs from a station blackout as envisioned under 10 CFR 50.63 in several fundamental ways. For beyond-design-basis external events, ac power may not be restored for a long period of time from either onsite or offsite. Additionally, such events are expected to impact the entire reactor site and the severe conditions associated with such events can adversely impact structures, systems, and components on the site. Accordingly, the definition is intended to support development of mitigation strategies that provide additional means to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities, simultaneously, for an indefinite period of time, for the entire reactor site.

An additional consideration on the use of an ELAP definition is not to unduly constrain the proposed provisions. A key attribute of sound strategies is the incorporation of contingency measures that provide alternate means for successfully maintaining or restoring functions should the event result in failures or potential challenges to the mitigation strategies. For example, the primary means for hooking up a portable pump may not be available due to failures or event conditions, and so the mitigation strategies should employ backup approaches for equipment connections. Another example is if the event results initially in a more severe condition such that dc power is also lost. In this circumstance, the alternate measure might involve local manual actions to operate a turbine-driven pump.

The ELAP condition, as a direct consequence, causes all ac-powered pumps to fail due to a loss of ac power to the essential and nonessential buses, which typically leads to a loss of capability to remove heat to the ultimate heat sink due to reliance on ac-powered pumps to move water. So while EA-12-049 identified the loss of normal access to the ultimate heat sink as a separate condition, it is viewed as a direct consequence of an ELAP for active plants having piping considered to be robust for external events[10]. However, for passive plants, loss of normal access to the normal heat sink resulting from non-safety related pipe failures may challenge the long term core cooling, containment, and SFP cooling capabilities as identified in the Order.

Finally, the NRC staff believes there is merit to offering additional design flexibility not allowed by EA-12-049. As discussed below, these provisions would allow for use of robust supplemental ac sources to restore power following beyond-design-basis events.

[10] With regard to what constitutes "robust," refer to NEI 12-06 Revision 0 (Ref. 12) that was endorsed by the NRC in JLD-ISG-12-01(Ref.13).

Mitigating Strategies Requirements

The NRC staff currently intends that the new section would contain requirements for licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel cooling capabilities for an ELAP condition. The NRC staff anticipates that these provisions would contain elements such as:

1. Requirements to develop, implement, and maintain guidance and strategies to maintain core cooling, containment, and spent fuel cooling capabilities for ELAP at all of the licensee's units on a site, and to restore such capabilities if one or more is lost.
2. The mitigating strategies would be adapted for implementation in each mode (as defined in the technical specifications for each unit).
3. The mitigating strategies would use or rely upon equipment of sufficient design and capacity, given consideration to the nominal conditions that could be expected, so that core cooling, containment, and spent fuel pool cooling functional capabilities can be maintained or restored for ELAP conditions.
4. The mitigating strategies would consider contingencies for when the primary means of accomplishing a function is lost or challenged.
5. The mitigating strategies would be integrated into the existing plant procedures and guidance for station blackout conditions, so that if a loss of all ac power event exceed the specified duration determined pursuant to 10 CFR 50.63 (or for licensees that use an alternate ac power source, if that source also fails), the mitigation strategies would be implemented to maintain or restore core cooling, containment, and spent fuel pool cooling.
6. The mitigating strategies would accommodate and use offsite assistance and resources to enable the functional capabilities to be indefinitely sustained.
7. The strategies would consider, and plan for, damage to the transportation infrastructure resulting from a beyond-design-basis external event that could adversely impact transportation to the site of offsite resources necessary to maintain the functional capabilities (i.e., core cooling, containment, and spent fuel pool cooling).
8. The strategies and supporting procedures would be in accordance with the requirements of the Recommendation 8 rulemaking "Onsite Emergency Response Capabilities," which is intended to integrate emergency operating procedures, severe accident mitigation guidelines, extensive damage mitigation guidelines, and the new mitigating strategies that would be required by this rulemaking.

