Draft Regulatory Analysis

Proposed Rulemaking to Address Mitigation of Beyond-Design-Basis Events

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U.S. Nuclear Regulatory Commission

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Executive Summary

The U.S. Nuclear Regulatory Commission (NRC) is proposing to amend Title 10 of the *Code of Federal Regulations* (10 CFR) to accomplish three objectives: (1) make the requirements in Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,* and Order EA-12-051, *Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,* generically applicable; (2) establish requirements for severe accident management guidelines (SAMGs) that would be included as part of an integrated response capability; and (3) incorporate other Fukushima-related actions intended to enhance the onsite emergency response capabilities for multi-unit events into the regulations (Refs. 1 and 2). To achieve these objectives, the proposed rulemaking would amend 10 CFR Parts 50 and 52 to require additional mitigation strategies for responding to beyond-design-basis events (BDBEs)(Ref. 3).

The analysis presented in this document examines the benefits and costs of the proposed *Mitigation of Beyond-Design-Basis Events* rule requirements relative to the baseline case (i.e., the no action alternative). In addition, the NRC staff estimated the historical costs incurred as a result of Order EA-12-049, Order EA-12-051, and related industry initiatives. See Appendix B for the complete historical cost analysis.

The key findings are as follows:

- Proposed Rule Analysis – Results. The proposed rule encompasses provisions that fall into two groups: (1) those within the scope set forth in Order EA-12-049, Order EA-12-051, and Nuclear Energy Institute (NEI) 12-06, Rev. 0, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide* (which is the industry's NRC-endorsed guidance document describing one acceptable approach for complying with Order EA-12-049) as well as related industry initiatives; and (2) those provisions associated with the new regulatory requirements for licensees to develop, implement, and maintain SAMGs, as well as the NRC's rulemaking-related costs (Ref. 4). Because the NRC staff uses a no action baseline to estimate incremental costs, the total cost of the proposed rule largely results from imposition of SAMGs-related requirements.

  As a result of the proposed rule, the NRC staff estimates that the industry as a whole would incur a total one-time cost of $30 million, followed by an annual cost of $2.4 million. The total present value of these costs is $58 million (using a 7 percent discount rate) and $72 million (using a 3 percent discount rate) over a 63-year period.

  The average site would incur a one-time cost of approximately $510,000, followed by an annual cost of approximately $42,000.

  The proposed rule would result in a total one-time cost to the NRC of $1.1 million to complete the rulemaking (i.e., complete the proposed rule, analyze public comments, hold public meeting(s), and develop the final rule and regulatory guidance) and oversee implementation of the SAMGs-related requirements (e.g., become familiar with owners groups' generic severe accident management guidance (SAMG), develop SAMGs oversight materials, review new drill and exercise scenarios). This one-time cost would be followed by an annual cost of approximately $170,000 for SAMGs-related activities (e.g., observe drills and exercises, oversee SAMGs change control process).

According to Executive Order 12866, *Regulatory Planning and Overview*, (58 FR 190), an economically significant regulatory action is one that would have an annual effect on the economy of $100 million or more (Ref. 5). This proposed rulemaking does not reach this threshold because the annualized cost of the proposed rule would be $4.2 million using a 7-percent discount rate and $2.7 million using a 3-percent discount rate.

- Benefits. Recent work by the NRC staff indicated that the use of SAMGs would result in minimal benefits to public health and safety (see Section 3.4). While the NRC recognizes that available quantitative risk information indicates that SAMGs have a small safety benefit, this information is not a complete measure of SAMG safety benefits. The NRC concludes that SAMG requirements would result in a substantial additional protection for public health and safety based on the qualitative reasons stated in Appendix A to this draft regulatory analysis. Specifically, SAMGs directly support maintenance of containment integrity following severe accidents, and indirectly support the protective action recommendations made by the emergency response organization in such circumstances, and as such, the SAMGs have a very important link to two foundational parts of the NRC's defense-in-depth framework: containment, and emergency preparedness. The proposed SAMGs requirements would ensure that operators and decision makers have an updated set of guidelines to use following the onset of core damage. The availability of updated SAMGs would provide pre-planned guidelines for the best use of all available resources to mitigate an accident.

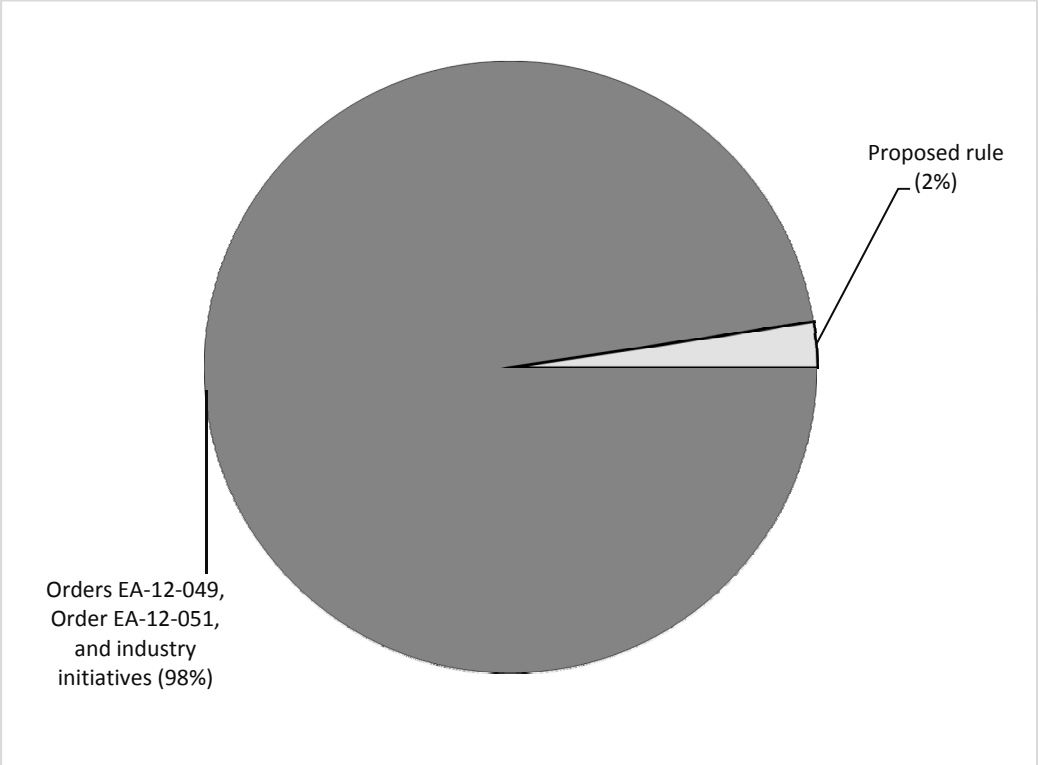
  The remaining proposed rule requirements (i.e., making Order requirements and industry initiatives generically applicable) are drawn from stakeholder feedback and lessons learned from the implementation of Order EA-12-049 and Order EA-12-051, including any challenges or unintended consequences associated with the implementation. These regulatory requirements would result in enhanced regulatory efficiency by providing 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 and introduce regulatory stability.

- Historical Cost Analysis – Results. For informational purposes, the NRC staff also estimated the costs that have been incurred (or will be incurred) as a result of Order EA-12-049, Order EA-12-051, and related industry initiatives (see Appendix B). The NRC staff estimates that these actions result in a total present value cost of $1.7 billion (using a 7-percent discount rate) and $1.8 billion (using a 3-percent discount rate).

  The average site incurred an upfront cost of approximately $29 million, followed by annual costs of approximately $40,000.

- Costs Incurred by Industry as a Result of the Proposed Rule, Order EA-12-049, Order EA-12-051, and Related Industry Initiatives. The incremental cost that would be incurred by industry as a result of the proposed rule (i.e., SAMGs-related costs) account for 2 percent of total costs when considered in conjunction with the estimated costs of Order EA-12-049, Order EA-12-051, and related industry initiatives, as shown in Figure ES-1.

Figure ES-1. Estimated Industry Cost of the Proposed Rule, Order EA-12-049, Order EA-12-051, and Industry Initiatives (Present Value, 7%)



- Decision Rationale. Relative to the no action baseline, the NRC staff concludes that the costs of this proposed rule are justified in view of the defens-in-depth safety benefits that would be gained from SAMG requirements. These defense-in-depth measures at nuclear power reactors are necessary in mitigating the consequences of BDBEs. Based on the NRC's assessment of the costs and benefits of the proposed rule, the staff has concluded that the proposed rule is justified.

- Backfit Analysis. The NRC staff determined that the provisions in the proposed rule that would make the requirements in Order EA-12-049, Order EA-12-051, industry initiatives, and the supporting guidance (as applied to existing licensees to whom Order EA-12-049 was directed) generically applicable would not constitute a new instance of backfitting under 10 CFR 50.109, or an additional inconsistency with the issue finality provisions applicable to holders of COLs in 10 CFR 52.98. Any backfitting and issue finality issues for this portion of the proposed rulemaking were addressed as part of the issuance of Order EA-12-049 and the associated guidance. The proposed requirements limited to mitigation measures in Order EA-12-049, Order EA-12-051, and associated guidance, would introduce no new backfitting and issue finality matters apart from those addressed in the underlying Orders and guidance. Therefore, the staff's position is that the NRC's consideration of backfitting and issue finality matters for the Orders 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.

The proposed rule requirements that support implementation of Order EA-12-049 and require multi-source dose assessment constitute backfits, but are justified under backfitting requirements. Appendix A details the NRC staff's conclusions for these requirements.

Finally, the SAMGs-related proposed requirements constitute a new instance of backfitting under 10 CFR 50.109. However, the SAMGs provide a set of information and considerations that directly supports actions to ensure that other important aspects of the NRC's regulatory framework are most effectively implemented and used to support public health and safety. The NRC staff has concluded that SAMGs are an essential part of the regulatory framework for the mitigation of the consequences of accidents. Imposition of SAMGs requirements (versus a continuation of the voluntary initiative) would ensure that SAMGs are maintained as an effective guideline set through time. Accordingly, the staff recommends that the Commission consider SAMGs to be a substantial additional protection for defense-in-depth to satisfy the requirements under 10 CFR 50.109(a)(3) and that the direct and indirect costs of implementation are justified in view of this increased protection.

- New Reactor Applicants. In addition to the costs and benefits estimated in this regulatory analysis, the NRC staff separately estimates costs and benefits to new reactor applicants. As a result of the proposed rule, the NRC staff estimates that new reactor applicants would incur a total one-time cost of $XX, followed by an annual cost of $XX. The total present value of these costs is $XX (using a 7-percent discount rate) and $XX (using a 3-percent discount rate) over a XX-year period. The average new reactor applicant would incur a one-time cost of approximately $XX, followed by an annual cost of approximately $XX.

Abbreviations

ac	Alternating current
ADAMS	Agencywide Documents Access and Management System
ADHR	Alternate decay heat removal
AFW	Auxiliary feedwater
ANPR	Advanced Notice of Proposed Rulemaking
ANS	American Nuclear Society
AP1000	Advanced pressurized 1000 reactor
ASI	Alternate seal injection
BDBE	Beyond-design-basis event
BDBEE	Beyond-design-basis external event
BWR	Boiling water reactor
BWROG	BWR owners group
CFR	Title 10 of the *Code of Federal Regulations*
COL	Combined license
CP	Construction permit
CRGR	Committee to Review Generic Requirements
CST	Condensate storage tank
CVCS	Chemical and volume control system
CWRT	Clean water receiver tank
DC	Design certification
dc	Direct current
DG	Diesel generator
DID	Defense-in-depth
DOT	U.S. Department of Transportation
EDG	Emergency diesel generator
EDMGs	Extensive damage mitigation guidelines
EFW	Emergency feedwater
ELAP	Extended loss of ac power
EOPs	Emergency operating procedures
EPRI	Electric Power Research Institute
ERDS	Emergency Response Data System
ERO	Emergency Response Organization
ESW	Essential service water
EWST	Emergency water storage tank
FENOC	FirstEnergy Nuclear Operating Company
FLEX	Diverse and flexible coping strategies
FSGs	FLEX Support Guidelines
GDC	General Design Criteria
gpm	Gallons per minute
HPCI	High-pressure coolant injection
HPCS	High-pressure core spray
ISG	Interim Staff Guidance
JLD	Japan Lessons-Learned Project Directorate
L&T	Logistics and transportation
LOE	Level of effort
LOOP	Loss of offsite power
LUHS	Loss of normal access to the ultimate heat sink
MCC	Motor control center
ML	Manufacturing license
mSv	millisievert
NEI	Nuclear Energy Institute
NLO	Non-licensed operator
NPP	Nuclear power plant
NSSS	Nuclear steam supply system
NTTF	Near-Term Task Force
NRC	Nuclear Regulatory Commission
OIP	Overall Integrated Plan
PWR	Pressurized water reactor
PWROG	PWR owners group
QHO	Quantitative health objective
RCIC	Reactor core isolation cooling
RCP	Reactor coolant pump
RCS	Reactor coolant system
REM	Roentgen equivalent man
RHR	Residual heat removal
RMWST	Reactor makeup water storage tank
RPV	Reactor pressure vessel
RRC	Regional response center
SAFER	Strategic Alliance for FLEX Emergency Response
SAG	Severe accident guidelines
SAMG	Severe accident mitigation guidance
SAMGs	Severe accident mitigation guidelines
SAT	Systems approach to training
SBO	Station blackout
SBOMS	Station blackout mitigation strategies
SCC	SAFER control center
SDA	Standard design approval
SFP	Spent fuel pool
SG	Steam generator
SRM	Staff requirements memoranda
SSC	Structure, system, and component
Sv	sievert
SW	Service water
TBR	Technical Basis Report
TEPCO	Tokyo Electric Power, Co.
UDM	Ultimate decision maker
UNSCEAR	United Nations Scientific

	Committee on the Effects of Atomic Radiation
VSL	Value of a statistical life

1. Introduction

This document presents the draft regulatory analysis of the proposed *Mitigation of Beyond-Design-Basis Events* rulemaking. This introduction is divided into two sections: Section 1.1 provides background information on the rulemaking; and Section 1.2 states the problem and the objectives for the proposed rulemaking.

