# Station Blackout Mitigation Strategies

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# Regulatory Basis Document

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# Table of Contents

## Acronyms

| | |
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| 10 CFR | Title 10 of the *Code of Federal Regulations* |
| ACRS | Advisory Committee on Reactor Safeguards |
| 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 damage 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 multi-unit site, the SBO rule assumed that an SBO occurred 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 that 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. The NRC staff plans to issue a proposed rule amending NRC regulations to address these scenarios for both current and new reactors.[1]

## 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 to the Commission, including a specific proposal for new requirements for long term station blackout mitigation. The NTTF suggested enhanced station blackout mitigation strategies, within NTTF Recommendation 4.1, as follows (Ref. 2):

> 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,[2] (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.

The recommendation regarding SBO and the need for revising 10 CFR 50.63, sometimes referred to as the SBO rule, was subsequently endorsed by the Natural Resources Defense Council in a petition for rulemaking (PRM), PRM-50-101 (Ref. 5). In the same section of the

[1] With regard to the loss of access to the ultimate heat sink, it should be noted that new passive reactor designs that use the atmosphere as the ultimate heat sink would be allowed to take a different approach.

[2] 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. The planned regulatory scope of this rulemaking differs from Recommendation 4.1 as described in section 3.1 of this regulatory basis document.

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

> 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.

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 mitigation strategies to provide additional capability to respond to beyond-design-basis external events, which can lead to an extended loss of ac power and loss of access to the ultimate heat sink. The Commission concluded that the new requirements were necessary to continue to have reasonable assurance of adequate protection of public health and safety. The Order significantly expanded the scope of the regulatory concerns addressed under NTTF Recommendation 4.2 in SECY-11-0124 (Ref. 7), 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 that lead to an extended loss of ac power and loss of normal access to the ultimate heat sink condition. 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 the capability to obtain 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 a Memorandum and Order authorizing the staff to issue COLs for Virgil C. Summer Nuclear Station, Units 2 and 3, *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), CLI-12-09, 75 NRC 421 (Ref. 11). The Commission decision in CLI-12-09 includes requirements for mitigation strategies as a license condition for the two Summer units. These requirements parallel those of EA-12-049 with respect to the Vogtle facility.

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 mitigation 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 Mitigation 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 (Ref. 14). This ANPR began the process for considering amendments to the NRC's regulations that address SBO. 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 mitigation 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 was a significant expansion of the regulatory action envisioned in NTTF Recommendation 4.2, 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 mitigation 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 required to mitigate a site-wide external event for which offsite ac power is lost indefinitely (Ref. 4). This 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:[3]

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.

[3] 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.

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 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, 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 mitigation 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 mitigation strategies that maintain or restore spent fuel pool cooling capabilities. The resulting mitigation 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 mitigation strategies Order and through a rulemaking of similar regulatory scope (Ref. 16). Note also that section 3.1 discusses the planned scope of this rulemaking and how it differs from the NTTF recommendations that were the impetus for this action. The NRC staff expects that the rulemaking for which this regulatory basis is developed would (1) make the Order requirements generically applicable; (2) consider external stakeholder feedback and lessons learned from implementation of the mitigation strategies Order (EA-12-049); and, (3) identify and resolve any potential failures or challenges to the implementation of these mitigation strategies, per the Commission's 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 mitigation strategies also would affect these same entities.

*General Design Criteria* (GDC)[4, 5]

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

GDC 2 requires nuclear power plants designed in accordance with Appendix A to 10 CFR Part 50 to be protected against natural phenomena, as follows:

> *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.

[4] 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 predecessor to the NRC, had yet to develop generic requirements for facility design criteria at that time.

[5] 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. For facilities with construction permits issued before 1971, plant-specific PDC, which differ in certain respects, 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.

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 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 criteria) 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. (Because 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):

> *Station blackout* means 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

[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.

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 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 multi-unit sites where onsite emergency ac sources are shared between units 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-related 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 as a result 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).

*Risk Assessments Associated with the SBO Rule*

Over the years, the NRC has conducted risk assessments to support the issuance of 10 CFR 50.63, assess the effectiveness of 10 CFR 50.63, and to re-evaluate station blackout risk (see NUREG-1032 (Ref. 24), NUREG-1109 (Ref. 36), NUREG-1776 (Ref. 34), and NUREG/CR-6890 (Ref. 35)). Prior to issuance of 10 CFR 50.63, the Commission indicated that the total station blackout risk from the causes considered, while significant, did not represent a level of risk that was undue. As such, the Commission determined that the risk did not rise to a level that justified action under the adequate protection exception provision of 10 CFR 50.109(a)(4)(ii). Instead, the risk warranted regulatory action that represented a cost-justified substantial safety enhancement under 10 CFR 50.109(a)(3). Therefore, prior to the issuance of 10 CFR 50.63, the known risk associated with station blackout (which did not include the risk associated with station blackouts caused by external events) was not considered to present an undue risk to public health and safety.

A post-implementation study of the SBO Rule (NUREG-1776 (Ref. 34)) concluded that 10 CFR 50.63 resulted in a substantial reduction in the mean core damage frequency (CDF) associated with station blackout events.[8] The station blackout initiating events accounted for in NUREG-1776 were grid-centered, switchyard-centered, and severe weather-driven LOOP events with coincident onsite failure of both trains of emergency ac power. The study found that implementation of 10 CFR 50.63 requirements removed approximately 75 percent of the known risk (estimated in terms of a mean CDF).

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[7] Current operating reactor licensees without alternate ac power sources were required to perform coping analyses to determine the SBO durations, which typically resulted in 4 hour SBO durations. 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.

[8] The study estimated that the SBO rule reduced the mean CDF from 4.2E-05 per reactor-year to 1E-05 per reactor year.