Currently, the NRC intends to maintain an approach, consistent with EA-12-049, that is fundamentally performance-based and does not prescriptively establish minimum time periods for the different phases associated with implementation of the mitigation strategies. Instead, licensees would be required to develop their strategies such that the phases overlap and, as a result, the key functions are maintained or can be restored. However, the NRC staff also recognizes that there may be merit to having a baseline minimum capacity for withstanding ELAP conditions during the first portion of the response, which relies on installed equipment and recognizes a need for event assessment and reduces reliance on human action in the event. The staff NRC expects that EA-12-049 implementation feedback will further inform this issue.

The NRC is currently intending to continue to use the terminology “guidance and strategies” in the new rule provisions recognizing that this language has been used extensively since 2002 (Section B.5.b of the Interim Compensatory Measures Order, EA-02-026, issued on February 25, 2002, and in follow-on regulatory actions and guidance including 10 CFR 50.54(hh)(2)). However, the NRC also notes that it has historically used the term “guidance” to refer to NRC-approved or endorsed approaches (i.e., regulatory guidance) for complying with regulations, rather than as a requirement itself (such as is done under 50.54(hh)(2), in which licensees are required to formulate “guidance”). Stakeholders are welcome to provide feedback on the benefit of defining “guidance and strategies” or using different terminology in order to avoid any confusion that might stem from this usage, or whether stakeholders feel this terminology is well understood and does not require definition.

The NRC currently intends to require that mitigation strategies be developed such that they can be implemented “in all modes,” and the NRC would simply refer the licensee’s existing technical specifications to define what “mode” means. Stakeholders are welcome to provide feedback on whether there is a benefit to defining this terminology for this specific set of requirements, which the NRC recognizes is fundamentally a beyond-design-basis event situation and therefore creates potential confusion when references are made to technical specifications.

Design Requirements

The NRC staff currently intends for the new regulation to contain design requirements applicable to the equipment used to mitigate ELAP conditions. Though in some cases the elements described below may reside in supporting guidance (to avoid unnecessarily prescriptive requirements), these requirements may include:

1. Equipment used for the mitigation of ELAP conditions would be designed to perform its functions as relied upon in the mitigation strategies.
2. Portable equipment relied upon in the mitigating strategies for the mitigation of ELAP conditions would be independent from installed structures, systems, and components credited in the safety analysis to accomplish the same functions.
3. Portable equipment relied upon in the mitigating strategies would be designed, stored, and protected to minimize common cause and common mode failure with installed structures, systems, and components credited in the safety analysis for the same function. This would include the need to provide protection of portable equipment from the effects of beyond-design-basis external events.
4. Portable equipment relied upon in the mitigating strategies would be designed, staged, and deployed to minimize the potential for damage or impairment to safety-related structures, systems, and components.
5. There would be a requirement to have sufficient sets of portable equipment to enable the equipment to be removed from service for maintenance.
6. Equipment relied upon in the mitigating strategies for the mitigation of ELAP conditions would be designed to permit periodic inspection and testing to enable its functional performance to be tested periodically.
7. A test program would be established to assure that equipment relied upon in the mitigating strategies for the mitigation of ELAP conditions will perform satisfactorily in service, and this test program would be performed in accordance with written test procedures that incorporate the acceptance limits.

The objective of the design requirements would be to have an appropriate level of assurance that SSCs relied upon in the mitigating strategies to mitigate ELAPs are designed to have a capability and capacity to function for the expected conditions, to be protected from the effects of beyond-design-basis external events, and to have an appropriate level of maintenance and testing to conclude that there is assurance that the equipment remains functional and available. A key element of these requirements would involve protection of this equipment from the effects of beyond-design-basis external events. The principal focus is towards portable equipment because installed equipment that would be initially relied upon (not powered from the onsite emergency ac power system and therefore potentially available such as turbine-driven pumps) would typically be designed to safety-related standards and as such would be protected by design from external events (per GDC-2) and therefore considered to have reasonable protection. This could be satisfied in part by having multiple sets of equipment stored in different locations to increase the likelihood that sufficient portable equipment remains available for event mitigation. However, the NRC staff recognizes that new reactors, through design and siting, can significantly reduce the risk associated with external events (e.g., location of a new reactor on a dry site can remove external flooding as a significant risk consideration), and as such the staff believes there is merit to having framework flexibility to allow for approaches that rely to a greater extent on engineered features, including flexibility for a supplemental ac power source as discussed below.