1.1 Background

The events of March 11, 2011, at the Fukushima Dai-ichi Nuclear Power Plant (NPP) site highlighted 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. The magnitude 9.0 earthquake and resulting tsunami inundated the Fukushima Dai-ichi site and resulted in a loss of alternating current (ac) electrical power, creating a station blackout (SBO). The SBO caused operators to lose the ability to cool the fuel in three of the six reactors and resulted in damage to the nuclear fuel shortly after the loss of cooling capabilities.

Following the Fukushima Dai-ichi event, the U.S. Nuclear Regulatory Commission (NRC) Chairman directed the NRC staff, through tasking memorandum COMGBJ-11-0002, *NRC Actions Following the Events in Japan,* to conduct a review of the NRC's processes and regulations to determine if any changes need to be made and to make recommendations based on their findings (Ref. 6). The Near-Term Task Force (NTTF) was created in response to the tasking memorandum. The NTTF's *Recommendations for Enhancing Reactor Safety in the 21st Century* (SECY-11-0093) called for the NRC to: (1) strengthen SBO mitigation capability at all operating and new reactors for design-basis events and beyond-design-basis events (BDBEs), (2) enhance spent fuel pool (SFP) makeup capability and instrumentation for the SFP, (3) strengthen and integrate onsite emergency response capabilities such as emergency operating procedures (EOPs), severe accident management guidelines (SAMGs), and extensive damage mitigation guidelines (EDMGs), (4) require facility emergency plans to address prolonged SBO and multi-unit events, (5) pursue additional emergency protection topics related to multi-unit events and prolonged SBO, and (6) pursue emergency management topics related to decision making, radiation monitoring, and public education (Ref. 7).

Following the issuance of the NTTF report, the NRC staff developed recommendations for the Commission's consideration. In response, in Staff Requirements Memoranda (SRM)-SECY-11-0124, *Recommended Actions to be Taken Without Delay From the Near-Term Task Force Report* and SECY-11-0137, *Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned,* the Commission directed the staff to initiate a high-priority rulemaking for SBO regulatory actions and Onsite Emergency Response Capabilities regulatory actions (Refs. 8 and 9).

On February 17, 2012, 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, including the proposed Order to implement enhanced mitigation strategies (Ref. 10). As directed by SRM-SECY-12-0025, on March 12, 2012, the NRC staff issued Order EA-12-049 and Order EA-12-051. Order EA-12-049 imposed new requirements to implement mitigation strategies to provide additional capability to respond to BDBEEs that lead to an extended loss of ac power (ELAP) and loss of normal access to the

ultimate heat sink (LUHS) (e.g., events arising from severe natural phenomena). The Commission concluded that the new requirements were necessary to continue to have reasonable assurance of adequate protection of public health and safety. Order EA-12-051 required power reactor licensees to have a reliable means of remotely monitoring wide-range SFP levels to support effective prioritization of event mitigation and recovery actions in the event of a BDBEE. The Commission concluded that the new requirements provided a greater capability, consistent with the overall defense-in-depth philosophy, and therefore greater assurance of protection of public health and safety from the challenges posed by BDBEEs to power reactors.

Following the imposition of the Orders, the NRC staff began work on two proposed rulemakings as directed by the Commission: the Station Blackout Mitigation Strategies (SBOMS) proposed rulemaking and Onsite Emergency Response Capabilities proposed rulemaking. During development of the proposed rulemakings, the NRC staff identified that the Onsite Emergency Response Capabilities rulemaking could not be issued before the SBOMS proposed rulemaking because it would need to reference the proposed SBOMS requirements. The NRC staff also identified several areas of overlap between the two proposed rules. The direct links between these post-Fukushima proposed rulemakings caused the NRC staff to conclude that they should be combined into a single proposed rulemaking package.

In response to a request from the NRC staff in SECY-14-0046, *Proposal to Consolidate Post-Fukushima Rulemaking Activities,* enclosure 6, the Commission agreed, in SRM dated July 9, 2014, to consolidate the SBOMS and Onsite Emergency Response Capabilities rulemakings (Ref. 11). The combined scope of this proposed rulemaking, described in terms of the relationship to various NTTF recommendations that provided the regulatory impetus for the proposed rulemaking, would include:

1. All the requirements that were within the scope of the SBOMS rulemaking, directed by COMSECY-13-0002, *Consolidation of Japan Lessons Learned Near-Term Task Force Recommendations 4 and 7 Regulatory Activities* (Ref. 12). This portion of the proposed rulemaking stems from NTTF Recommendations 4 and 7, and is intended, in part, to make the requirements of Order EA-12-049 (and equivalent license conditions) generically applicable.

2. All the requirements that were within the scope of the Onsite Emergency Response Capabilities rulemaking. This portion of the proposed rulemaking stems from NTTF Recommendation 8, and was directed by SRM-SECY-11-0137 (Ref. 9). This includes command and control issues, and as such, addresses NTTF Recommendation 10.2 concerning command and control and the qualifications of decision makers. Command and control is being addressed in supporting draft regulatory guidance for this proposed rulemaking including NEI 14-01, *Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents*, Rev. 0 (Ref. 13).

3. Numerous emergency preparedness actions are addressed within this proposed rulemaking. These emergency preparedness actions are currently being implemented in conjunction with the implementation of Order EA-12-049, and through the development of guidance supporting this proposed rulemaking. Specifically those regulatory actions and the associated NTTF Recommendations from which they stem, are:

a. Staffing and communications issues in this proposed rulemaking stem from NTTF Recommendation 9.3, and are also discussed in NTTF Recommendations 9.1 and 9.2. These regulatory issues are currently being addressed through Order EA-12-049 implementation guidance; specifically NEI 12-01 which is referenced in NEI 12-06, currently endorsed by the NRC in Japan Lessons-Learned Project Directorate-Interim Staff Guidance (JLD-ISG)-12-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events* (Ref. 14). The draft supporting guidance for this proposed rulemaking includes this guidance.

b. Facilities and equipment issues addressed in this proposed rulemaking stem from NTTF Recommendation 9.3, and are also discussed in NTTF Recommendations 9.1 and 9.2. These regulatory issues are currently being addressed through Order EA-12-049 implementation guidance. These issues are addressed by draft guidance for this proposed rulemaking which includes NEI 13-06, *Enhancements to Emergency Response Capabilities for Beyond Design Basis Accidents and Events*, Rev. 0 (Ref. 15).

c. Multi-Source Dose Assessments addressed in this proposed rulemaking stem from NTTF Recommendation 9.3, and are also discussed in NTTF Recommendation 9.1. This regulatory issue is being voluntarily implemented by industry, and is also addressed by draft guidance for this proposed rulemaking which includes NEI 13-06, Rev 0.

d. Training and drills or exercise issues addressed in this proposed rulemaking stem from NTTF Recommendation 9.3, and are also discussed in NTTF Recommendations 9.1 and 9.2. These regulatory issues are currently being addressed through Order EA-12-049 implementation guidance. These issues are addressed by draft guidance for this proposed rulemaking which includes NEI 13-06, Rev 0.

e. Onsite emergency resources to support multi-unit events with SBO, including the need to deliver equipment to the site with offsite infrastructure degraded, stem from NTTF Recommendation 11.1. This is a regulatory issue currently being addressed by Order EA-12-049 implementation. This issue is addressed by draft guidance for this proposed rulemaking.

Accordingly, this proposed rulemaking addresses, either in requirements or through implementation guidance, all of the recommendations in NTTF Recommendations 4, 7, 8, 9.1, 9.2, 9.3 with one exception (maintenance of emergency response data system (ERDS) capability throughout the accident), 10.2, and 11.1.[1]

[1] The proposed rulemaking also addresses NTTF Recommendation 9.4 to modernize ERDS. This action differs from the above list of regulatory actions because ERDS is not an essential component of a licensee's capability to mitigate a BDBE. However, ERDS is important for communication purposes between the licensee and the NRC, and in some situations, other external stakeholders. The modernization has been voluntarily completed by industry, and the NRC concluded it could readily be incorporated into this proposed rulemaking to amend the technology-specific references in 10 CFR Part 50, Appendix E, Section VI, "Emergency Response Data System."

1.2 Statement of the Problem and Nuclear Regulatory Commission Objectives for the Rulemaking

The NRC staff has developed this proposed rulemaking in order to address gaps in current regulations. With regard to SAMGs, the development of a growing number of accident mitigating procedures lacks consistent oversight to ensure that they are developed to promote a comprehensive, coherent, and integrated strategy for response to severe accidents. Further, there are no current regulatory requirements for SAMGs, including training and drills or exercises in the area of severe accident mitigation.

With regard to FLEX support guidelines (FSGs), current NRC regulations do not incorporate requirements to implement mitigation strategies to provide additional capability to respond to events that could lead to an ELAP (e.g., events arising from severe natural phenomena).[2] A proposed rulemaking would make SAMGs a regulatory requirement and make generically applicable requirements similar to those imposed by Order EA-12-049, Order EA 12-051, and other post-Fukushima industry initiatives. The regulatory objectives of the proposed rulemaking are as follows:

- Make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable. The rulemaking is intended to place the requirements in Order EA-12-049 and Order EA-12-051 into the NRC's regulations to provide regulatory clarity to operating reactors and to ensure that they apply to all future power reactor applicants. Operating reactor licensees and two combined license (COL) holder reactor sites currently are subject to the Order requirements. Any future licensees would not be covered by the Order requirements. In the absence of a rule, these requirements would need to be implemented for new reactor sites through additional Orders or license conditions (as was done for the Vogtle and Virgil C. Summer COLs).

  As part of the rulemaking process to make Order EA-12-049 and Order EA-12-051 generically applicable, the NRC considered stakeholder feedback and lessons learned from the implementation of the Orders. As a result, the NRC considered unintended consequences or challenges associated with implementation of the mitigation strategies (consistent with Commission direction in an August 2012 SRM). These are captured in the updated guidance for mitigation strategies. Pursuing rulemaking allows the NRC to make the Order requirements generically applicable with adjustments to account for any lessons learned. These adjustments would result in more effective regulation, but would not extend beyond the footprint of the existing scope of the Orders. Once the resulting proposed rule is implemented, the NRC may choose to withdraw Order EA-12-049 and Order EA-12-051.

- Establish requirements for SAMGs to promote consistency across industry. An objective of the proposed rulemaking is to require that all licensees' SAMGs are consistent with the standards agreed upon in the plan presented by industry owners groups regarding lessons learned from Fukushima Dai-ichi (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12073A283). Currently, the SAMGs are a voluntary industry initiative and licensees are not required to maintain, update, or

[2] In the context of the proposed mitigation of beyond-design-basis events rulemaking, the term FSGs has replaced the term SBOMS.

implement SAMGs. After the accident at Fukushima Dai-ichi, the NRC's performance of Temporary Instruction (TI) 2515/184, *Availability and Readiness Inspection of Severe Accident Mitigation Guidelines,* revealed that while most licensees have SAMGs written to a common standard from the nuclear power industry owners groups, training and procedural control for SAMGs are inconsistent across the industry (Ref. 16). The proposed rulemaking would principally aim to ensure that SAMGs are updated and maintained to strengthen plants' coordinated responses to potential severe accidents.

- Incorporate enhanced onsite emergency response capabilities into the regulations. Numerous enhanced onsite emergency response actions are being addressed as part of this proposed rulemaking. These enhancements are being implemented in conjunction with the implementation of Order EA-12-049, and through the development of guidance supporting the onsite emergency response portion of this proposed rulemaking. These new requirements would address emergency response-related actions such as staffing and communications (NTTF Recommendation 9.3, also addressed in NTTF Recommendations 9.1 and 9.2), facilities and equipment (NTTF Recommendation 9.3, also addressed in NTTF Recommendations 9.1 and 9.2), training and exercises (NTTF Recommendation 9.3, also addressed in NTTF Recommendations 9.1 and 9.2), command and control structure and decision-making qualifications (NTTF Recommendation 10.2), and multi-source dose assessment (NTTF Recommendation 9.3, also addressed in NTTF Recommendation 9.1). Requiring current and future licensees to meet these requirements would ensure robust emergency response capabilities for BDBEs impacting multiple units.

To achieve these objectives, the proposed rulemaking would amend 10 CFR Parts 50 and 52 to require additional mitigation strategies for responding to BDBEs that is intended to result in an integrated response capability that includes FSGs, EDMGs, EOPs, and SAMGs.

2. Identification and Preliminary Analysis of Alternative Approaches

In addition to the proposed rule (identified as Option 2), the NRC has identified two alternatives for consideration.

- Option 1: Take no action.
- Option 2: Undertake rulemaking to require SAMGs and make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable.
- Option 3: Undertake rulemaking to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable.

The following sections provide a preliminary analysis of these options.

2.1 Option 1: Take No Action

This alternative entails continuing the implementation of the mitigation strategies requirements in Order EA-12-049, Order EA-12-051, and other related industry initiatives. No further action would be taken to make the Order requirements generically applicable or to consider

stakeholder feedback and lessons learned from the implementation of these Orders. This alternative is equivalent to the status quo and serves as a baseline to measure against the other identified alternatives.

This option would avoid certain costs that the proposed rule would impose, while benefits associated with voluntary initiatives would remain. However, under this option, the NRC staff would need to address mitigation strategies requirements for new reactor sites on a case-by-case basis (either through additional Orders or license conditions). As a result, this option would not achieve the NRC's objectives.

2.2 Option 2: Undertake Rulemaking to Require SAMGs and Make Order EA-12-049, Order EA-12-051, and Industry Initiatives Generically Applicable

This option (i.e., the proposed rule) would address the NRC's objective to make the requirements in Order EA-12-049, Order EA 12-051, and industry initiatives generically applicable, while also requiring SAMGs.