Subsequent to this analysis, an additional re-evaluation of SBO risk was performed and documented in NUREG/CR-6890 (Ref. 35). This re-evaluation estimated SBO risk in terms of CDF per reactor critical year for all plants using updated standardized plant analysis risk (SPAR) models. The analysis considered risk associated with internal events only; as such, seismic, flood and fire events were excluded. However, the effects of severe weather events resulting in a LOOP were considered in the risk assessment. The evaluation estimated a small remaining SBO risk, consistent with the conclusions of NUREG-1776.[9]

The results of these analyses indicate that known SBO risk from internal events and estimated in terms of mean CDF, has trended substantially downward from the 1970s to the 2000s, and current levels appear to be below about 1E-05 CDF.

## 3. Technical Basis for Incorporating Station Blackout Mitigation Strategies Requirements into Regulations

The existing SBO regulation in 10 CFR 50.63 was intended only to address events such as switchyard-related or grid-related events (due to grid disturbances) or weather events (such as high winds, snow, and ice loading affecting the offsite power system), as discussed in the previous section. Typically, these events involve recovery of offsite or onsite power within a few hours. While the existing SBO rule does require consideration of the probable time to restore a loss of 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 an 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 multi-unit site. Although the probability of all emergency power sources failing is generally low, consideration should 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 an external event such as the one that 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 subsequently granted COLs(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.

[9] In fact, the NUREG/CR-6890 found somewhat smaller risks relative to the NUREG-1776 report. Specifically, NUREG/CR-6890 concluded that SBO risk was at an average CDF of 3E-06 per reactor critical year, with a range from 6.6E-07 to 5.3E-06.

**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 (the ISG clarifies that this does not include the loss of ac power from buses fed by batteries through inverters) |
| General requirement | A single unit's 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:<br>• Onsite ac system configuration<br>• Average diesel reliability<br>• Expected frequency of LOOP<br>• Probable restoration time for offsite power<br>(This was a single determination accomplished at the time of implementation.)<br><br>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<br><br>Demonstrate ability to transition between phases of strategies |
| Requirements on plant procedures and equipment | -Highly reliable ac power system<br>-Procedures and training to restore offsite and onsite power<br>-Plant capability to cope with an SBO for a specified duration<br>-Maintain diesel generator reliability | Development of a three-phased strategy:<br>-Phase 1: installed equipment<br>-Phase 2: onsite portable equipment and supplies<br>-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 |

| | 10 CFR 50.63 | EA-12-049 |
|---|---|---|
| Acceptable options | -Enhancements to plant equipment and procedures to meet the specified duration (ac-independent heat removal systems, battery capacity, water sources)<br>-New and enhanced plant procedures and training<br>-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 (other than ac sources) that is safety-related is allowed for the initial phase. Use of reasonably protected equipment is allowed for the second phase. Replenishing and supplementing equipment and resources 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. Guidance recommends protection from 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 cannot be credited for compliance with EA-12-049 - specifically EA-12-049 requires 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 |
| 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 |

| | 10 CFR 50.63 | EA-12-049 |
|---|---|---|
| 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).<br>-There are requirements to maintain diesel generator reliability | -One time modifications to plant equipment<br>-One-time addition of onsite and offsite portables<br>-Continuing configuration/design control requirements<br>-Possible ongoing commitments |

Following the Fukushima event, and as NTTF Recommendation 4.2 implies, there were suggestions that the strategies implemented to meet 10 CFR 50.54(hh)(2) were potentially useful to mitigate the effects of prolonged station blackout events. However, these strategies were not intended to address 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 for: (1) events that can impact more than one unit at a site with two or more units, (2) maintenance or restoration of multiple safety functions at each of several units located on the same site, and (3) events that 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.[10] To provide additional capability to respond to events that lead to an extended loss of ac power and loss of access to the ultimate heat sink (e.g., events arising from severe natural phenomena), the NRC imposed by Order EA-12-049 (Ref. 10) new requirements for mitigation strategies at licensed nuclear power reactors so that the NRC can continue to have reasonable assurance of adequate protection of public health and safety.

The strategies and guidance developed and implemented in response to Order EA-12-049 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. In addition, 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 capability 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 requirements stemming from NTTF Recommendation 4 and 7 into the NRC regulations to ensure that these requirements are applied to future nuclear power plant designs and licensing applications.

[10] 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 to provide adequate protection of the public health and safety.

### 3.1 Regulatory Scope of a Station Blackout Mitigation Strategies Rulemaking

This section discusses the planned scope for a station blackout mitigation strategies rulemaking. As a preliminary matter, the station blackout mitigation strategies requirements will be premised on the adequacy of the design basis for every licensed nuclear power plant (which is addressed by NTTF Recommendation 2). In that regard, the Commission has taken or is taking a variety of actions to ensure the adequacy of the design bases of operating power plants that include implementation of NTTF Recommendations 2.1 and 2.3 using a two-phase process.

Under phase 1, NRC issued a request for information letter under 10 CFR 50.54(f), which requests that licensees:

- Perform seismic walkdowns[11] and flood walkdowns,[12]
- Reevaluate site-specific seismic and flooding hazards using present-day guidance and methodologies, and
- Perform assessments of the capability of the plant to withstand any reevaluated hazard that is not bounded by the plant's design basis. For some plants, this assessment may include evaluation of the capabilities provided by SBOMS equipment for responding to the reevaluated hazard.[13]

Under Phase 2, NRC will determine if additional regulatory actions are necessary to provide additional protection against the updated hazards.

The current regulatory approach differs from NTTF Recommendation 4 (which was the primary impetus for the planned regulatory action).[14] The NRC staff plans to address the potential for external events to adversely impact plant safety with the following regulatory approach:

- Requirements that licensees provide resources (i.e., a diverse and flexible additional capability that uses guidance, strategies and equipment), in addition to design-basis equipment, to respond to an extended loss of ac power and loss of normal access to the ultimate heat sink currently imposed through issuance of Order EA-12-049. The planned rulemaking would make these requirements generically-applicable.