With regard to testing, the staff notes that mitigation of ELAP events places heavy reliance on batteries, and as such, testing would need to provide assurance that batteries will function for the conditions and time periods required. Additionally, the NRC staff is considering whether there needs to be (in guidance or requirements) specific limits on a minimum condition for batteries (such as a minimum voltage or some other more applicable parameter) such that when, and if, ac power is recovered, there is sufficient battery capacity to support the actions needed to provide ac power to the emergency buses and/or the associated motor control centers, including reenergizing emergency diesel generator exciter fields to allow starting the generators.

Design Flexibility to Use a Supplemental AC Power Source

Currently, the NRC staff envisions that the new requirements could provide more engineering flexibility than EA-12-049 requirements and allow for the supplemental ac power source(s) to be used to restore power following a beyond-design-basis external event. Supplemental ac power source(s) would be subject to requirements that contain the following:

1. The supplemental ac power source would be required to be electrically independent from the emergency ac power sources.
2. The supplemental ac power source may be required to be diverse in design from the normal emergency ac power sources.
3. The supplemental ac power source would be required to be physically located to minimize the potential for common cause failure stemming from external events, where warranted, based on the nature and magnitude of the external events applicable to that site.
4. The supplemental ac power source(s) would be required to have sufficient combined capacity and capability to operate the equipment necessary to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities following a beyond-design-basis external event for each reactor unit at a site.
5. The supplemental ac power source would be required to have the capability to supply power through physically and electrically separate pathways to multiple

electrical distribution systems or motor control centers that provide power to the equipment important to maintaining or restoring core cooling, containment, and spent fuel pool cooling capabilities.

6. The supplemental ac power source would be required to be designed for, and protected from, the effects of external events with margin at least equivalent to that of all SSCs to which the supplemental ac source supplies power.
7. The supplemental ac power source would be required to be designed to interact with connected SSCs to minimize the potential for damage to both the connected SSCs and itself.

The NRC staff recognizes the advantages of having an installed capability to restore power following events that lead to ELAP conditions. Such a design capability would reduce the reliance on human action. At a high level, the design requirements the NRC staff would place on this power source would be intended to provide assurance that it would be available following beyond-design-basis external events. Accordingly, the design requirements are intended to ensure a level of protection for the supplemental ac power source from event effects that meets or exceeds the level of protection of the equipment that this power source would supply. A key objective for the supplemental ac power source is that it be able to withstand extreme events, while recognizing that at some point these extreme events would destroy the powered equipment. Accordingly, there is a practical limit to protection for the supplemental ac power source beyond which there is little or no safety benefit. The supplemental power source would need to be electrically independent from the class 1E emergency ac power sources to minimize the likelihood of adverse interactions and consequential failures between the power sources. Also, locating the supplemental power sources physically away (within practical limits) from the unit's class 1E emergency ac power sources would reduce the likelihood that adverse effects from a beyond-design-basis external event could cause the complete failure of all the ac power sources. Whether physical separation is needed and beneficial would depend on the nature and magnitude of the external events that impact the site.

Use of a supplemental ac power source would reduce, but not eliminate, reliance on mitigation strategies. Beyond-design-basis external events can have catastrophic impacts on the offsite ac power system, and as a result, the final phase of the mitigation strategies associated with the use of offsite assistance and resources to replenish consumables on site would appear to be needed in all cases. Additionally, the severity of these events may mean that manual actions to align the supplemental ac power source may not be taken for some period of time, so that an initial reliance on installed equipment and portable equipment may still be required until the supplemental ac power source can be used to restore ac power.