The proposed rule would make Order EA-12-049 and Order EA-12-051 generically applicable, and incorporate industry initiatives into 10 CFR. The NRC regulations do not currently contain requirements for the mitigation of beyond-design-basis external events as addressed by Order EA-12-049, or for spent fuel pool wide-range level as addressed by Order EA-12-051 The strategies required by the Orders (which sites are currently implementing in conjunction with numerous onsite emergency response initiatives) 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. The Commission directed the staff to develop this proposed rulemaking to incorporate the Order requirements into NRC regulations to ensure that future NPP designs and licensing applications are subject to the same requirements as current operating sites and COL holders.

SAMGs are currently voluntary industry initiatives, which are implemented when an accident leads to fuel damage. Industry updated the generic SAMG technical work to reflect lessons learned from the Fukushima event. This option would require licensees to update their site-specific SAMGs and maintain the SAMGs within the plant configuration management program. The proposed SAMGs would be supported with requirements that include command and control; change control; drills and exercises; training. The SAMGs would be one of the three guideline sets that would be integrated with the existing EOPs to provide for an integrated response capability.

The NRC staff (through performance of TI-2515/184) discovered that several licensees were not adequately maintaining their site-specific SAMGs in accordance with the respective owners group's generic SAMG and technical guidance. Thus, an objective of the proposed rulemaking is to promote consistency in SAMGs development, implementation, and maintenance across the industry, which this option would achieve.

The proposed rule would impose costs on industry and the NRC. Licensees would be required to develop, implement, and maintain site-specific SAMGs, for which the NRC would have to develop oversight materials. Supporting provisions of the proposed rule would impose costs

associated with integrating site-specific emergency procedures, updating organizational structures for command and control, and developing change control procedures.

During the proposed rule development process, the NRC made several adjustments to Option 2 in order to minimize costs to licensees, without sacrificing benefits. This effort stems in part from the NRC making use of the risk insights obtained from its backfitting analysis to structure a proposed framework for SAMGs requirements that minimized the resultant regulatory impact on licensees. For example, the NRC originally intended to propose more intensive requirements for SAMGs trainings that would result in a required effort similar to that of existing EOP trainings. However, after stakeholder feedback during a public meeting, the NRC revised the proposed SAMGs training requirement to be consistent with the systems approach to training (SAT) process instead. The SAT process is well-established and meets the NRC's regulatory objectives while reflecting lessons learned through engagement with stakeholders.

In addition, the NRC considered requiring the integration of additional procedures (e.g., fire-fighting, alarm response procedures, abnormal operating procedures) with the strategies and guidelines in the proposed rule. However, the NRC determined that the existing regulations governing these procedures are adequate, and there is no demonstrated need for mandatory integration. Integration with EOPs is limited to those procedures identified in 10 CFR 50.155(b)(1)-(3). A more comprehensive procedure integration requirement would have increased costs while providing little to no benefits.

Requiring SAMGs would establish a consistent, industry-wide standard for the implementation of SAMGs, in addition to making the requirements of Order EA-12-049 and Order EA-12-051 generically applicable including the enhanced onsite emergency response capabilities that are being implemented in conjunctions with the orders. Therefore, Option 2 is the most appropriate to address the NRC staff's regulatory objectives.

2.3 Option 3: Undertake Rulemaking to Make Order EA-12-049, Order EA-12-051, and Industry Initiatives Generically Applicable

Because the provisions associated with SAMGs and SAMGs-related activities would impose additional costs on industry and the NRC, the NRC staff considered a rulemaking option omitting all the SAMGs-related requirements. This option would address the NRC's objective to make the requirements in Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. Option 3 would ensure that future NPP designs and licensing applications are subject to the same requirements as current operating sites and COL holders without the need for additional Orders or license conditions. This option also would allow the NRC staff to consider stakeholder feedback and lessons learned from the implementation of these Orders and would provide regulatory clarity to operating reactors.

However, by not requiring licensees to develop, implement, and maintain site-specific SAMGs, the NRC would not address one of the key objectives of the proposed rulemaking. Following the events at Fukushima Dai-ichi, the NRC inspected the implementation, ongoing training, and maintenance of licensees' SAMGs at all power reactor sites, except those that had permanently ceased operation, through performance of TI-2515/184. The NRC found that some licensees had not maintained the SAMGs in accordance with the latest revisions of the applicable industry owners group's generic technical guidelines nor conducted training in a consistent and systematic approach. The inspectors attributed the inconsistent implementation and training of SAMGs to the voluntary nature of this initiative. Without SAMGs, this alternative would not fully

address the NRC staff's objective to establish requirements for an integrated accident response capability for BDBEs that would integrate existing guideline sets with the already existing EOPs. Although Option 3 would be less costly relative to Option 2, it also would yield fewer benefits.

Section 3 presents the results of the NRC staff's detailed cost-benefit analysis of all three options.

2.4 Non-rulemaking Alternatives

The NRC staff did not consider non-rulemaking approaches, such as voluntary initiatives, NRC guidance, and generic communications (e.g., Information Notices, Regulatory Information Summary, Generic Letters) in the regulatory basis (and by extension in this regulatory analysis) for two reasons. First, in SRM-SECY-11-0124 and SRM-SECY-11-0137, the Commission directed the staff to initiate a rulemaking for SBO regulatory actions and onsite emergency response capabilities and designated the rulemakings as "high-priority." Further, a non-rulemaking approach would not achieve the NRC staff's objective to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable and, at the same time, incorporate stakeholder feedback and lessons learned from implementation, including any challenges or unintended consequences. Non-rulemaking approaches would not achieve the broad applicability of a rulemaking, and therefore would not be appropriate to address the NRC staff's objectives.

3. Estimation and Evaluation of Benefits and Costs: Presentation of Results

This section describes the NRC staff's approach to estimating costs and benefits, and presents the results of the analysis:

- Section 3.1 details the methodology, assumptions, and baseline used to evaluate the costs and benefits associated with the options considered in the regulatory analysis.
- Section 3.2 summarizes the costs and benefits associated with the options.
- Section 3.3 presents the details of the costs associated with the proposed rule.
- Section 3.4 discusses the benefits of the proposed rule.
- Section 3.5 provides a discussion of the disaggregated results.
- Section 3.6 discusses the sensitivity analysis.

3.1 Methodology and Assumptions

This section explains the process used to evaluate the costs and benefits associated with the rulemaking options, consistent with the guidance provided in NUREG/BR-0058, *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission* (Ref. 17). The benefits include any desirable changes in affected attributes (e.g., monetary savings, improved safety, improved security), while the costs include any undesirable changes in affected attributes (e.g., monetary costs, increased exposures).

The NRC staff analyzes costs and benefits according to a "no action" baseline. The no action baseline includes the historical costs incurred by industry and the NRC to implement Order EA-12-049 and Order EA-12-051, as well as related guidance and industry initiatives. The NRC staff estimates all of the incremental costs and benefits resulting from the proposed

rule requirements that would be incurred beginning in 2017, the year the proposed rule is assumed to become effective.

In addition, the NRC staff estimated the historical costs associated with Orders EA-12-049 and EA-12-051, as well as related guidance and industry initiatives. Appendix B discusses the methodology and results of the historical cost analysis.

Affected Universe

The regulatory options under consideration would affect all NPP licensees at the site-level. However, the costs affecting individual sites differ depending on various characteristics (e.g., type of reactor, design, and nuclear steam supply system (NSSS)). The differences in cost are discussed in more detail in Section 3.3.

The NRC staff estimates the costs incurred by 60 operating sites. Incremental costs to the five currently decommissioning sites (i.e., Crystal River, Kewaunee, Oyster Creek, San Onofre, and Vermont Yankee) are not considered in the regulatory analysis. Proposed 10 CFR 50.155(a)(3) would exempt decommissioning licensees from the proposed rule, with the exception of proposed 10 CFR 50.155(b)(2), EDMGs, which would not impose incremental costs because EDMGs are existing requirements under the no action baseline. To be granted an exemption, the proposed rule would require decommissioning sites to prepare and submit an analysis demonstrating that the decay heat of the fuel in the SFP is removed solely by heating and boiling of water within the SFP and the boil-off period provides sufficient time for the licensee to obtain offsite resources (referred to as an "exemption analysis" in the regulatory analysis). The NRC staff assumes that the five currently decommissioning sites have submitted, or will soon submit, the exemption analysis and will therefore not incur incremental costs. Appendix B details the historical costs that will be incurred by current decommissioning sites prior to the effective date of the proposed rule.

Of the 60 operating sites included in the analysis, 22 are boiling water reactor (BWR) sites and 38 are pressurized water reactor (PWR) sites. Some SAMGs-related costs differ between BWRs and PWRs. Exhibit 3-1 lists BWR and PWR operating sites that are included in the universe of affected entities under this analysis. The AP1000 reactor units are under construction at two of the operating sites (i.e., Virgil C. Summer and Vogtle). Because incremental costs are estimated at the site-level, the new units are accounted for as part of the operating site on which they are located. However, the difference in reactor types on the Virgil C. Summer and Vogtle sites does affect the costs incurred by the sites, and the timeline over which costs are incurred. Section 3.3 provides additional detail regarding the cost analysis for each type of site.

For cost estimating purposes, each of these affected sites has been identified as either a single-SAMGs site or a dual-SAMGs site. Costs for certain SAMGs-related activities (i.e., developing, implementing, maintaining, and updating site-specific SAMGs; developing and updating training materials; attending and documenting training; developing new training and exercise scenarios; and conducting drills and exercises) differ depending on whether an operating site has one or two sets of SAMGs. Single-SAMGs sites have one set of guidelines for severe accident management, while dual-SAMGs sites have two sets of guidelines for severe accident management. The NRC staff assumes that single-SAMGs sites are single-unit sites, or multi-unit sites with one reactor, design, and NSSS types. Similarly, the NRC staff

assumes that dual-SAMGs sites are multi-unit sites with different reactor, design, or NSSS types.[3]

The NRC staff identified five operating sites as dual-SAMGs sites (i.e., Arkansas Nuclear One, Millstone, Nine Mile Point, Virgil C. Summer, and Vogtle). Exhibit 3-2 provides the number of single-SAMGs and dual-SAMGs sites by reactor type.

Exhibit 3-1. List of Operating PWR and BWR Sites

PWR Sites	BWR Sites
Arkansas Nuclear One	Nine Mile Point
Millstone	Browns Ferry
Virgil C. Summer	Brunswick
Vogtle	Clinton
Beaver Valley	Columbia
Braidwood	Cooper
Byron	Dresden
Callaway	Duane Arnold
Calvert Cliffs	Edwin I. Hatch
Catawba	Fermi
Comanche Peak	Grand Gulf
Davis-Besse	Hope Creek
Diablo Canyon	James A. FitzPatrick
Donald C. Cook	LaSalle County
Fort Calhoun Station	Limerick
H. B. Robinson	Monticello
Indian Point	Peach Bottom
Joseph M. Farley	Perry
McGuire	Pilgrim
North Anna	Quad Cities
Oconee	River Bend
Palisades	Susquehanna
Palo Verde	
Point Beach	
Prairie Island	
R.E. Ginna	
Salem	
Seabrook	
Sequoyah	
Shearon Harris	
South Texas Project	
St. Lucie	

[3] The NRC staff considered vintage as another cost variation that could affect SAMGs-related costs. According to the NRC staff's assessment, two sites (i.e., Beaver Valley and Dresden) have units of different vintages. The NRC staff treats these sites as single-SAMGs sites, and not dual-SAMGs sites, because even with different vintages, the NRC staff believes costs for these two sites would be more similar to single-SAMGs sites rather than dual-SAMGs sites.

PWR Sites	BWR Sites
Surry	
Three Mile Island	
Turkey Point	
Waterford	
Watts Bar	
Wolf Creek	
38 Sites	**22 Sites**

Exhibit 3-2. Operating Site Counts by SAMGs and Reactor Type

	Number of Single-SAMGs Sites	Number of Dual-SAMGs Sites	Total Number of Sites
BWR	21	1	**22**
PWR	34	4	**38**
Total Sites	**55 Sites**	**5 Sites**	**60 Sites**

The affected universe in this regulatory analysis does not include current and future license applicants. These costs and benefits are estimated in a separate analysis.

Cost Estimation

All costs presented in this analysis are in 2013 dollars.

In order to estimate the costs associated with the proposed rule, the NRC staff used a work breakdown approach to deconstruct the proposed rule requirements according to required activities. For each required activity, the NRC staff further sub-divided the work across labor categories (i.e., executive, manager, staff, clerical, licensing). The NRC staff estimated the required level of effort (LOE) for each labor category for each required activity in order to develop a bottoms-up cost estimate.

The NRC staff gathered data from several sources and consulted industry experts to develop LOE and unit cost estimates. Mean hourly wage rates for various industry labor categories were derived from 2013 Occupational Employment and Wages data. As per NUREG/CR-4627, *Generic Cost Estimates*, direct wage rates are loaded using a multiplier of 2 to account for licensee and contractor labor and overhead (i.e., fringe, benefits, general administration, and profit) (Ref. 18). Exhibit 3-3 presents the wage rates used throughout this analysis.

Exhibit 3-3. Wage Rate Estimates by Labor Category

Labor Category	Mean Wage Rate	Loaded Wage Factor	Loaded Wage Rate
	A	b	c = a x b
Industry Executives	$79.82	2	$159.63
Industry Managers	$52.11		$104.21
Industry Staff	$41.93		$83.85
Industry Clerical Staff	$26.34		$52.68
Industry Licensing Staff	$64.36		$128.71
NRC Staff	$62.00		$124.00

*The loaded wage rates for Industry Managers, Industry Staff, and Industry Licensing Staff are based on those used in a related NRC regulatory analysis.
**The mean wage rate for Industry Executives was calculated as the average of the mean hourly wage (in the Electric Power Generation, Transmission, and Distribution Industry) for Top Executives (SOC 11-1011) and Chief Executives (SOC 11-0000) from BLS.
***The mean wage rate for Clerical Staff was calculated as the average of the mean hourly wage (in the Electric Power Generation, Transmission, and Distribution Industry) for Office and Administrative Support Occupations (SOC 43-0000), Office Clerks, General (SOC 43-9061), and First-line Supervisors of Office and Administrative Support Workers (SOC 43-1011) from BLS.