In general, the NRC staff expects the regulatory scope of a station blackout mitigation strategies rulemaking to remain consistent with the scope established by Order EA-12-049. However, to make the Order requirements generically-applicable, the station blackout mitigation strategies rulemaking also should consider: (1) how the new requirements relate to the existing station blackout requirements in 10 CFR 50.63; and, (2) whether it is appropriate to differentiate the requirements applicable to current operating reactor licensees and new reactor applicants and licensees. The approach currently envisioned is to apply the mitigation strategies requirements

[11] The seismic walkdowns are intended to identify and address plant-specific vulnerabilities (through its corrective action program) and verify the adequacy of monitoring and maintenance procedures.
[12] The flooding walkdowns are intended to identify and address plant-specific degraded, nonconforming, or unanalyzed conditions and so-called "cliff-edge" effects (through the corrective action program) and verify the adequacy of monitoring and maintenance procedures.
[13] Crediting SBOMS as part of an evaluation of the capability of the plant to protect against or mitigate the consequences of the new reevaluated hazard could mean that revisions to the mitigation strategies may be necessary to reflect the new conditions under which they are being credited (e.g., flood levels, flood event duration, warning time, equipment and staffing requirements, storage locations, etc).
[14] Refer to Section 2.1 of this document for a description of NTTF Recommendations 4.1 and 4.2, which are subparts of Recommendation 4.

to all power reactors (i.e., currently licensed power reactors and new reactors), with special provisions to address the unique aspects of newer designs.

The staff's current regulatory approach for the station blackout mitigating strategies rulemaking differs from the NTTF's recommendations with respect to physical protection of equipment, as follows: Under NTTF Recommendation 4, the task force recommended that certain equipment, relied upon to mitigate an external flooding event, be located one level above the design basis flooding level or in watertight enclosures. This would provide additional design margin to protect that equipment from external flooding events. Instead, the staff's planned regulatory approach is to address issues associated with the protection of SSCs from seismic and flooding events through the implementation of NTTF Recommendation 2.1 (as discussed above). As a result, the protection level for external events for SBOMS equipment would initially be set at a design basis or equivalent level and not revised until the results of the NTTF 2.1 regulatory activities are available, or new information or operating experience feedback is received. However, if as a result of these activities, there are impacts to the SBOMS equipment and strategies, then the SBOMS strategies and equipment protection would be updated accordingly as is discussed further in section 3.3 under the heading "Implementation Issues." As mentioned in other portions of this document, the means by which SBOMS addresses beyond design basis external events is through requirements that licensees provide a diverse and flexible additional capability that uses guidance, strategies and multiple sets of equipment that are used to mitigate an extended loss of ac power condition and loss of normal access to the ultimate heat sink. These resources would be in addition to design-basis equipment, but this equipment and resources would not be subject to requirements for additional margin associated with the physical protection for beyond design basis external events.

*Consideration of the Need for Additional Regulatory Actions*

It should be noted that the NRC could increase the scope of the station blackout mitigating strategies rulemaking beyond making the EA-12-049 requirements generically applicable. The staff considered the need to broaden the scope of the regulatory action by reviewing available risk information to judge whether additional requirements might be appropriate. In particular, the staff reviewed the risk assessments discussed at the end of Section 2.2. The purpose of this review was to identify existing risks or safety issues that might warrant additional regulatory action under the NRC's backfit rule. After completing this review, the staff concluded that the available information does not justify pursuing additional requirements beyond those addressed in EA-12-049, for the following reasons:

1. As discussed in Section 2.2, the results of NRC's SBO risk assessments indicate that known SBO risk from internal events and estimated in terms of mean CDF, has trended substantially downward from the 1970s to the 2000s, and current levels appear to be below 1E-05 CDF. These studies, however, do not analyze external event-driven SBO risk other than severe weather-driven events.

2. The events that occurred at the Fukushima Dai-ichi Nuclear Power Plant site on March 11, 2011, highlight external event risk, specifically risk from severe external events that lead to an extended loss of ac power and subsequent core damage. Due to new information and the evolution of the state-of-practice, the use of current guidance and methodologies to assess seismic and flooding hazards may reveal deficiencies with regard to the definition of credible external events (e.g., flood height and associated effects) as well as associated protection. Further requirements that apply to conditions

involving the loss of ac power may need to reflect the risk from external events. The staff's response to NTTF Recommendations 2.1 and 2.3 are intended to (1) identify vulnerabilities or deficiencies in the plant's ability to protect against or mitigate the consequences of a design basis flooding or seismic event; (2) re-evaluate flooding and seismic hazards using current guidance and methodologies; and (3) evaluate the capability of the plant to respond to this newly determined hazard (if the newly determined hazard is not bounded by the design basis). These issues must be addressed on a plant specific basis and reflect the plant location, age, design, and applicable external hazards. The staff, therefore, considers the current regulatory approach for NTTF Recommendations 2.1 and 2.3 as being the best means for addressing these issues associated with the effects of seismic and flooding external hazards.

3. The mitigation strategies requirements imposed through Order EA-12-049 provide additional resources (in addition to design basis equipment) that licensees can use to mitigate extended loss of ac power events. The staff acknowledges that the mitigation strategies are designed for beyond design basis conditions resulting from external events by using equipment protected to a design-basis level of protection recognizing that this level of protection may change as a result of activities associated with NTTF 2.1 (refer to section 3.3 under the heading "Implementation Issues" for further discussion of potential impacts to SBOMS equipment and strategies and the need to update SBOMS strategies and equipment protection accordingly). Nonetheless, there is no guarantee that the margins built into such equipment will be sufficient to ensure that such equipment will withstand any particular beyond-design-basis external event. However, the strategies are linked to the symptom-based station blackout EOP and may therefore be leveraged to address a range of events (both internal and external). Specifically, implementation of the mitigation strategies requirements should reduce the risk associated with station blackouts that previously would have extended beyond the 10 CFR 50.63 specified duration. As a result, the mitigation strategies requirements should reduce the residual SBO risk by providing licensees with additional means for coping with SBO events.

In summary, the actions planned in response to NTTF Recommendations 2.1 and 2.3 are the best regulatory vehicles for addressing issues associated with deficiencies and/or vulnerabilities under a site's current design basis and to evaluate the effects of re-evaluated seismic and flooding hazards on the plant.

Further, the mitigation strategies should reduce the risk from events that lead to a station blackout event condition, and will provide resources, in addition to design-basis equipment, which can potentially be leveraged in an event leading to an extended loss of ac power. It is expected that implementation of Order EA-12-049 will further reduce remaining risk associated with station blackout events.