Control of Changes

The NRC believes that there is a need to include a change control requirement in the draft rule in recognition that the guidance and strategies apply to beyond-design-basis situations and the current change control requirements of 10 CFR 50.59 may not be effective under such circumstances. The NRC staff believes that change control would involve elements such as:

1. Licensees could make changes to the strategies and equipment required by the new provisions without obtaining a license amendment pursuant to 10 CFR 50.90, provided no existing requirements are triggered that result in the need for prior NRC approval, and only if the licensee performs and retains an evaluation that shows that

the guidance, strategies and supporting equipment, as changed, continue to meet the new mitigation strategy requirements.

2. Licensees would be required to retain an auditable record of each change to the guidance, strategies, and supporting equipment.

The intent of the change control is to ensure that the mitigating strategies continue to be able to achieve their objectives (i.e., maintaining or restoring core cooling, spent fuel pool cooling, and containment capabilities) following beyond-design-basis external events). Of course changes to the facility would continue to be addressed under existing requirements, but the issue is whether the NRC should be involved with the approval of a change to the mitigation strategies or the equipment relied upon in the mitigation strategies. This is in recognition that these requirements were issued in EA-12-049 as being necessary for ensuring continued adequate protection of public health and safety. Currently the NRC staff has concluded that controlling the configuration of the strategies and supporting equipment is appropriate. Changes that enhance mitigation or that enhance the protection of structures, systems, and components, for example, would not need prior NRC review and approval.

External stakeholders are encouraged to provide feedback and suggest better ways of achieving this objective.

Link with the Current 10 CFR 50.63 Requirements

The NRC staff currently intends that the new requirements would be linked with the current station blackout requirements in 10 CFR 50.63. The requirements would be amended to indicate that in the event of a station blackout that exceeds the specified duration determined in accordance with 10 CFR 50.63, or failure or unavailability of an alternate ac source used to comply with 10 CFR 50.63 during a station blackout, the requirements of 10 CFR 50.xxx (i.e., the mitigation strategy requirements that are the subject of this rulemaking) will be implemented.

A central objective for this new regulation would be to ensure continuity with current requirements in 10 CFR 50.63. For station blackout events, the mitigation strategies would be implemented when those events extend beyond a licensee's capability to withstand and recover from a station blackout as required by 10 CFR 50.63 (or for licensees that use an alternate ac power source, if that source also fails or is unavailable). At the implementation level, the mitigation strategies would connect into the emergency operating procedure for station blackout conditions. Specifically, when operators are not able to restore ac power from either offsite or onsite power sources, operators would presumably take actions to implement the mitigation strategies. Accordingly, linking the current station blackout requirements residing in 10 CFR 50.63 with the new requirements is viewed by the NRC as aligning the regulations with the implementation of these requirements at the plant level.

As this rulemaking proceeds, the NRC may conclude that for new reactors the station blackout mitigating strategies requirements make the 10 CFR 50.63 coping determination irrelevant (i.e., always result in more bounding requirements to be able to cope with station blackout conditions). If this occurs, then additional changes to 10 CFR 50.63 may be required so that new reactor designs are not unnecessarily performing 10 CFR 50.63 specified duration determinations.

Implementation

The NRC staff envisions several different implementation scenarios depending on the status of the license or application, and dependent on the licensing process being used:

1. Current licensees subject to the requirements of EA-12-049 or the equivalent license conditions are not expected to have significant implementation challenges, and would not be required to re-submit information that was already provided for review in response to EA-12-049 or the equivalent license condition.
2. Combined license holders in the pre-10 CFR 52.103(g) finding stage, would need to complete full implementation of the requirements (e.g., complete installation of equipment and development and implementation of guidance and strategies) prior to initial fuel load.
3. Combined license applicants who reference a design certification that has not been updated to meet the new rule would need to address the equipment requirements in their applications.
4. Operating license and combined license applicants whose applications are under NRC review would need to supplement their applications within 6-12 months with the required information.
5. Design certification, standard design approval, and manufacturing license applicants would need to address the equipment requirements in their applications.
6. Current design certification holders would not need to amend their design certifications but would need to address equipment requirements in renewal applications.
7. All other future license, design certification, and design approval applicants would need to address the applicable requirements in their applications.