Cost Estimation Methods

The NRC staff applied several cost estimation methods in this analysis. Many costs were estimated using expert opinion, which relies on the NRC staff's professional knowledge and judgment. The NRC staff consulted industry experts within and outside of the agency to develop most of the level of effort (LOE) estimates used in the analysis. For example, the NRC staff referred to industry comments in response to the Onsite Emergency Response Capabilities Advance Notice of Proposed Rulemaking (77 FR 23161) to inform the LOE estimates used for developing site-specific SAMGs.

Some cost activities were estimated using extrapolation, which relies on actual past or current costs to estimate the future cost of similar activities. The NRC staff extrapolated LOE estimates from existing NRC documentation and licensee submittals to estimate the LOE of the proposed rule's required activities. For example, the NRC staff reviewed exemption analyses already submitted by licensees to extrapolate the cost of this activity under the proposed rule.

Some activities were estimated using the engineering build-up method of cost estimation, which combines incremental costs of an activity from the bottom-up to estimate a total cost. For instance, the NRC staff built up the dual-SAMGs costs based on the costs associated with single-SAMGs. In these cases, the NRC staff assumed that dual-SAMGs sites would require roughly twice the effort of single-SAMGs sites to develop, implement, and maintain SAMGs as well as to comply with SAMGs-related activities.

Finally, other costs were developed relying on the method of analogy, which compares similar activities in order to estimate costs. Some examples of cost activities that were estimated using the analogy method include the effort required to develop new SAMGs training and the cost to the NRC to observe drills and exercises. The NRC staff considered the costs associated with existing training, drill, and exercise programs to derive the costs imposed by the narrower scope of SAMGs-related training, drill, and exercise requirements.

Time Period of Analysis

To define the period of analysis covered by this regulatory analysis (i.e., the period over which costs and benefits would be incurred), the NRC staff derived an average remaining license term for operating licensees and COL licensees. These average remaining license terms were calculated based on data from NUREG-1350, vol.26, *NRC Information Digest* (Ref. 19). In total, the regulatory analysis covers a 63-year period.

To estimate the average remaining license term for operating reactors, the NRC staff assumed each operating site applies for and receives one, 20-year license renewal beyond its original 40-year license term. For the 60 operating sites in the analysis, the NRC staff estimated that

the average remaining license term is 24 years, as of the effective date of the proposed rule. At the end of this 24-year period, the NRC staff assumes that these sites would enter the decommissioning phase, and would in turn incur decommissioning site costs associated with the proposed rule for the first two years of decommissioning. According to 10 CFR 50.155(a)(3), if the licensee performs and retains an analysis (hereafter referred to as the "exemption analysis") demonstrating that the decay heat of the fuel in the SFP is removed solely by heating and boiling of water within the SFP and the boil-off period provides sufficient time for the licensee to obtain offsite resources on an ad hoc basis to sustain the SFP cooling function indefinitely, they must only comply with 10 CFR 50.155(b)(2) of the proposed rule, which has no associated incremental costs. Therefore, the period of analysis for operating reactors begins in 2017, the year the proposed rule is assumed to take effect, and runs through 2040. From 2041 through 2042, the costs associated with these sites decrease to reflect the change in operating status.[4]

There are two new reactor sites included in the analysis (i.e., Virgil C. Summer and Vogtle). The NRC staff assumes that both sites will apply for and receive one 20-year license renewal in addition to the original 40-year license. Based on these assumptions, the new reactor sites would incur costs associated with the proposed rule from 2017 through 2077. In 2078, costs associated with the new reactor sites would shift to those for decommissioning sites for two years, from 2078 through 2079, based on the NRC staff's assumption that both sites would prepare and submit an exemption analysis to the NRC, exempting them from all but 10 CFR 50.155(b)(2) of the proposed rule requirements.[5]

Present Value Calculations

The NRC staff calculated the present value of the costs sites would incur over the average remaining license term. The NRC staff assumes that the proposed rule would be finalized and become effective in 2017. One-time implementation costs would be incurred in 2017, while annual operations costs would begin in 2018 and end in 2079. The analysis uses a 3 percent and 7 percent discount rate to calculate present values. Costs that would be incurred before the effective date of the proposed rule (e.g., cost to the NRC to develop and issue the final rule) are expressed in present value terms using the 3 percent and 7 percent discount rates, which increase the costs due to the time value of money.

3.2 Summary of Costs and Benefits of the Regulatory Options

This section presents the costs and benefits of the proposed rule with respect to three options: (1) take no action, (2) undertake a rulemaking to require SAMGs and make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable, and (3) undertake a rulemaking to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. Where possible, the NRC monetizes impacts. Those impacts that cannot be monetized are instead described, to the extent possible, quantitatively or qualitatively. This section presents a summary of the total costs and benefits associated with each option. Sections 3.3 and 3.4 describe in greater detail the costs and benefits of the proposed requirements. Appendix B

[4] The cost associated with the exemption analysis is considered an historical cost (see Appendix B). Currently, decommissioning sites are preparing these analyses to be granted an exemption from Orders EA-12-049 and EA-12-051. Therefore, the NRC staff assumes that in the absence of the rule, operating and new reactor sites would similarly prepare and submit the exemption analysis. As a result, the cost is reflected in the no action baseline.

[5] See previous footnote.

presents the historical costs of the Orders and industry initiatives. Note that all costs presented in this analysis are rounded to two significant figures. Refer to Appendices C and D for a more detailed presentation of the cost data.

Option 1: Take No Action

Under Option 1, the NRC staff assumes that the proposed rule would not be implemented; however, existing programs and regulatory efforts would still be in effect. Therefore, the NRC staff assumes that industry would continue with the implementation of all Orders (including EA-12-049, Order EA-12-051, and Order EA-13-109, *Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions*) as well as industry initiatives undertaken following the Fukushima (Ref. 20). There would be no incremental costs or benefits associated with this option, as shown in Exhibit 3-4.

Exhibit 3-4. Summary of Incremental Costs and Benefits for Option 1: No Action Baseline

Incremental Costs	Incremental Benefits
Industry: $0 using a 3% discount rate $0 using a 7% discount rate	None.
NRC: $0 using a 3% discount rate $0 using a 7% discount rate	

Option 2: Undertake Rulemaking to Require SAMGs and Make the Orders and Industry Initiatives Generically Applicable

Under Option 2, the NRC would undertake the proposed rulemaking to require industry to develop and implement SAMGs and conduct SAMGs-related activities. In addition, under this option, the proposed rule would make Order EA-12-049 and Order EA-12-051 as well as industry initiatives generically applicable. The NRC estimates the costs of Option 2 relative to a no action baseline (i.e., Option 1). Option 2 would result in incremental costs of $61 million (using a 7-percent discount rate) or $76 million (using a 3-percent discount rate). Exhibit 3-5 presents the total costs.

The total one-time cost amounts to approximately $31 million. The total annual cost is approximately $2.6 million. The average one-time cost per site is estimated at $510,000 and the average annual cost per site is approximately $42,000 (based on a universe of 60 affected sites).

Exhibit 3-5. Summary of Total Costs for Option 2: Undertake Rulemaking to Require SAMGs and Make the Orders and Industry Initiatives Generically Applicable

	Average Cost Per Site		Total Costs				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Develop and Issue Final Rule							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	Average Cost Per Site		Total Costs				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
NRC	N/A	N/A	$880,000	N/A	$880,000	$940,000	$910,000
Subtotal	*N/A*	*N/A*	*$880,000*	*N/A*	*$880,000*	*$940,000*	*$910,000*
SAMGs-Related Activities							
Industry	$510,000	$42,000	$30,000,000	$2,400,000	$94,000,000	$58,000,000	$72,000,000
NRC	N/A	N/A	$230,000	$170,000	$4,400,000	$2,100,000	$3,000,000
Subtotal	*$510,000*	*$42,000*	*$30,000,000*	*$2,600,000*	*$98,000,000*	*$60,000,000*	*$75,000,000*
Total							
Industry	$510,000	$42,000	$30,000,000	$2,400,000	$94,000,000	$58,000,000	$72,000,000
NRC	N/A	N/A	$1,100,000	$170,000	$5,300,000	$3,000,000	$3,900,000
Total	**$510,000**	**$42,000**	**$31,000,000**	**$2,600,000**	**$99,000,000**	**$61,000,000**	**$76,000,000**

*Results are rounded.

Exhibit 3-6 summarizes the incremental costs and benefits of the proposed rule under Option 2.

Exhibit 3-6. Summary of Incremental Costs and Benefits for Option 2

Incremental Costs	Incremental Benefits
Industry: $72,000,000 using a 3% discount rate $58,000,000 using a 7% discount rate	**Qualitative Benefits:** Enhances regulatory efficiency Enhances DID
NRC: $3,900,000 using a 3% discount rate $3,000,000 using a 7% discount rate	Enhances decision making for the mitigation of the consequences of core damage Supports effective use of emergency procedures by ensuring that strategies and guidelines are useable and cohesive Ensures adequate command and control and communication for multi-unit events Allows for the effective use of mitigation strategies and guidelines by enhancing knowledge and abilities of personnel Maintains the effectiveness of SAMGs over time

Option 3: Undertake Rulemaking to Make the Orders and Industry Initiatives Generically Applicable

Under Option 3, the NRC would undertake the proposed rulemaking to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable, but would not require SAMGs or SAMGs-related activities. As with Option 2, the NRC estimates the costs and benefits of Option 3 relative to a no action baseline. Option 3 would result in incremental costs of $940,000 (using a 7 percent discount rate) or $910,000 (using a 3 percent discount rate). These costs result from the NRC's rulemaking activities. Exhibit 3-7 presents the total costs associated with Option 3. The total one-time cost amounts to approximately $880,000.

Exhibit 3-7. Summary of Total Costs for Option 3: Undertake Rulemaking to Make the Orders and Industry Initiatives Generically Applicable

	Average Cost Per Site		Total Costs				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Develop and Issue Final Rule							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	$880,000	N/A	$880,000	$940,000	$910,000
Subtotal	*N/A*	*N/A*	*$880,000*	*N/A*	*$880,000*	*$940,000*	*$910,000*
Total							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	$880,000	N/A	$880,000	$940,000	$910,000
Total	**N/A**	**N/A**	**$880,000**	**N/A**	**$880,000**	**$940,000**	**$910,000**

*Results are rounded.

Exhibit 3-8 summarizes the incremental costs and benefits of Option 3.

Exhibit 3-8. Summary of Incremental Costs and Benefits for Option 3

Incremental Costs	Incremental Benefits
Industry: $0 using a 3% discount rate $0 using a 7% discount rate	**Qualitative Benefits:** Enhances regulatory efficiency
NRC: $910,000 using a 3% discount rate $940,000 using a 7% discount rate	

3.3 Costs of the Proposed Rule

This section details the estimated costs of Option 2 (and by extension, Option 3 because the costs associated with Option 3 are a subset of the costs of Option 2). These costs include developing and issuing the final rule and complying with SAMGs-related requirements:[6]

- Section 50.155(b)(3) would require each applicant or licensee to develop, implement, and maintain SAMGs. SAMGs are used to mitigate the consequences of events that result in significant damage to fuel in the reactor vessel or SFP. SAMGs support actions intended to arrest the progression of fuel damage, maximize the duration for which containment capability is maintained, and minimize radiological releases.

- Section 50.155(b)(4) would require integration of FSGs, EDMGs, and SAMGs with the EOPs.

- Section 50.155(b)(5) would require each applicant or licensee to develop, implement, and maintain sufficient staffing to support implementation of FSGs, EDMGs, and SAMGs in conjunction with the EOPs during an event.

[6] The regulatory analysis does not account for industry costs incurred prior to the effective date of the final rule (i.e., any costs incurred during the development of the final rule).

- Section 50.155(b)(6) would require each applicant or licensee to develop, implement, and maintain a supporting organizational structure with defined roles, responsibilities, and authorities for directing and performing the FSGs, EDMGs, and SAMGs.

- Section 50.155(e) would require each licensee to provide training to personnel that perform activities in accordance with FSGs, EDMGs, and SAMGs.

- Section 50.155(f)(1)-(4) would require drills or exercises demonstrating implementation of FSGs, EDMGs, and SAMGs.

- Section 50.155(g)(1)-(3) would allow a licensee to make changes to FSGs, EDMGs, and SAMGs without prior NRC approval, provided that the licensee performs an evaluation demonstrating that regulatory requirements continue to be met. Documentation of all changes would need to be maintained.

The proposed rule also would include the following requirements, which are not analyzed in this regulatory analysis:

- Section 50.155(a)(3) would allow licensees to prepare and submit an analysis to the NRC in order to be exempted from the proposed rule, with the exception of Section 50.155(b)(2). The costs associated with this rule provision are considered historical (because currently decommissioning sites are preparing these analyses in the baseline to be exempted from Order EA-12-049 and Order EA-12-051), and are estimated and discussed in Appendix B.

- Section 50.155(b)(1) would require strategies and guidelines to mitigate BDBEE from natural phenomena that result in an ELAP concurrent with either a LUHS or a loss of normal access to the normal heat sink. These strategies and guidelines are consistent with the existing FSGs. The costs associated with this rule provision are considered historical (due to the requirements of Order EA-12-049), and are estimated and discussed in Appendix B.

- Section 50.155(c)(2) would require licensees to provide reasonable protection of the equipment relied on for mitigation strategies. This analysis does not account for the costs associated the re-evaluation of protection levels because the NRC is explicitly seeking stakeholder feedback regarding this proposed requirement.

- Section 50.155(c)(4) would require licensees to install SFP level instrumentation, as required by Order EA-12-051. The costs associated with this rule provision are considered historical, and are estimated and discussed in Appendix B.