Additional regulatory effort to develop new requirements (beyond the general scope of requirements already imposed by EA-12-049 and being made generically-applicable in the planned station blackout mitigation strategies rulemaking) does not appear warranted. The known risk (from events other than severe natural phenomena such as earthquakes and floods) does not appear to satisfy the requirements of 10 CFR 50.109(a)(3), which require the NRC to show that there can be substantial additional protection of public health and safety, unless needed to ensure adequate protection of the public health and safety or that the facility is in

accord with the common defense and security. The staff has concluded that the remaining known risk associated with station blackout is below a level warranting action under the adequate protection provisions of 10 CFR 50.109(a)(4). However, this conclusion is subject to change based on the feedback and lessons-learned from implementation of EA-12-049, NTTF Recommendation 2.3, and NTTF Recommendation 2.1 activities. It should be noted that for some plant sites, applicable hazards, and licensed physical protection, there may be action that is warranted based on the re-evaluated hazards under NTTF Recommendation 2.1. The NRC staff anticipates that this scenario, should it arise, would be a plant-specific issue as to whether regulatory action is warranted. However, as discussed below in section 3.3 under the heading "Implementation Issues," impacts to the SBOMS equipment and strategies stemming from these activities would need to be addressed, and the SBOMS strategies and equipment protection would be updated accordingly.

### 3.2 Regulatory Objectives

The NRC staff has defined the regulatory scope (as discussed in Section 3.1) in order to address an apparent gap in current regulations. Current NRC regulations do not incorporate requirements to implement mitigation strategies to provide additional capability to respond to events that could lead to an extended loss of ac power (e.g., events arising from severe natural phenomena). A rulemaking would make generically applicable requirements similar to those imposed by 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 as a result of implementing the Order requirements. In doing so, the NRC would give consideration to whether there are potential failures or challenges associated with the implementation of the mitigation 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. The NRC will determine what action to take in regard to EA-12-049 in the context of a proposed rule, and will request comment on that action in the notice of proposed rulemaking. Such action could include, among other things, relaxation or withdrawal of that order.

- Establish a regulatory framework that links the new station blackout mitigation strategies with the currently existing SBO requirements in 10 CFR 50.63. The mitigation strategies required by EA-12-049, if made generically applicable as part of this rulemaking, would fit into the plant station blackout emergency operating procedures (EOPs) and would be implemented when ac power cannot be recovered from either offsite or onsite sources. As such, the station blackout requirements and the mitigation strategies requirements are directly related at the implementation level. Accordingly, the rulemaking should consider the need for a direct linkage between the two sets of requirements with the intent of providing regulatory clarity. The staff recognizes that the two sets of requirements are directed to different scenarios and that anything more than a link between the two could create confusion and unintended impact.

Based on the information presented in this regulatory basis document, the NRC staff concludes that rulemaking is warranted to amend 10 CFR Parts 50 and 52 to require additional mitigation strategies for responding to events that lead to an extended loss of ac power (e.g., events arising from severe natural phenomena). These same mitigation strategies may enhance the current capabilities for mitigation of SBO sequences stemming from grid-centered, switchyard-centered, and severe weather events.

The regulatory basis document issued for comment included an Appendix A that provided a discussion of preliminary staff rule concepts, and a set of questions for comment. Appendix A and the associated questions were used to gather stakeholder input that the staff will use to inform its efforts to develop proposed rule language and supporting information. Appendix A was not revised to reflect stakeholder feedback since the staff believes this input warrants more careful deliberation, and Appendix A is not being republished with this regulatory basis document. However, observations concerning stakeholder comments are provided in section 5.

### 3.3 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 likely 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 guidance with the new mitigation strategies requirements and supporting guidance. The NRC expects that these changes would note that licensees would be required to deploy mitigation 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 Mitigation 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 strive to 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). To be clear, new requirements would apply DCs, SDAs, and MLs only to the extent the requirements apply to design matters within the scope of the covered DC, SDA, or ML, but all requirements would apply to the subject COLs. Under this approach, previously certified or approved standard designs would not require modification until renewal, if at all; issued COLs would be treated like an issued operating license (OL) or CP; DC and COL applications currently under NRC review would need to demonstrate compliance before the NRC can certify such a design or issue such a license; and any future DC, SDA, COL, or ML applicant would need to demonstrate how it complies in its application. Further, the NRC would ensure that any permanent equipment and connection requirements are included in the scope of a DC, SDA, or ML application, whereas the portable equipment requirements and mitigation strategies (operational requirements) would be included in the scope of a COL application. This separation of permanent and portable equipment and mitigation strategies would implement the Commission's direction but impose the requirements the licensing action best suited to address those requirements.

*Implementation Issues*

As described below, implementation issues include the rulemaking schedule, the necessary level of protection of SSCs from external events, and potential design changes resulting from other NRC initiatives. 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 mitigation 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 NRC staff views the revised proposed rule schedule (proposed rule due to the Commission June 2014) as sufficient to enable the staff to consider lessons learned from the NRC review of these plans.

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

- Since the purpose of the SBOMS rulemaking would be to provide mitigation capability for extreme external events, information from NTTF Recommendation 2.1 regulatory activities or other re-evaluations of site-specific hazards would be relevant and need to be addressed and could result in changes to the facility. These changes could include changes to: installed equipment; portable equipment; portable equipment connections; and/or guidance and strategies. Consistent with Order EA-12-049 and related regulatory guidance, it is expected that the SBOMS rule would contain requirements to maintain the SBOMS capabilities, including the protection afforded the equipment consistent with any updated hazard analyses. The supporting SOC and regulatory guide would indicate that the meaning and intent of this provision would be to ensure that new information or

operating experience feedback (e.g., new information about a reevaluated hazard) that impacts the SBOMS equipment and strategies would need to be addressed, and the SBOMS strategies and equipment protection would be updated accordingly.