The NRC staff intends to follow its cumulative effects of regulations procedures throughout this rulemaking, and during the final rulemaking phase expects to explore with external stakeholders whether there remain any implementation challenges that can and should be accommodated in the final rule's implementation requirements.

Additional Questions for Stakeholder Consideration

The following are additional questions that are intended to solicit additional feedback from external stakeholders to support the NRC staff's effort to assemble a proposed rule, supporting statement of considerations, and regulatory analysis containing the elements described in this appendix.

1. Should the agency consider a broader rule that combines the current 10 CFR 50.54(hh)(2) and 10 CFR 50.63 with the proposed rule into a single regulatory framework, potentially enhancing efficiency and effectiveness and reducing the cumulative effects of regulation?"
2. New reactors and their siting will be evaluated with up-to-date knowledge of external events (per GDC-2). Further, they may have better and more robust designs reflecting the operating experience of the current generation of reactors with respect to station blackout mitigation. Therefore, the NRC requests comment on the application of station blackout mitigating strategies requirements to new reactors:
    a. Should new reactor designs be required to have station blackout ac power sources that are designed for external events (e.g., safe shutdown earthquake, flooding, and wind) and have sufficient capacity to shutdown the reactor? Should

new reactor designs be required to include additional margin for flooding or other external events?

b. If so, should the NRC allow credit (i.e., allowing these ac sources to re-energize safety buses) under ELAP conditions, or should there be requirements for portable equipment as a diverse means to maintaining or restoring the key functions regardless of whether there are ac sources capable of re-energizing safety buses?
c. What station blackout mitigation strategy requirements should be applied to small modular reactors?
d. The NRC is considering requiring a design certification applicant to address the first portion of the mitigative response with installed equipment and connections to allow for maintenance of functions, and then have the remaining scope (i.e., the portion of the response that is more reliant on portable equipment) be the responsibility of a combined license applicant. What are stakeholder views on the appropriate division of requirements between a design certification and a combined license?
e. What information about mitigation strategies and the equipment to be used should be included in the final safety analysis report? Where should other supporting information be located?
f. For the combined license process, how should implementation be phased with application for a combined license, combined license issuance, and fuel load?

3. How should human reliability be considered for beyond-design-basis external events for which there is an undefined damage state and potentially severe conditions under which human actions would be required?

4. The NRC understands that licensees may incur impacts as a result of station blackout mitigation strategies requirements already imposed under Order EA-12-049 or as a result of the proposed rule contemplated in this regulatory basis document. The NRC requests feedback on the costs associated with the specific station blackout mitigation strategies and related activities, regardless of whether they arise as a result of the Order or the rule. The NRC specifically requests information addressing the following questions. In your response, please indicate whether the information applies to (a) operating reactor licensees, (b) applicants, (c) design certification licensees/applicants, or (d) other (specify).

    a. What specific equipment (and quantity of specific equipment) will licensees or applicants need to procure in order to comply with station blackout mitigation strategies requirements? If applicable, please specify whether the specific equipment will be shared by multiple units at a site or by multiple sites in a region. What are the capital and maintenance costs associated with the equipment?

    b. What plant modifications (i.e., beyond the equipment described above) will licensees or applicants need to make in order to comply with station blackout mitigating strategies requirements? What are the estimated costs associated with these plant modifications? Will these plant modifications extend the duration of plant outages when they are installed? If so, by how much calendar time?

c. What changes to procedures will licensees or applicants likely need to make in order to comply with station blackout mitigation strategies requirements? What are the estimated costs associated with developing these procedure changes? Would operational costs be affected, and if so, at what estimated cost?

d. What training are licensees or applicants likely to purchase or develop to comply with station blackout mitigation strategies requirements? In what format will this training be given and to what types and numbers of workers at what duration and frequency? What is the estimated cost to purchase or develop the training?

e. What other types of activities are anticipated, and what are the estimated costs associated with the activities?

f. What benefits will be gained as a result of station blackout mitigation strategies requirements?