- Section 50.155(d) would impose costs on reactor applicants to incorporate into the plant design features that enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and SFP cooling capabilities during an ELAP concurrent with either a LUHS or a loss of normal access to the normal heat sink. The costs associated with this proposed provision are estimated in a separate analysis.

- Part 50, Appendix E, Section IV.B would require licensees to maintain the capability to determine the magnitude of, and continually assess the impact of, the release of

radioactive materials, including from all reactor core and SFP sources. The costs associated with this rule provision are considered historical (because of existing industry initiatives), and are estimated and discussed in Appendix B.

- Part 50, Appendix E, Section VII would require each applicant or licensee to perform a detailed analysis demonstrating that sufficient staff is available to implement the guidelines and strategies to respond to a BDBEE. The costs associated with this rule provision are considered historical (because of existing industry initiatives), and are discussed in Appendix B. This proposed provision also would require licensees to make and describe adequate provisions for onsite and offsite communication. The costs associated with this rule provision are considered historical (due to the requirements of Order EA-12-049), and are therefore estimated and discussed in Appendix B.

The proposed SAMGs-related requirements would result in an estimated cost of $61 million (using a 7 percent discount rate) and $76 million (using a 3 percent discount rate), as shown in Exhibit 3-9. These monetized costs are described in more detail in the following sections.

Exhibit 3-9. Summary of Industry and NRC Total Costs

	Average Cost Per Site		**Total Cost**				
	One-Time Cost	Annual Cost	One-Time Cost	Annual Cost	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Develop and Issue Final Rule							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	$880,000	N/A	$880,000	$940,000	$910,000
Subtotal	*N/A*	*N/A*	*$880,000*	*N/A*	*$880,000*	*$940,000*	*$910,000*
SAMGs-Related Activities							
§ 50.155(b)(3) SAMGs							
Industry	$220,000	$2,200	$13,000,000	$130,000	$17,000,000	$14,000,000	$15,000,000
NRC	N/A	N/A	$99,000	$30,000	$800,000	$440,000	$600,000
Subtotal	*$220,000*	*$2,200*	*$13,000,000*	*$160,000*	*$18,000,000*	*$14,000,000*	*$16,000,000*
§ 50.155(b)(4) Integration of Emergency Procedures							
Industry	$20,000	N/A	$1,200,000	N/A	$1,200,000	$1,200,000	$1,200,000
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$20,000*	*N/A*	*$1,200,000*	*N/A*	*$1,200,000*	*$1,200,000*	*$1,200,000*
§ 50.155(b)(6) Command and Control							
Industry	$2,800	N/A	$170,000	N/A	$170,000	$170,000	$170,000
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$2,800*	*N/A*	*$170,000*	*N/A*	*$170,000*	*$170,000*	*$170,000*
§ 50.155(e) SAMGs Training							
Industry	$220,000	$27,000	$13,000,000	$1,600,000	$55,000,000	$32,000,000	$41,000,000
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$220,000*	*$27,000*	*$13,000,000*	*$1,600,000*	*$55,000,000*	*$32,000,000*	*$41,000,000*
§ 50.155(f)(1)-(4) SAMGs Drills and Exercises							
Industry	$32,000	$3,300	$1,900,000	$200,000	$6,400,000	$3,600,000	$4,800,000

	Average Cost Per Site		**Total Cost**				
	One-Time Cost	Annual Cost	One-Time Cost	Annual Cost	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
NRC	N/A	N/A	$120,000	$8,900	$310,000	$190,000	$240,000
Subtotal	*$32,000*	*$3,300*	*$2,000,000*	*$210,000*	*$6,700,000*	*$3,800,000*	*$5,000,000*
§ 50.155(g)(1)-(3) SAMGs Change Control							
Industry	$15,000	$9,000	$880,000	$510,000	$14,000,000	$6,800,000	$9,900,000
NRC	N/A	N/A	$12,000	$130,000	$3,300,000	$1,500,000	$2,200,000
Subtotal	*$15,000*	*$9,000*	*$890,000*	*$640,000*	*$17,000,000*	*$8,300,000*	*$12,000,000*
Total							
Industry	$500,000	$42,000	$30,000,000	$2,400,000	$94,000,000	$58,000,000	$72,000,000
NRC	N/A	N/A	$1,100,000	$170,000	$5,000,000	$3,100,000	$4,000,000
Total	**$500,000**	**$42,000**	**$31,000,000**	**$2,600,000**	**$99,000,000**	**$61,000,000**	**$76,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***The annual cost data represents the per year costs incurred by sites during their operating license term.
****Although costs vary according to site characteristics, the average cost per site represents an industry average.

3.3.1. Industry Implementation

The proposed rule would impose implementation costs on 60 power reactor sites, including operating licensees and COL holders. These incremental costs include procedural and administrative activities (such as developing SAMGs, integrating emergency procedures, revising procedures to document command and control, developing trainings on SAMGs, conducting SAMGs drills or exercises, and developing SAMGs change control policy and procedures). One-time industry implementation costs are assumed to begin in 2017 (the expected effective date of the proposed rule). As discussed in Section 3.1, decommissioning sites would not incur implementation costs because proposed 10 CFR 50.155(a)(3) would exempt decommissioning sites from SAMGs-related requirements once the NRC approves the site's exemption analysis. See Appendix B, the NRC's historical cost analysis, for more information regarding the costs incurred by decommissioning sites.

Exhibit 3-10 lists the industry's implementation costs, which amount to a total one-time cost of approximately $30 million. The average one-time cost per site is estimated at $500,000 (based on 60 affected sites).

Exhibit 3-10. Present Value of Industry's Implementation Cost

Section	**Average Cost per Site**	**Total Cost**		
	One-Time Cost	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
SAMGs	$220,000	$13,000,000	$13,000,000	$13,000,000
Integration of Emergency Procedures	$20,000	$1,200,000	$1,200,000	$1,200,000

Section	Average Cost per Site	Total Cost		
	One-Time Cost	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
Command and Control	$2,800	$170,000	$170,000	$170,000
SAMGs Training	$220,000	$13,000,000	$13,000,000	$13,000,000
SAMGs Drills and Exercises	$32,000	$1,900,000	$1,900,000	$1,900,000
SAMGs Change Control	$15,000	$880,000	$900,000	$880,000
Total	**$500,000**	**$30,000,000**	**$30,000,000**	**$30,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The following sections detail the compliance activities required of affected sites (i.e., related to SAMGs, Integration of Emergency Procedures, Command and Control, SAMGs Training, SAMGs Drills and Exercises, and Change Control).

Section 50.155(b)(3) SAMGs

Exhibit 3-11 shows that the industry implementation cost associated with proposed 10 CFR 50.155(b)(3) is $13.0 million. These one-time costs would be incurred in 2017.

The NRC staff assumes that each of the 60 operating sites (including the two AP1000 COL sites) would develop and implement site-specific SAMGs.

The LOE to develop and implement site-specific SAMGs is dependent on a site's reactor type (e.g., BWR or PWR) and whether the site is a single-SAMGs or dual-SAMGs site (as defined in Section 3.1).

Specifically, the NRC staff assumes:

- Development of site-specific SAMGs for PWR sites would require more effort than for BWR sites because the pressurized water reactor owners group (PWROG) generic SAMG recently consolidated three generic SAMGs into one (i.e., Westinghouse, Combustion Engineering, and Babcock and Wilcox).
- The two AP1000 units are co-located with operating sites, so they are categorized as dual-SAMGs sites.
- Development of site-specific SAMGs at a dual-SAMGs site would require twice the amount of effort required by a single-SAMGs site.

Exhibit 3-11. Industry Implementation Cost: SAMGs

Activity	Average Cost per Affected Site	Total Cost
Develop and implement site-specific SAMGs (single-SAMGs BWR sites)	$170,000	$3,700,000
Develop and implement site-specific SAMGs (dual-SAMGs BWR sites)	$350,000	$350,000

Activity	Average Cost per Affected Site	Total Cost
Develop and implement site-specific SAMGs (single-SAMGs PWR sites)	$210,000	$7,200,000
Develop and implement site-specific SAMGs (dual-SAMGs PWR sites)	$420,000	$1,700,000
Subtotal		**$13,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.1 for additional detail on these cost estimates.

Section 50.155(b)(4) Integration of Emergency Procedures

The industry implementation cost associated with proposed 10 CFR 50.155(b)(4) is $1.2 million, as shown in Exhibit 3-12. These one-time costs, which are associated with integrating emergency procedures, would be incurred in 2017.

The NRC staff assumes that each of the 60 operating sites would review the FSGs, EDMGs, and SAMGs to confirm that the guidelines are integrated with the EOPs. The NRC staff assumes that the LOE to review guidelines would not vary between single-SAMGs and dual-SAMGs sites. The costs associated with revisions to site-specific SAMGs resulting from these reviews are accounted for under SAMGs Change Control, proposed 10 CFR 50.155(g)(1)-(3). In addition, the costs associated with integrating the FSGs with the EOPs are included in the historical cost analysis found in Appendix B.

Exhibit 3-12. Industry Implementation Cost: Integration of Emergency Procedures

Activity	Average Cost per Affected Site	Total Cost
Review the FSGs, EDMGs, and SAMGs to confirm integration with EOPs	$20,000	$1,200,000
Subtotal		**$1,200,000**

*Results are rounded.
**All costs are presented in 2013 dollars
***See Appendix C.2 for additional detail on these cost estimates.

Section 50.155(b)(6) Command and Control

Exhibit 3-13 shows that the industry implementation costs associated with proposed 10 CFR 50.155(b)(6) is estimated to be $170,000. The one-time costs associated with the Command and Control requirements would be incurred in 2017. The NRC staff assumes that each of the 60 operating sites would revise its procedures to verify the site's supporting organizational structure and to define roles, responsibilities, and authorities for directing and performing the activities called for in the SAMGs. The NRC staff assumes that effort required to implement Command and Control procedures would not vary between single-SAMGs and dual-SAMGs sites.

Exhibit 3-13. Industry Implementation: Command and Control

Activity	Average Cost per Affected Site	Total Cost
Revise procedures to document command and control	$2,900	$170,000
Subtotal		**$170,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.4 for additional detail on these cost estimates.

Section 50.155(e) SAMGs Training

Exhibit 3-14 documents the industry implementation costs for compliance activities related to SAMGs training. The one-time cost associated with proposed 10 CFR 50.155(e) is estimated to be $13 million and would be incurred in 2017. This provision would affect the 60 operating sites (including the two AP1000 COL sites). The NRC staff assumes that each site would develop new training materials to incorporate provisions of the proposed rule into existing training materials.

The NRC staff assumes that the training materials would be developed by a third-party contractor. The contractor cost would depend on whether the site is a single-SAMGs or dual-SAMGs site. Specifically, the staff assumes the cost to develop training materials for a dual-SAMGs site would be twice as expensive as the cost for a single-SAMGs site.

Exhibit 3-14. Industry Implementation Cost: SAMGs Training

Activity	Average Cost per Affected Site	Total Cost
Develop new training materials (single-SAMGs sites)	$200,000	$11,000,000
Develop new training materials (dual-SAMGs sites)	$400,000	$2,000,000
Subtotal		**$13,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***Contractor cost estimates are based on the NRC's professional judgment.
****See Appendix C.6 for additional detail on these cost estimates.

Section 50.155(f)(1)-(4) SAMGs Drills and Exercises

Exhibit 3-15 presents the industry implementation costs associated with SAMGs Drills and Exercises. The NRC staff estimates that the 60 operating sites would incur a one-time cost of $1.9 million.

The NRC staff estimates the incremental cost of SAMGs drills and exercises because drills and exercises for EDMGs are currently required (in the baseline), and FSGs drills and exercises are accounted for in the historical cost analysis, specifically related to Order EA-12-049, found in Appendix B. The NRC staff assumes that each site would develop SAMGs drill and exercise scenarios to incorporate into existing emergency preparedness drills and exercises. Each site also would be required to conduct an initial drill or exercise within four years of the effective date of the proposed rule. The NRC staff assumes each operating site would conduct an initial drill, rather than an exercise. In addition, the NRC staff assumes:

- The LOE to develop new drill and exercise scenarios for a dual-SAMGs site is twice the LOE for a single-SAMGs site.

- Initial drills (as opposed to exercises) would be performed by each of the 60 operating sites within four years after the rule becomes effective (2017 – 2020). Initial drills by the COL holders would occur in 2017.

- Each initial SAMGs drill would require four hours per participant. One ultimate decision maker (UDM) would participate in initial drills at each site. Ten non-licensed operators (NLOs) would participate in initial drills at site. NLOs would include onshift NLOs, maintenance workers, and security personnel assigned operational tasks under SAMGs.

Exhibit 3-15. Industry Implementation Cost: SAMGs Drills and Exercises

Activity	Average Cost per Affected Site	Total Cost
Develop new drill and exercise scenarios (single-SAMGs sites)	$22,000	$1,200,000
Develop new drill and exercise scenarios (dual-SAMGs sites)	$44,000	$220,000
Conduct initial drills (operating license holders)	$7,900	$470,000
Conduct initial drills (COL holders)	$7,900	$16,000
Subtotal		**$1,900,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.7 for additional detail on these cost estimates.

Section 50.155(g)(1)-(3) SAMGs Change Control

Exhibit 3-16 summarizes the industry implementation costs for proposed 10 CFR 50.155(g)(1)-(3). The one-time cost to implement the change control requirements would be $880,000. The NRC staff assumes that each of the 60 operating sites would develop change

control policies and procedures and the costs incurred would be equivalent for single- and dual-SAMGs site.

Exhibit 3-16. Industry Implementation Cost: SAMGs Change Control

Activity	Average Cost per Affected Site	Total Cost
Develop change control policy and procedures (operating sites)	$15,000	$880,000
Subtotal		**$880,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.8 for additional detail on these cost estimates.