The relevant hazard information would be taken into account in showing that adequate time for use of portable equipment can reasonably be met as described in NEI 12-06, Section 3.2.1.7, Principle 6, and clarified in JLD-ISG-2012-01's Staff Position of Section 2.1. The establishment of an appropriate hazard is therefore an important element of the strategies that requires maintenance of mitigation capability for changes in the facility that could impact the identified time constraints. As such, the staff expects that NTTF Recommendation 2.1 activities, for licensees having reevaluated hazards that exceed their current design basis, could have a significant impact on their SBOMS equipment and strategies. For example, the industry and the NRC are currently considering an expedited approach for the treatment of seismic issues to address NTTF Recommendation 2.1, and the result of that effort could impact the SBOMS equipment and strategies related to this rulemaking. The SBOMS rule could serve to codify the requirement for establishing and addressing re-evaluated hazards and their impact on mitigation equipment and strategies.

- There is ongoing consideration regarding the use of the mitigation strategies equipment after core damage (under severe accident conditions). For example, use of this equipment for Mark I and Mark II containments as part of filtering and venting strategies is under consideration. If such an approach is used, it could result in changes to the facility and the portable equipment. As a result, these activities could impact the station blackout mitigation strategies rulemaking.

- The NRC staff will follow its cumulative effects of regulations procedures throughout this rulemaking. During the final rulemaking phase, the NRC staff 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.

*Impact on Operating Reactor Licensees*

Based on stakeholder feedback, the NRC expects operating reactor licensees to incur the following site-specific impacts as a result of Order EA-12-049:

- development, implementation, and maintenance of the mitigation strategies (referred to by industry as the "Flex Support Guidelines," Ref. 12);
- modification of safety and non-safety related structures, systems, and components to enable ready connection of mitigation strategies equipment;
- engineering evaluations to support the key assumptions in the mitigation 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 activities; 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 provided the NRC staff with preliminary 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.

Impacts of the rulemaking are expected to be far more limited, although the staff's current vision for the rulemaking may result in additional costs for operating reactor licensees. For example, if the rulemaking allows licensees to use a supplemental ac power source as a mitigation strategy, then licensees may incur costs to implement such an approach. However, because this rulemaking provision would be voluntary, licensees would not be compelled by the NRC to incur the associated costs. In addition, the NRC staff may propose a change control process in the rulemaking 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, like Order EA-12-049, 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 mitigation strategies, a rulemaking likely would allow licensees to rely on previous submissions to comply with certain information collection rule requirements if licensees have received NRC staff approval of mitigation strategies prepared to comply with the Order.

*Impact on Licensees with Plants Under Construction*

There are currently five 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 similar to the impact 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 credited safety functions beyond 72 hours to 7 days and connections for offsite equipment to back up installed equipment. The requirements to address mitigation 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 mitigation strategies requirements were included as conditions of the Summer licenses. Regardless, there is an equivalent impact on the Vogtle and Summer plants. However, because of the passive design of the AP1000 standard design and the previously-planned equipment connections, the impact of the mitigation strategies requirements on the Vogtle and Summer plants will be less than that on the operating reactors.

*Impact on Issued Design Certifications and Standard Design Approvals*

The NRC has certified four standard designs 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 of any other standard designs or licensing any particular reactor facility. 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 mitigation strategies requirements 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 mitigation strategies requirements 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 four cases the burden would likely 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. (A design approval cannot be renewed, but a vendor may 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 (Ref. 9), the NRC staff plans to ensure that Commission-approved Fukushima actions are addressed prior to certification of the designs now under review or licensing the proposed facilities. As a result, all applicants for design certification would need to address the final rule requirements 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 applicable final rule requirements (assuming that for new OLs or COLs the Commission would impose the requirements of EA-12-049 by license condition in the interim before a final rule becomes effective). The NRC also notes that, because of the difference in the designs, passive plants would likely have fewer requirements to address than active plants. Thus, the impact on AP1000 and ESBWR (passive) plants would likely be less than on the U.S. EPR and U.S. APWR (active) plants.

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

The NRC staff currently intends to make the requirements under a potential rulemaking applicable to all future applications for COLs, DCs, SDAs, and MLs. 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 a station blackout mitigation strategies rulemaking likely would only refine the requirements under Order EA-12-049, there would not be a 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 significant NRC impacts for this rulemaking would be limited to future reactors. These impacts would include reviewing all current and future DC, COL, SDA, and ML applications to ensure compliance with the requirements associated with this rulemaking.

*Impact on Public Health and Safety*

Because the station blackout mitigation strategies rulemaking would ensure uniform application of mitigation strategies requirements to all reactor facilities, there would be a net increase in public health and safety, although this increase would likely not be substantial in view of the requirements already imposed through EA-12-049 and EA-12-051.

*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.[15] At these meetings, the NRC staff 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 mitigation 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 43 comment submissions (identified below). The NRC staff considered the stakeholder feedback from the ANPR submissions in developing this regulatory basis. A significant portion of the stakeholder feedback involved considerations of specific events, or specific event conditions, and in many cases this was a direct result of the NRC's questions that were posed in the ANPR. As evidenced by the draft rule concepts in the appendix of this document, the staff pursued a more performance-based approach that was influenced to a great extent by the development of the guidance for the mitigation strategies Order.