3.3.2 Industry Operation

The proposed rule also would impose operations costs on 60 operating sites, including the two COL holders. These incremental costs include routine and recurring activities (such as SAMGs maintenance, attending and documenting SAMGs training, conducting and documenting SAMGs drills and exercises, and updating SAMGs-related documents). These annual costs are assumed to begin in 2018, with the exception of the Strategic Alliance for FLEX Emergency Response (SAFER) training which would begin in 2017, and accrue up to 61 years, depending on the activity and reactor type.

Exhibit 3-17 presents the industry's operations costs. The NRC staff estimates that industry would incur an annual cost of approximately $2.4 million. The present value of these costs is approximately $29 million (using a 7 percent discount rate) and $42 million (using a 3 percent discount rate). The average annual cost per site is approximately $42,000 (based on 60 affected sites).

Exhibit 3-17. Present Value of Industry's Operations Cost

Section	Average Cost per Site	Total Cost		
	Annual Cost	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
SAMGs	$2,200	$130,000	$1,500,000	$2,400,000
SAMGs Training	$27,000	$1,600,000	$19,000,000	$28,000,000
SAMGs Drills and Exercises	$3,300	$200,000	$2,000,000	$2,900,000
SAMGs Change Control	$9,000	$510,000	$6,000,000	$9,100,000
Total	**$42,000**	**$2,400,000**	**$29,000,000**	**$42,000,000**

*Results are rounded.
**The annual cost data represents the per year costs incurred by sites during their operating license term.
***All costs in this table are presented in 2013 dollars.

The following sections detail the annual compliance activities required of affected sites (i.e., related to SAMGs, SAMGs Training, SAMGs Drills and Exercises, and SAMGs Change Control). As discussed in Section 3.1, at the end of the average operating license term, the NRC staff assumes that sites would enter the decommissioning phase, and would in turn incur

decommissioning site costs associated with the proposed rule for the first two years of decommissioning. The following sections discuss the operations costs during both the operating license term and the first two years of decommissioning.

Section 50.155(b)(3) SAMGs

Exhibits 3-18 and 3-19 present the annual costs associated with maintaining SAMGs over time. These costs are incurred during the operating license term (Exhibit 3-18) and the first two years of decommissioning (Exhibit 3-19).

The NRC staff assumes that each of the 60 operating sites would update their site-specific SAMGs on a triennial basis. These costs would be incurred throughout the operating license term. The NRC staff assumes that 58 BWR and PWR sites would incur SAMGs maintenance costs for the average remaining license term, beginning in 2018 and ending in 2040. The two AP1000 sites would incur operations costs from 2018 through 2077 (the average remaining license term for new reactors). Refer to Section 3.1 for more detail regarding how these average license terms were calculated.

Each site also would incur costs associated with maintaining SAMGs during the first two years of decommissioning. The NRC staff assumes that the 58 BWR and PWR sites would incur decommissioning costs in 2041 and 2042, and the two AP1000 sites would incur decommissioning costs in 2078 and 2079. After two years, the NRC staff assumes the licensees would have prepared and submitted the exemption analysis to the NRC, exempting them from all but proposed 10 CFR 50.155(b)(2) of the proposed rule.

Assumptions Related to Costs Incurred During the Operating Period

The NRC staff assumes that operating sites would perform a high-level review of the site-specific SAMGs on a triennial basis to determine if any updates are needed. The SAMGs review would be added to the site's existing procedure review processes, which would need only slight modifications. Therefore, the NRC staff expects the incremental impact of this provision to be small.

The NRC staff assumes that a dual-SAMGs site would require twice the effort required by a single-SAMGs site to maintain its site-specific SAMGs. Any revisions resulting from these reviews would impose incremental costs. However, these costs are accounted for in the operations costs for SAMGs Change Control. The NRC staff estimates that industry would incur annual costs of $130,000 to maintain site-specific SAMGs.

Exhibit 3-18. Industry Operations Cost: SAMGs (During the Operating Term)

Activity	Average Annual Cost per Affected Site	Annual Cost
Maintain site-specific SAMGs (single-SAMGs operating sites)	$5,900	$110,000
Maintain site-specific SAMGs (dual-SAMGs operating sites)	$12,000	$24,000

Subtotal	**$130,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.1 for additional detail on these cost estimates.

Assumptions Related to Costs Incurred During the First Two Years of Decommissioning

The NRC staff assumes that sites would incur costs related to maintaining SAMGs for the first two years of decommissioning. The NRC staff estimates that industry would incur $120,000 in annual costs to maintain SAMGs during the first two years of decommissioning.

Exhibit 3-19. Industry Operations Cost: SAMGs (During the First Two Years of Decommissioning)

Activity	Average Annual Cost per Affected Site	Annual Cost
Maintain site-specific SAMGs (BWR and PWR decommissioning sites)	$5,900	$110,000
Maintain site-specific SAMGs (AP1000 decommissioning sites)	$5,900	$5,900
Subtotal		**$120,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix D.2 for additional detail on these cost estimates.

Section 50.155(e) SAMGs Training

Exhibits 3-20 and 3-21 present the annual training costs incurred during the operating license term and the first two years of decommissioning, respectively. This provision would affect the 60 operating sites (including the two AP1000 COL sites). During the operating license term, the NRC staff assumes that 58 BWR and PWR sites would incur operations costs beginning in 2018 and ending in 2040 (the average remaining industry-wide license term for currently licensed BWRs and PWR sites). The two AP1000 sites would incur these operations costs from 2018 to 2077 (the average remaining industry-wide license term for currently licensed AP1000 sites). See Section 3.1 for more detail on how these average license terms were derived.

In addition, each site would incur costs during the first two years of decommissioning. The NRC staff assumes that for two years following the end of the operating license term (2041 and 2042), the 58 BWR and PWR sites would incur costs to conduct training on a narrowed scope of SAMGs (limited to SFP SAMGs), while the two AP1000 sites would incur these costs in 2078 and 2079. After two years, the NRC staff assumes the sites would have prepared and submitted the necessary analysis to the NRC, exempting them from all but proposed 10 CFR 50.155(b)(2) of the proposed rule.

Assumptions Related to Costs Incurred During the Operating Period

The NRC staff assumes that each of the 60 operating sites would provide SAMGs training to UDMs and NLOs on a biennial basis.[7] Specifically, the training would target personnel that perform activities under the SAMGs.[8] Sites also would be required to document training attendance and update training materials on a biennial basis.

The LOE to perform these activities varies for single-SAMGs and dual-SAMGs sites. Specifically, the NRC staff assumes that:

- SAMGs training would require eight hours per participant. Five UDMs would attend training at each single-SAMGs and dual-SAMGs site. Thirty NLOs and 60 NLOs would attend training at each single-SAMGs and dual-SAMGs site, respectively.

- The costs to document attendance and update training materials incurred by dual-SAMGs sites as twice that of single-SAMGs sites.

The NRC staff estimates that during the sites' operating license term, industry would incur an annual cost of $1.6 million to train staff on SAMGs.

Exhibit 3-20. Industry Operations: SAMGs Training (During the Operating License Term)

Activity	Average Annual Cost per Affected Site	Annual Cost
Attend training for UDMs and NLOs (single-SAMGs sites)	$28,000	$790,000
Attend training for UDMs and NLOs (dual-SAMGs sites)	$50,000	$150,000
Document training and update materials (single-SAMGs sites)	$20,000	$570,000
Document training and update materials (dual-SAMGs sites)	$41,000	$120,000
Subtotal		**$1,600,000**

*Results are rounded.
**The activities in the table occur on a biennial basis. The costs have been annualized to reflect this.
***All costs in this table are presented in 2013 dollars.
****See Appendix C.6 for additional detail on these cost estimates.

Assumptions Related to Costs Incurred During the First Two Years of Decommissioning

The NRC staff assumes that each of the 60 sites would continue to provide SAMGs training to UDMs and NLOs, document training attendance, and update training materials on a biennial basis during the first two years of decommissioning.

The NRC staff makes the following assumptions:

[7] NLOs would include on-shift NLOs, maintenance workers, and security personnel assigned operational tasks under SAMGs.
[8] The incremental costs of training licensed operators are not considered in the analysis because they would be trained in the baseline.

- UDMs and NLOs at decommissioning sites require less time in training, relative to operating sites. SAMGs training would require two hours per participant. Five UDMs and 10 NLOs would attend training at each decommissioning site.

- The LOE to document and update training materials for decommissioning sites is less than that required at operating sites.

As shown in Table 3-21, during the first two years of decommissioning, the NRC staff estimates that industry would incur an annual cost of $250,000 to train staff on SAMGs.

Exhibit 3-21. Industry Operations: SAMGs Training (During the First Two Years of Decommissioning)

Activity	Annual Cost per Affected Site	Annual Cost
Attend training for UDMs and NLOs (BWR and PWR decommissioning sites)	$4,100	$120,000
Attend training for UDMs and NLOs (AP1000 decommissioning sites)	$4,100	$4,100
Document training and update materials (BWR and PWR decommissioning sites)	$4,200	$120,000
Document training and update materials (AP1000 decommissioning sites)	$4,200	$4,200
Subtotal		**$250,000**

*Results are rounded.
**The activities in the table occur on a biennial basis. The costs have been annualized to reflect this.
***All costs in this table are presented in 2013 dollars.
****See Appendix D.4 for additional detail on these cost estimates.

Section 50.155(f)(1)-(4) SAMGs Drills and Exercises

Exhibit 3-22 provides the annual costs associated with SAMGs Drills and Exercises, which is estimated to be $200,000. The NRC staff assumes that 60 operating sites would conduct drills or exercises and document the results. Although the proposed rule would allow sites to choose between a drill or an exercise in succeeding 8-year intervals, the NRC staff assumes that each year, one single-SAMGs site and one dual-SAMGs site would conduct and document the results of a SAMGs exercise, which is approximately six times more costly than a drill. The remaining sites would choose to perform drills instead. Therefore, on an annual basis, approximately six single-SAMGs sites and one dual-SAMGs site would conduct a SAMGs drill and document the results. In addition, the NRC staff assumes that representatives from SAFER would participate in one drill per year.

In addition:

- Each SAMGs drill would require four hours per participant. One UDM would participate in drills at each site. Ten NLOs would participate in drills at each single-SAMGs site, while 20 NLOs would participate at each dual-SAMGs site.

- Each SAMGs exercise would require ten hours per participant. Five UDMs per site would participate in exercises. Forty NLOs would participate in exercises at each single-SAMGs site, while 80 NLOs would participate at each dual-SAMGs site.

- SAFER participation in drills would include a SAFER Control Center (SCC) Lead, an SCC Logistics and Transportation (L&T) Coordinator, an SCC SA Coordinator, and two Regional Response Center (RRC) Leads.

Exhibit 3-22. Industry Operations Cost: SAMGs Drills and Exercises

Activity	Average Annual Cost per Affected Site	Annual Cost
Conduct drills and document performance (single-SAMGs sites)	$7,900	$47,000
Conduct drills and document performance (dual-SAMGs sites)	$14,000	$14,000
Conduct an exercise and document performance (single-SAMGs sites)	$47,000	$47,000
Conduct an exercise and document performance (dual-SAMGs sites)	$86,000	$86,000
Participate in drills (SAFER)	N/A	$4,200
Subtotal		**$200,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.7 for additional detail on these cost estimates.

Section 50.155(g)(1)-(3) SAMGs Change Control

Exhibits 3-23 and 3-24 present the annual SAMGs change control costs that would be incurred during the operating license term and during the first two years of decommissioning, respectively.

The NRC staff assumes the boiling water reactor owners group (BWROG), PWROG, and each of the 60 operating sites would incur costs associated with this provision. The 60 operating sites would incur operating costs for the remainder of the operating license term. Therefore, 58 BWR and PWR sites would incur these operating costs beginning in 2018 and ending in 2040 (the average remaining industry-wide license term for currently licensed BWR and PWR sites), and the two AP1000 sites would incur these operations costs from 2018 to 2077.

Each site also would incur costs for the first two years of decommissioning. The NRC staff assumes that for two years following the end of the license term (i.e., 2040-2041 for BWR and PWR sites, and 2078-2079 for AP1000 sites) sites would incur change control costs. After two years, the NRC staff assumes that licensees would have prepared and submitted the appropriate exemption analysis to the NRC, triggering the provision in proposed 10 CFR 50.155(a)(3), which exempts decommissioning licensees from all but proposed 10 CFR 50.155(b)(2) of the proposed rule.

Assumptions Related to Costs Incurred During the Operating Period

The NRC staff assumes that the BWROG would update the generic severe accident guidelines (SAG)[9] and the PWROG would update the generic SAMG on a triennial basis. The two AP1000 sites would refer to the generic PWROG SAMG when developing their site-specific SAMGs. Therefore, the costs associated with the PWROG updates to the generic SAMG would continue throughout the remaining operating license term for these two sites (i.e., from 2017 through 2077). The BWROG would incur costs to update the generic SAG for the remainder of the operating license term for BWR sites (i.e., 2017 through 2040).

In addition, each of the 60 operating sites would update their site-specific SAMGs on a triennial basis. The NRC staff assumes that the LOE varies for single-SAMGs and dual-SAMGs sites, with dual-SAMGs sites requiring twice the effort of single-SAMGs sites.

The NRC staff estimates that industry would incur annual operating costs of $510,000 to carry out the SAMGs change control requirements.

Exhibit 3-23. Industry Operations Cost: SAMGs Change Control (During Operating License Term)

Activity	Average Annual Cost per Affected Site	Annual Cost
Update generic BWROG SAG	N/A	$4,700
Update generic PWROG SAMG	N/A	$5,000
Update site-specific SAMGs (single-SAMGs BWR sites)	$6,500	$140,000
Update site-specific SAMGs (dual-SAMGs BWR sites)	$13,000	$13,000
Update site-specific SAMGs (single-SAMGs PWR sites)	$8,400	$290,000
Update site-specific SAMGs (dual-SAMGs PWR sites)	$17,000	$68,000
Subtotal		**$510,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.8 for additional detail on these cost estimates.

Assumptions Related to Costs Incurred During the First Two Years of Decommissioning

Exhibit 3-24 presents the annual cost of SAMGs change control during the first two years of decommissioning. The NRC staff assumes that each of the 60 operating sites would incur costs to update site-specific SAMGs for the first two years of decommissioning. Due to the narrowed scope of the SAMGs during decommissioning, the NRC staff assumes that variations in reactor

[9] SAGs are specific to BWR sites and SAMGs are specific to PWR sites. Both provide strategies taken after the onset of fuel damage. This analysis uses the term "SAMGs" to refer to these strategies unless referring specifically to the BWR sites.

type would not affect change control costs. The NRC staff estimates that industry would incur an annual cost of $180,000 for the first two years of decommissioning.

Exhibit 3-24. Industry Operations Cost: SAMGs Change Control (During the First Two Years of Decommissioning)

Activity	Average Annual Cost per Affected Site	Annual Cost
Update site-specific SAMGs (BWR and PWR decommissioning sites)	$3,000	$170,000
Update site-specific SAMGs (AP1000 decommissioning sites)	$3,000	$6,000
Subtotal		**$180,000**

*Results are rounded
**All costs in this table are presented in 2013 dollars.
***See Appendix D.5 for additional detail on these cost estimates.

3.3.3 NRC Implementation

The proposed rule also would impose implementation costs on the NRC. These incremental costs include procedural and administrative activities (such as developing and issuing the final rule, becoming familiar with the owners groups' SAMGs, developing SAMG oversight materials, reviewing new scenarios and observing initial drills, as well as revising existing inspection procedures). These one-time costs are assumed to be incurred in 2017 with the exception of developing and issuing the final rule, which would occur in 2016.

Exhibit 3-25 presents the NRC's total implementation costs which amount to a one-time cost of approximately $1.1 million. The total present value of these costs is approximately $1.2 million (using a 7 percent discount rate) and $1.1 million (using a 3 percent discount rate).

Exhibit 3-25. Present Value of NRC Implementation Cost

Section	Total Cost		
	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
Develop and Issue Final Rule	$880,000	$940,000	$910,000
SAMGs	$99,000	$99,000	$99,000
SAMGs Drills and Exercises	$120,000	$120,000	$120,000
SAMGs Change Control	$12,000	$12,000	$12,000
Total	**$1,100,000**	**$1,200,000**	**$1,100,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The following sections describe the NRC's one-time costs (i.e., related to developing and issuing the final rule, SAMGs, SAMGs Drills and Exercises, and SAMGs Change Control).

Developing and Issuing the Final Rule

Exhibit 3-26 summarizes the one-time costs for developing and issuing the final rule. The NRC staff assumes these costs would be occurred in 2016, in advance of the issuance of the final rule in 2017. The NRC staff estimates that the cost to complete the rulemaking would be $880,000.

Exhibit 3-26. NRC Implementation Cost: Developing and Issuing the Final Rule

Activity	Total Cost
Develop and issue MBDBE final rule	$880,000
Subtotal	**$880,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.10 for additional detail on these cost estimates.

Section 50.155(b)(3) SAMGs

Exhibit 3-27 summarizes the one-time costs of SAMGs compliance activities. The NRC would incur costs to become familiar with the owners groups' generic SAMGs. Because all sites are assumed to adopt the owners groups' generic SAMGs, the NRC would not review any site-specific SAMGs. In addition, the NRC would develop SAMG oversight materials such as inspection procedures. The NRC staff estimates that the NRC would incur one-time costs of $99,000 in response to the new SAMGs requirements.

Exhibit 3-27. NRC Implementation Cost: SAMGs

Activity	Total Cost
Become familiar with the owners groups' generic SAMGs	$50,000
Develop SAMG oversight materials (e.g., inspection procedures)	$50,000
Subtotal	**$99,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.1 for additional detail on these cost estimates.

Section 50.155(f)(1)-(4) SAMGs Drills and Exercises

Exhibit 3-28 contains the one-time costs of compliance activities related to SAMGs drills and exercises. The NRC would review the new drill and exercise scenarios developed by the 60 operating sites. In addition, the NRC would observe the initial drills conducted by the operating licensees and the COL holders in the first four years following the effective date of the proposed rule (2017 – 2020). The NRC would incur one-time costs of $120,000 as a result of the new SAMGs Drills and Exercises requirements.

Exhibit 3-28. NRC Implementation Cost: SAMGs Drills and Exercises

Activity	Total Cost
Review new scenarios	$60,000
Observe initial drills (operating licenses)	$60,000
Observe initial drills (combined license holders)	$2,000
Subtotal	**$120,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.7 for additional information on these cost estimates.

Section 50.155(g)(1)-(3) SAMGs Change Control

Exhibit 3-29 reports the one-time cost to the NRC for SAMGs change control compliance activities. The NRC would revise existing inspection procedures to include oversight of SAMGs change control procedures. Because these changes would be made to existing inspection procedures, ongoing updates to inspection procedures are assumed to be included in the baseline. The NRC would incur one-time costs of $12,000.

Exhibit 3-29. NRC Implementation Cost: SAMGs Change Control

Activity	Total Cost
Revise existing inspection procedures	$12,000
Subtotal	**$12,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.8 for additional detail on these cost estimates.

3.3.4 NRC Operation

The NRC also would incur ongoing, operations costs (specifically, overseeing site-specific SAMGs, observing drills and exercises, as well as overseeing sites' SAMGs change control processes). These annual costs are assumed to begin in 2018 and accrue over the following 58 years. The NRC will incur costs associated with the 58 BWR and PWR sites through 2040, while costs associated with the two AP1000 sites will continue through 2077.

Exhibit 3-30 provides the NRC's total operations cost which amounts to an annual cost of approximately $170,000. The total present value of these costs is approximately $1.9 million (using a 7 percent discount rate) and $2.8 million (using a 3 percent discount rate).

Exhibit 3-30. Present Value of NRC's Operations Cost

Section	Total Cost		
	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
SAMGs	$30,000	$340,000	$500,000
SAMGs Drills and Exercises	$8,900	$78,000	$120,000
SAMGs Change Control	$130,000	$1,500,000	$2,200,000
Total	**$170,000**	**$1,900,000**	**$2,800,000**

*Results are rounded.
**The annual cost varies based on the number of operating reactor sites.
***All costs in this table are presented in 2013 dollars.

The following sections detail the annual costs incurred by the NRC (i.e., related to SAMGs, SAMGs Drills and Exercises, and SAMGs Change Control).

Section 50.155(b)(3) SAMGs

Exhibit 3-31 contains the annual costs incurred by the NRC associated with maintaining SAMGs over time. The NRC would oversee licensee implementation of site-specific SAMGs. The costs associated with SAMGs oversight of the 58 BWR and PWR sites would be incurred by the NRC beginning in 2018 and ending in 2040. Oversight of the AP1000 sites would begin in 2018 and end in 2077. To oversee site-specific SAMGs, the NRC would incur annual costs of $30,000.

Exhibit 3-31. NRC Operations Cost: SAMGs

Activity	Annual Cost
Oversee site-specific SAMGs	$30,000
Subtotal	**$30,000**

*Results are rounded.
**The annual cost varies based on the number of operating reactor sites.
***See Appendix C.1 for additional detail on these cost estimates.

Section 50.155(f)(1)-(4) SAMGs Drills and Exercises

Exhibit 3-32 presents the annual costs incurred by the NRC associated with SAMGs Drills and Exercises. The NRC staff would observe SAMGs drills and exercises performed in 8-year intervals by each of the 60 operating sites. The proposed rule would not impose incremental costs on State and local offsite response organizations because the NRC staff assumes SAMGs drills and exercises would occur concurrently with other emergency preparedness drills and exercises that occur in the baseline. The NRC would oversee drills and exercises conducted by the 58 BWR and PWR sites until 2040, and would oversee drills and exercises performed by the AP1000 sites until 2077. The NRC would incur annual costs of $8,900 to oversee the SAMGs drills and exercises.

Exhibit 3-32. NRC Operations Cost: SAMGs Drills and Exercises

Activity	Annual Cost
Observe drills or exercises	$8,900
Subtotal	**$8,900**

*Results are rounded.
**The annual cost varies based on the number of operating reactor sites.
***See Appendix C.7 for additional detail on these cost estimates.

Section 50.155(g)(1)-(3) SAMGs Change Control

Exhibit 3-33 displays the annual costs incurred by the NRC to oversee licensees' SAMGs change control programs. Oversight would entail some incremental inspection activity on the NRC's behalf. The NRC would require twice the amount of effort to oversee the implementation of change control procedures for site-specific SAMGs for dual-SAMGs sites than it would for single-SAMGs sites. The NRC would provide oversight of the change control process until 2040 for the 58 BWR and PWR sites and until 2077 for the two AP1000 sites. The NRC would incur annual costs of $130,000 to oversee SAMGs change control.

Exhibit 3-33. NRC Operations Cost: SAMGs Change Control

Activity	Annual Cost
Oversee SAMG change control process for single-SAMGs sites	$110,000
Oversee SAMG change control process for dual-SAMGs sites	$20,000
Subtotal	**$130,000**

*Results are rounded.
**The annual cost varies based on the number of operating reactor sites.
***See Appendix C.8 for additional detail on these cost estimates.

3.4. Benefits of the Proposed Rule

Relative to the no action baseline which includes the benefits derived from Order EA-12-049, Order EA-12-051, and related industry initiatives, the incremental benefits from the options under consideration are as follows:

- Option 1: No action alternative. This option would not result in any incremental benefits above those resulting from the Orders and related industry initiatives.

- Option 2: Undertake rulemaking to require SAMGs and make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. This option, which is the proposed option, would result in improvements (discussed more below) in the following attributes: Public Health (Accident), Occupational Health (Accident), Offsite Property, Onsite Property, Regulatory Efficiency, and Environmental Considerations.

- Option 3: Undertake rulemaking to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. This option, which consists of a subset of the

requirements in the proposed rule, would result in improvements (discussed more below) in Regulatory Efficiency.

3.4.1 Benefits Associated with Public Health (Accident), Occupational Health (Accident), Offsite Property, Onsite Property, and Environmental Considerations

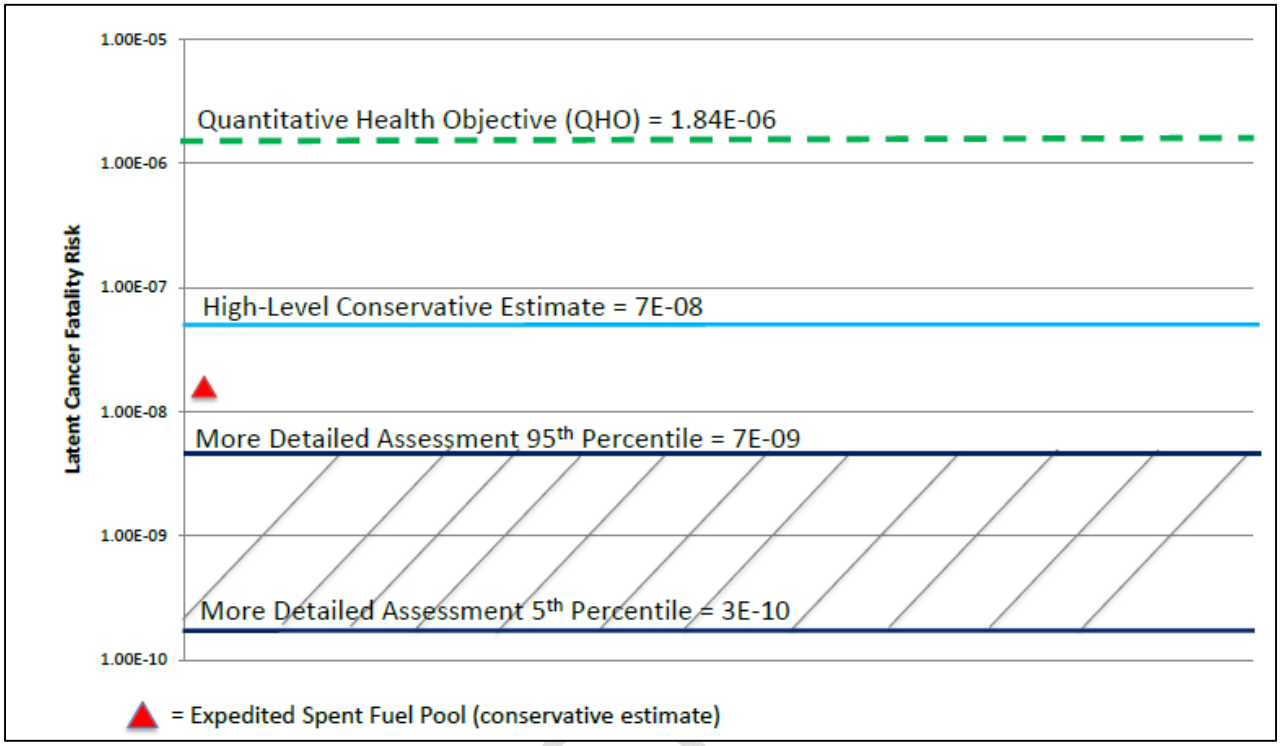
Under Option 2, the NRC staff anticipates that the SAMGs-related requirements would result in benefits to public and occupational health (accident), offsite and onsite property, and environmental considerations. These benefits are discussed in terms of recent quantitative risk analysis, qualitative factors, and comparisons to the Fukushima experience.

Recent Risk Analysis Results

The NRC decided in 1985 that the severe accident risk did not represent an undue risk to public health and safety. (See Appendix A, Backfit and Issue Finality Analysis.)

Subsequent and recent work performed by the NRC staff indicates that quantifiable risk information is not sufficient to justify the imposition of SAMGs requirements. The estimated benefit to safety showed no benefit for acute fatalities and small benefits for latent cancer fatalities (an estimated reduction of 10^{-9} or 10^{-10} for latent cancer fatalities). Exhibit 3-34 presents the results of the risk evaluation. The quantitative health objective (QHO) provides a risk criterion for regulatory decision-making, and in this case the results are 1,000 to 10,000 times below this QHO. Even the high-level conservative estimate (i.e., this can be considered a bounding level that equates to a maximum possible safety benefit) is well below the QHO. This quantitative result indicates that the use of SAMGs would result in minimal benefits to public health and safety.