[15] 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, 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.

| Comment No. | ADAMS No. | Commenter Affiliation | Commenter Name |
|---|---|---|---|
| 1 | ML12082A018 | Woodward Corporation | Tom Woodward |
| 2 | ML12082A046 | Minnesota Homeland Security and Emergency Management | Kevin Leuer |
| 3 | ML12082A048 | Lovejoy Controls Corporation | Kim Lovejoy |
| 4 | ML12083A006 | ENUSA | Javier Haces |
| 5 | ML12083A007 | AMEC Environmental and Infrastructure | John Fuoto |
| 6 | ML12086A276 | Private citizen | Tom Gurdziel |
| 7 | ML12088A030 | Private citizen | Tom Gurdziel |
| 8 | ML12088A031 | Private citizen | Tom Gurdziel |
| 9 | ML12089A128 | Private citizen | Tom Gurdziel |
| 10 | ML12101A114 | Unknown | Anonymous |
| 11 | ML12101A115 | Unknown | Anonymous |
| 12 | ML12101A116 | Unknown | Anonymous |
| 13 | ML12101A117 | Private Citizen | Joseph Quinlan |
| 14 | ML12101A317 | Private Citizen | Terry Tyler |
| 15 | ML12103A167 | Private Citizen | Liz Hampton |
| 16 | ML12107A425 | Unknown | Anonymous |
| 17 | ML12115A241 | Private Citizen | John Hoyle |
| 18 | ML121170483 | Private Citizen | Ed Battle |
| 19 | ML12122A106 | Foundation for Resilient Societies | William Harris |
| 20 | ML121220283 | Private Citizen | Paul Sicard |
| 21 | ML12125A140 | TVA | J.W. Shea |
| 22 | ML12128A009 | Private Citizen | Ipatia Apostolides |
| 23 | ML12128A010 | Private Citizen | John Sutton |
| 24 | ML12128A011 | GE Hitachi Nuclear Energy | Patricia Campbell |
| 25 | ML12128A012 | Westinghouse | James Gresham |
| 26 | ML12128A008 | AREVA | Pedro Salas |
| 27 | ML12128A283 | STP Units 3 and 4 | Scott Head |
| 28 | ML12128A284 | NEI | A Pietrangelo |
| 29 | ML12128A285 | UniStar Nuclear Energy | Mark Finley |
| 30 | ML12128A286 | PPL Bell bend | R.R. Sgarro |
| 31 | ML12128A287 | Mitsubishi Nuclear Energy Systems | Yoshiki Ogata |
| 32 | ML12128A288 | First Energy | Robin Ritzman |
| 33 | ML12128A289 | Prairie Island Indian Community | Philip Mahowald |
| 34 | ML12128A290 | UCS | Edwin Lyman |
| 35 | ML12128A291 | Foundation for Resilient Societies | William Harris |
| 36 | ML120190247 | Private Citizen | J. Decker-Smith |
| 37 | ML12129A042 | Private Citizen | Janice Nelson |
| 38 | ML12129A043 | Private Citizen | Anthony Apostolides |
| 39 | ML12129A044 | Private Citizen | Barry Quigley |
| 40 | ML12129A045 | Private Citizen | Martina Eichhorn |
| 41 | ML12131A272 | PWR Owners Group | Maurice Dingler |
| 42 | ML12139A128 | Exelon | Michael Jesse |
| 43 | ML12139A129 | STARS | Carl Corbin |

The staff concluded that the performance-based approach for the mitigation strategies Order was the best regulatory approach to pursue given the nature of the events under consideration. In addition, the specific means by which the strategies were to be implemented, linked into the symptom-based emergency operating procedure for station blackout, provided a direct link between current SBO requirements and the new mitigation strategies. The net result is a regulatory approach that is somewhat different than what was originally recommended by the NTTF in Recommendations 4 and 7. Section 3.1 discusses the scope of this rulemaking effort and how it differs from the applicable NTTF recommendations.

The NRC staff published the draft station blackout mitigation strategies regulatory basis in the *Federal Register* on April 10, 2013 (78 FR 21275) for a 45-day comment period (Ref. 39). On May 13, 2013, during the draft regulatory basis public comment period, the staff held a Category 3 public meeting. The purpose of the public meeting was to allow the NRC staff to discuss issues and answer clarifying questions associated with the draft station blackout mitigation strategies regulatory basis to support more informed written public comments. The meeting summary for this meeting can be found at ADAMS Accession Number ML13134A298.

The NRC received the following 15 sets of comments from stakeholders on the draft regulatory basis. The comments were all supportive of the need for rulemaking. Comments were received from private citizens, licensees, new reactor designers, and industry groups. The sections below discuss the changes that were made to the regulatory basis and the staff's observations on those comments based on its review and consideration of the comments at the time this regulatory basis was finalized. The follow sections also provide details regarding Advisory Committee on Reactor Safeguards (ACRS) interactions.

The draft regulatory basis document issued for comment included an Appendix A that provided a discussion of preliminary staff rule concepts, and a set of questions for comment. Appendix A and the associated questions were used to gather stakeholder input that the staff will use to inform its efforts to develop proposed rule language and supporting information. Appendix A was not revised to reflect stakeholder feedback since the staff believes this input warrants more careful deliberation, and Appendix A is not being republished with this final regulatory basis document.

| Comment No. | ADAMS No. | Commenter Affiliation | Commenter Name |
|---|---|---|---|
| 1 | ML13119A416 | Private Citizen | Adam Graham |
| 2 | ML13129A395 | Maine Yankee | James Connell |
| 3 | ML13129A402 | Yankee Atomic | Robert Mitchell |
| 4 | ML13136A213 | Connecticut Yankee | Brantley Burger |
| 5 | ML13149A191 | PWR Owners Group | N. J. Stringfellow |
| 6 | ML13151A417 | Mitsubishi Nuclear Energy Systems Inc | T. Yamaguchi |
| 7 | ML13151A430 | NuScale Power | E. Wallace |
| 8 | ML13151A434 | NEI | J. Pollock |
| 9. | ML13151A443 | Decommissioning Plant Coalition | M Callahan |
| 10 | ML13151A447 | AREVA | D. White |
| 11 | ML13155A253 | PPL Susquehanna (LLC) | B. O'Rourke |
| 12 | ML13156A401 | Nuclear Innovation North America LLC (NINA) | M. McBurnett |
| 13 | ML13176A438 | Nuclear Energy Institute | J. Pollock |
| 14 | ML13176A450 | STARS Alliance | J. Becker |
| 15 | ML13189A315 | Exelon | J. Barstow |

As this rulemaking effort continues, the next opportunity for public comment will be during the proposed rule phase. At that time, the NRC will solicit input from stakeholders on the draft rule language and supporting guidance for station blackout mitigation strategies.

### 5.1 ACRS Interactions

The NRC staff held several public meetings with the ACRS. The NRC staff held meetings on December 5, 2012, and April 23, 2013, with the ACRS Regulatory Policies and Practices Subcommittee to discuss the station blackout mitigation strategies regulatory basis. On June 5, 2013, the NRC staff discussed the draft regulatory basis with the ACRS full committee. Following the June 5, 2013, ACRS full committee briefing, the ACRS provided its conclusions and recommendations concerning the station blackout mitigation strategies regulatory basis in a letter dated June 17, 2013 [ML13161A247] (Ref. 38). The ACRS concluded there is sufficient basis to support proceeding with the station blackout mitigation strategies rulemaking. The NRC staff plans to continue interactions with the ACRS on the following specific recommendations and issues:

- Possible use of a robust supplemental ac power source as a means for restoring power.
- Adequacy of guidance for evaluating the feasibility and reliability of the manual actions necessary to implement the mitigating strategies.
- Robustness requirements for equipment used for mitigation of external events and the need to follow the activities associated with NTTF Recommendation 2.1.

### 5.2 Changes to the Regulatory Basis As a Result of Stakeholder Feedback

The NRC staff made the following changes to the draft regulatory basis as a result of stakeholder comment and internal review:

- New section 3.1 was added to describe the differences between the current station blackout mitigation strategies regulatory approach and the originating NTTF recommendations. This section is the result of internal review and discussions with the ACRS Regulatory Policies and Practices subcommittee where it was evident that the draft regulatory basis lacked clarity concerning the scope of the regulatory action. This section also discusses whether there are any data that would support broader requirements than those currently imposed by EA-12-049. This discussion also resulted in conforming changes throughout the regulatory basis document, including the addition of previous risk assessment information into the background in section 2.2 and should assist the staff in developing regulatory and backfit analyses for the proposed rule.
- Section 5 Stakeholder Involvement (the current section) was updated to reflect the regulatory basis interactions and comments.
- Appendix A was not revised to reflect feedback from stakeholders. Rather, the staff provides its observations in Section 5.3 of this regulatory basis.

### 5.3 NRC Staff Observations on Stakeholder Feedback

The following observations reflect the NRC staff's review and consideration of the comments at the time this regulatory basis was finalized. Neither senior NRC management nor the Commission has reviewed and approved any specific elements of the station blackout mitigation

strategies rulemaking framework at this time, and as such, any conclusions regarding the elements of the station blackout mitigation strategies rulemaking are subject to change.

1. There were 4 comment submissions that commented that the mitigating strategies requirements should not apply to ISFSIs. The NRC staff agrees that mitigation strategies do not need to be applied to ISFSIs.
2. The NRC staff believes there is merit in avoiding the term “in any mode” (which is associated with Technical Specifications) by, for example, substituting language such as, “whenever there is fuel in the reactor or in the spent fuel pool.”
3. The NRC staff agrees that while the use of safety-related equipment to support implementation of the station blackout mitigation strategies may well be acceptable, there is no requirement that safety-related equipment must be used, and instead non-safety-related equipment can be used to mitigate these events, however in order to credit the use of such equipment it needs to meets the associated functional and physical protection requirements. The staff intends to consider the hierarchy for use of equipment as appropriate in connection with the preparation of a proposed rule and associated implementing guidance.
4. The NRC staff notes that the use of “contingencies” in the draft rule concepts is not meant to imply an unending supply of backup mitigation strategies, but rather a reasonable set of contingencies that reflect the guidance provided in NEI 12-06 Rev. 0 (e.g., the need to have two connection points is a contingency in NEI 12-06).
5. While the NRC staff notes that the potential flexibility of a supplemental ac power source is still a tentative consideration in this rulemaking framework, we also note the support from external stakeholders for its inclusion, and the support from ACRS to continue the dialogue regarding this potential feature of the rulemaking. The NRC staff agrees with the suggestion to have more flexibility associated with use of a supplemental ac power source to allow its use in combination with portable equipment, as well as to allow it to be used for all phases of the event mitigation. However, there would appear to always be a need for the final phase to accept and accommodate the use of offsite resources, such as the resupply of diesel fuel oil (due to the extended loss of offsite ac power that could occur as a result of these events). The NRC also notes that the regulatory basis document was not meant to imply that an existing alternate ac could not be upgraded to meet the more robust supplemental ac standards. In fact the NRC staff sees this as possible approach. On the other hand, the staff’s current view is that external event protection would need to be at least as good as safety-related structures (e.g., seismic category I structure with a bounding design for floods and winds).
6. The NRC staff agrees with the suggestion that, when defining functional performance, we should indicate that the equipment *be capable of* performing the function but not necessarily *designed for* the function, and the example given was a fire truck that could perform a specific function for which it was not specifically designed.
7. The staff agrees that design requirements should not call for equipment to be designed for “beyond design basis external event” conditions because this is fundamentally an unbounded set of conditions and would institute unbounded requirements that would be impossible for licensees to satisfy. To the extent the NRC ultimately sets any design requirements, the staff intends to bound them.
8. The staff notes the stakeholder support for potentially revising the initial defined onsite damage condition that the strategies and guidance are designed to mitigate (i.e., for EA-12-049 this was an extended loss of ac power and loss of normal access to the ultimate heat sink). The staff notes that this is another potential feature of the rulemaking framework that would be a change from EA-12-049 and is not yet approved by staff

management or the Commission. The staff believes there is merit to continue to consider limiting the initial condition to an extended loss of ac power and not always assume an additional loss of normal access to the ultimate heat sink, unless such a loss would occur as a direct consequence of the extended loss of ac power (i.e., ultimate heat sink pumps are powered from onsite 1E emergency power which is lost) or its failure can be expected as a result of the event (i.e., ultimate heat sink pumps are not designed to withstand design basis external events or otherwise be justified as robust for such events). For example, a specific design that has robust or safety-related ultimate heat sink pumps that are diverse in terms of their power source from the emergency onsite ac power system (e.g., diesel driven) would be assumed to be functional and therefore that plant would assume only an extended loss of ac power occurs.

9. The feedback concerning whether to keep 10 CFR 50.63 and a new 50.xx separate or to integrate these requirements with 50.54(hh)(2) was mixed. The staff's objectives are to allow maximum flexibility for new reactor designs and licensees while avoiding inadvertent impact on current licensed reactors. At this time, the staff believes that the best approach is to keep the various regulatory provisions separate, but recognize that a new reactor applicant or licensee could meet all the provisions with one set of guidance, strategies, and equipment.

## 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 proposed rulemaking would codify (in 10 CFR Part 50) the requirements in Order EA-12-049 and the supporting guidance in JLD-ISG-2012-01 (Ref. 13, such that they would become substantive requirements for existing as well future nuclear plants licensed under Parts 50, 52, and 54. At this time, the staff does not expect that the proposed rule would contain requirements on mitigating strategies which would go beyond that already required by Order EA-12-049. The staff is considering whether the proposed rule should also contain additional *design* requirements (as opposed to mitigation strategy requirements, which are procedural in nature) governing station blackout and extended loss of power.

The NRC's backfitting provisions for holders of construction permits, and applicants and holders of operating licenses are found in the regulations at 10 CFR 50.109 (the Backfit Rule). Issue finality provisions (analogous to the backfitting provisions in 10 CFR 50.109) for design certifications are in 10 CFR 52.63 and the Appendices to Part 52 for design certification rules. Issue finality provisions applicable to combined licenses are in 10 CFR 52.83 and 52.98 for combined licenses. The backfitting and issue finality considerations as applied to these entities and regulatory approvals are considered below.

*Current and future applicants*

Applicants and potential applicants (of licenses, permits and regulatory approvals such as design certifications) are not, with certain exceptions, protected by either the Backfit Rule or any issue finality provisions under Part 52. Neither the Backfit Rule nor the issue finality provisions under Part 52 – with certain exclusions discussed below – were intended to apply to every NRC action which substantially changes the expectations of current and future applicants.

The exceptions to the general principle are applicable whenever an applicant references a Part 52 license (*e.g.*, an early site permit) and/or NRC regulatory approval (*e.g.*, a design certification rule) with specified issue finality provisions. The issues which are resolved in an early site permit or a design certification and accorded issue finality do not include operational matters such as the mitigating strategies which would be the subject of the proposed rule. Therefore, the proposed rule provisions limited to mitigation strategies would not be inconsistent with the issue finality provisions applicable to early site permits and design certifications. In addition, because the issues which are resolved in an early site permit or a design certification and accorded issue finality do not address mitigating strategies, a combined license applicant referencing either an early site permit or design certification would not be protected by the issue finality provision applicable to combined license applicants (§ 52.83) with respect to compliance with a rule setting forth requirements for mitigation strategies.

However, if: (i) the rule includes design requirements; (ii) the rule is applicable to combined licenses; and (iii) a combined license references a design certification rule which does not comply with the design requirements in the final rule; then the application of the rule to that combined license applicant would be inconsistent with the issue finality provision in § 52.83. In such circumstance, the NRC would prepare a discussion as part of the rulemaking explaining how one or more of the criteria in § 52.83 would be satisfied.

*Existing design certifications*

The issues which are resolved in a design certification and accorded issue finality do not include operational matters such as the mitigating strategies which would be the subject of the proposed rule. Therefore, a rulemaking limited to mitigating strategies would not be applied to existing (or future) design certifications. However, if the proposed rule also included design requirements applicable to the certified portion of a nuclear power reactor, and these requirements were imposed on existing design certifications, then imposition of the rule on existing design certifications would be inconsistent with the issue finality provision in § 52.63. In such circumstance, the NRC would prepare a discussion as part of the rulemaking explaining how one or more of the criteria in § 52.63 would be satisfied.

*Existing licensees*

To the extent that the proposed rule would codify the requirements in Order EA-12-049 and the supporting guidance, the proposed rule, as applied to existing licensees to whom Order EA-12-049 was directed, would not constitute a new instance of backfitting under § 50.109, or an additional inconsistency with the issue finality provisions applicable to holders of combined licenses in § 52.98. Any backfitting and issue finality issues for this rulemaking were addressed as part of the issuance of Order EA-12-049 and the associated guidance. The proposed rule, if limited to mitigation measures in Order EA-12-049 and associated guidance, would introduce no new backfitting and issue finality matters apart from those addressed in the underlying Order and guidance. Therefore, the staff's position is that the NRC's consideration of backfitting and issue finality matters for the Order and the associated guidance also serves as the NRC's consideration of the same backfitting and issue finality matters for the proposed rule with respect to mitigation measures.

If a proposed rule includes any design requirements or mitigation measure beyond the mitigation measures in Order EA-12-049 and associated guidance, then the NRC staff will

address the applicable backfitting and issue finality provisions with respect to the added requirements as part of the rulemaking.

*Regulatory Flexibility Act*

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.

*Compliance with NEPA*

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 mitigation strategies are likely to be very similar to the requirements already imposed by EA-12-049 and implemented by power reactor licensees, and more importantly because the requirements should only result in reductions of radiological 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 enhancement backfits because the new requirements are expected to meet 10 CFR 50.109(a)(4)(ii) (or similar a provision in Part 52), 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 a station blackout mitigation strategies rulemaking would make generically-applicable requirements that are essentially equivalent to the requirements already imposed by EA-12-049, the staff expects that there will be no additional backfits. Furthermore, since the requirements already imposed by EA-12-049 qualify as an adequate protection action, a safety goal evaluation would not be required.

*Peer Review of Regulatory Basis*

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 include requirements that licensees provide resources (i.e., a diverse and flexible additional capability that uses guidance, strategies and relied-upon equipment), in addition to design-basis equipment, which can potentially be leveraged in an event leading to an extended loss of ac power similar to those currently imposed through issuance of Order EA-12-049. More specifically, the current station blackout requirements do not address the types of events of concern as discussed elsewhere in this basis document, hence the need for Order EA-12-049 and this rulemaking. This rulemaking make generically-applicable requirements similar to those imposed by Order EA-12-049, and thereby provide a predictable and stable set of regulations for future designs and applications, so as to avoid the need for issuance of orders or license conditions which can be resource intensive and introduce regulatory instability.

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.

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