Exhibit 3-34. NRC's QHO and Risk Evaluation Results of CPPR Rulemaking Alternatives



Source: NRC. 2014 Advisory Committee on Reactor Safeguards (ACRS) Meeting Schedule and Related Documents. Retrieved from: http://pbadupws.nrc.gov/docs/ML1433/ML14337A651.pdf

Qualitative Considerations

These minimal quantitative benefits were not developed with the intent of measuring possible SAMG safety benefits, and as such are not a complete measure of SAMG safety benefits. The referenced work was performed to address whether strategies taken after core damage for power reactors having Mark I and Mark II containment designs could be justified for new requirements. As such it is an indication of the benefits that can be achieved for SAMGs, since such strategies are implemented using SAMGs, but it is not a complete assessment of such benefits). SAMGs lead to indirect benefits by maintaining containment integrity (i.e., this contributes to the mitigation of releases which manifest as reduced doses) and by supporting the ERO with regard to making more informed protective action recommendations (i.e., this can support efforts to protect onsite personnel, and possibly to move people out of the path of effluents and therefore could result in reduced doses). Following the onset of core damage, SAMGs are valuable at providing important information to decision makers that support more informed decisions and actions on the use of resources in a severe accident. Typically, the SAMGs support decision makers as they work to minimize, reduce, and delay the releases of fission products. Furthermore, there are some accident sequences for which SAMGs actions may be successful in halting the progression of the accident (i.e., providing a much larger benefit for those sequences). Recognizing the substantially increased mitigation capabilities stemming from the implementation of Order EA-12-049 requirements and additionally noting the flexible and adaptable nature of the strategies to include the potential for offsite resources to assist with mitigation, it is more likely that the opportunities for halting a core melt progression have increased.

Therefore, although available quantitative risk information does not indicate that SAMGs would have a safety benefit, qualitatively SAMGs would support better use of resources thereby reducing risk and benefiting public health and safety.

Specifically, updated SAMGs would enable about 20 years of additional insights to be considered, including Fukushima insights. This results in an improved SAMGs decision-making, and leads to better post core damage decisions and actions. Requiring SAMGs (i.e., requiring licensees to develop, implement, and maintain site-specific SAMGs that reflect the recent generic efforts and the site-specific features, including a nominal level of training and drills) would specifically result in more informed decisions and actions (when compared to a presumed state of voluntary SAMGs that are not up to date and may not reflect the current plant configuration) involving:

- Containment;
- Minimization and delay of radiological releases;
- Use of all equipment including the mitigation equipment of Order EA-12-049;
- Use of Order EA-13-109 EPG/SAGs for Mark I and II designs;
- Decisions made by the ERO following core damage.

SAMGs directly support two key, defense-in-depth foundational elements of the NRC's regulatory framework: Containment and Emergency Preparedness. These features and requirements have their greatest importance to safety after the onset of core damage (i.e., when fission products are present), at which time the site transitions to SAMGs, which then serve as the operative guideline set for decisions and actions concerning the use of containment (to minimize and delay of fission product releases) and support to emergency response (to inform the ERO regarding fission product barrier integrity).

Additionally, SAMGs requirements could facilitate a more complete treatment of external event uncertainties as well as events that have yet to be anticipated. The Fukushima Dai-ichi event resulted in a greater appreciation for the uncertainties surrounding external events. Having updated SAMGs to reflect the availability and use of equipment would facilitate the implementation of mitigation strategies following core damage.

Finally, the SAMGs are an essential part of the regulatory framework for the mitigation of the consequences of accidents and it is critical that the SAMGs and thereby the knowledge base related to SAMGs is maintained. Prior to this proposed rule, all licensees developed SAMGs as a voluntary industry initiative in the 1990s. However, TI 2515/184 found that there was not a consistent approach to conducting periodic reviews.[10] Imposing SAMGs requirements would ensure that SAMGs are maintained as effective guidelines set through time, allowing licensees to better engage in knowledge management through the incorporation of industry-wide lessons learned and operating experience. Training and drills or exercises also would support the knowledgebase and abilities of licensee staff, while allowing demonstration and evaluation of their capability to respond to events. The proposed integrated response capability requirements would support the licensee use of the available guideline sets (to include SAMGs) in conjunction

[10] United States. Nuclear Regulatory Commission. *Summary of Observations Temporary Instruction 2515/184, "Availability and Readiness Inspection of Severe Accident Management Guidelines (SAMGs)"*. 2011. Web. 25 Jan. 2015. <http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/Summary-of-Observations-TI 2515-184.pdf>

with the emergency operating procedures. The proposed command and control requirements would clarify roles, responsibilities, and communication during multi-unit events.

Comparisons to the Fukushima Experience

SAMGs are a tool that would be used under conditions like those experienced during the Fukushima event. The severe accident which occurred at the Fukushima nuclear plant in 2011 resulted in radiation exposure to the public, offsite and onsite property damage, and damage to the environment. By requiring SAMGs, costs like those incurred as a result of the Fukushima Dai-ichi event may be reduced or averted. The NRC staff acknowledges that these benefits are not risk-weighted due to the uncertainty of BDBEEs. The benefits discussed in this section are, instead, for informational purposes only.

The sources listed below cite some of the estimated costs associated with the Fukushima accident. These figures, expressed in Japanese yen, are converted to U.S. dollars by applying the average annual exchange rate for the appropriate year. Exhibit 3-35 provides the average annual exchange rates used in this analysis,[11] inflated into 2013 dollars using BLS' CPI-U.[12]

Exhibit 3-35. Average Annual Exchange Rate (Yen per Dollar)

Year	Average Annual Exchange Rate (yen per dollar)
2012	82.931
2013	101.517
2014	110.101

One study found that "inhalation exposure, external exposure, and ingestion exposure of the public to radioactivity may result in 15 to 1,300 cancer mortalities and 24 to 2,500 cancer morbidities worldwide, mostly in Japan."[13] The study also estimated approximately "600 non-radiological deaths attributed to the evacuation following the accident."[14,15] Additionally, Tokyo Electric Power, Co. (TEPCO) compensated individuals for medical fees and mental distress.[16]

[11] United States. Internal Revenue Service. *Yearly Average Exchange Rates.* 23 January 2015. Web. 27 Jan. 2015. <http://www.irs.gov/Individuals/International-Taxpayers/Yearly-Average-Currency-Exchange-Rates>.

[12] United States. Bureau of Labor Statistics. *CPI Detailed Report, December 2014. "Table 24. Historical Consumer Price Index for All Urban Consumers (CPI-U): U.S. City Average, All-Items."* December, 2014. Web. 27 Jan. 2015. <http://www.bls.gov/cpi/tables.htm>

[13] Hoeve, John E. Ten, and Mark Z. Jacobson. *Worldwide Health Effects of the Fukushima Daiichi Nuclear Accident.* Energy & Environmental Science 5.9: 8743-8757. Web.

[14] Ibid

[15] In contrast, a report released by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) stated that "no radiation-related deaths or acute diseases have been observed among the workers and general public exposed to radiation from the accident." The committee did not expect any discernable increases in cancer incidence due to radiation exposure. [United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2013). Sources, effects and risks of ionizing radiation: UNSCEAR 2013 Report to the General Assembly with Scientific Annexes. Volume I, Scientific Annex A. 2014. Web. 27 Jan. 2015. <http://www.unscear.org/docs/reports/2013/13-85418_Report_2013_Annex_A.pdf>]

[16] Nuclear Energy Institute. *TEPCO Guidelines Outline Compensation for Accident*" 31 August 2011. Web. 27 Jan. 2015. <http://safetyfirst.nei.org/japan/tepco-guidelines-outline-compensation-for-accident/>

NUREG-1530, "Reassessment of NRC's Dollar per Person-REM Conversion Factor Policy," (December 1995) provides the NRC's estimate for the value of a statistical life (VSL) ($3 million in 2013 dollars).[17] Using this estimate, the value associated with reducing the cancer mortalities expected to be caused by the Fukushima Dai-ichi event (according to the Hoeve and Jacobson study) would be between $45 million and $3.9 billion. Other Federal agencies use a higher VSL. The U.S. Department of Transportation's (DOT's) VSL is currently $9.2 million (in 2013 dollars).[18] Using the DOT's estimate, the value associated with reducing the cancer mortalities expected to result from the Fukushima Dai-ichi event would be between $138 million and $12 billion.

Using the total undiscounted cost for Option 2, which is the proposed rulemaking ($120 million undiscounted), and dividing by the NRC's VSL, the proposed rule would have to prevent the accidental deaths resulting from radiation exposure from a Fukushima-type accident of approximately 31 individuals. Using the DOT's VSL, the proposed rule would have to prevent the accidental deaths of approximately 10 individuals. For an NPP accident similar to the one that occurred at the Fukushima plant, the benefits resulting from averted public health fatalities resulting from radiation exposure exceeded the cost of developing and implementing the proposed rule and implementing SAMGs-related activities.[19]

Exhibit 3-36. Break-Even Analysis Using Fatalities Reduction Metric

Source	Value of Statistical Life (2013 $mil)	Undiscounted 63-Year Cost of Proposed Rule (2013 $mil)	Number of Fatalities that Need to be Avoided	Annual Number of Fatalities that Need to be Avoided
	a	b	c = b ÷ a	d = c ÷ 63 years
NRC	$3.0	$94.0	31.0	0.5
DOT	$9.2	$94.0	10.0	0.2

*Results are rounded.

According to the American Nuclear Society (ANS), TEPCO monitored 14,841 TEPCO employees and contractors for external and internal doses throughout and following the accident (from March 2011 to July 2011).[20] The ANS states that the "total collective dose for all emergency workers is estimated to be 115 [person-sievert (Sv)]," or 11,500 person-REM.[21]

[17] The VSL is adjusted to 2013 dollars from $3 million in 1995 dollars, per United States Nuclear Regulatory Commission, *Reassessment of NRC's Dollar per Person-REM Conversion Factor Policy*, NUREG-1530, NRR, December 1995.

[18] United States Department of Transportation. *Guidance on the Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses – 2014 Adjustment*. 13 June 2014. Web. 27 Jan. 2015. <http://www.dot.gov/office-policy/transportation-policy/guidance-treatment-economic-value-statistical-life>

[19] This conclusion is based on two suppositions. The first assumption is that a similar result would have occurred if a U.S. NPP would have experience a Fukushima-type event. The second assumption is that after the post-Fukushima requirements are implemented should a severe event occur at a U.S. facility and if it results in a loss of ac electrical power, creating an extended SBO, the post-Fukushima features and strategies will successfully prevent the occurrence of any radiation exposure mortality.

[20] American Nuclear Society. *Fukushima Daiichi: ANS Committee Report: A Report by the American Nuclear Society Special Committee on Fukushima*. March 2012, Revised June 2012. Web. 5 June, 2014. <http://fukushima.ans.org/report/health-physics>.

[21] Ibid.

Using NRC's dollar-per-person-Roentgen equivalent man (REM) conversion factor of $2,000 per person-REM, the value associated with reducing these doses would be $23 million. Further, TEPCO committed to pay for annual ultrasound thyroid gland tests for every worker who has a radiation dose above the 100-millisievert (mSv) threshold for the rest of their lives; 1,973 workers would be eligible for this service.[22] The average cost for an ultrasound thyroid gland test is $244.[23,24] However cost of in-network procedures can vary by over 400 percent due to factors such as where the care is provided.

Some researchers estimated that TEPCO will pay up to $54 billion to buy up all land within 20 kilometers of the plant. In addition, 2012 research indicated that TEPCO may pay $7.9 billion for compensation payments to local residents.[25,26] More recent estimates have drastically increased the cost of compensating individuals to $45 billion.[27,28] There are significant costs related to onsite property damage as well. According to one estimate, the onsite property costs at the Fukushima Dai-ichi site (i.e., to decommission the Fukushima Dai-ichi reactors) total between $9.2 and $190 billion.[29] More recent research estimates that the cost to decommission the Fukushima reactors would total approximately $20 billion.[30,31]

The Fukushima Dai-ichi event also caused considerable damage to the environment. The National Institute of Advanced Industrial Science and Technology estimates that the cost to decontaminate the area may range from $31 billion to $57 billion.[32,33] This range results from

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[22] Gayathri, Amrutha. *Fukushima Nuclear Plant Workers Face Increased Thyroid Cancer Risk, Tepco Says.* International Business Times. 20 July 2013. Web. 27 Jan. 2015. <http://www.ibtimes.com/fukushima-nuclear-plant-workers-face-increased-thyroid-cancer-risk-tepco-says-1353999>.

[23] Healthcare Bluebook. *Neck Ultrasound*" Web. 27 Jan. 2015. <https://healthcarebluebook.com/page_ProcedureDetails.aspx?id=381&dataset=MD&g=Neck+Ultrasound>

[24] The price includes the amount for physician (interpretation) and technical (imaging) fees. The neck ultrasound includes the thyroid and the parathyroid. This is Healthcare Bluebook's fair price estimate; the fee that providers accept as payment from insurance companies.

[25] JCER Economic Research Department. *Impact to Last Decade or More if Existing Nuclear Plants Shut Down: GDP Could Drop 2% on Power Shortages*. Japan Center for Economic Research. 25 April 2011 Web. 27 Jan. 2015. <http://www.jcer.or.jp/eng/research/pdf/pe(iwata20110425)e.pdf>

[26] Purchasing land was estimated to cost 4.3 trillion in 2011 yen, compensating individuals was 0.63 trillion in 2011 yen, and decommissioning the nuclear reactor was 0.74 to 15 trillion in 2011 yen.

[27] The Japan Times. *Fukushima nuclear crisis estimate to cost ¥11 trillion: Study*. 27 August 2014. Web. 19 Nov. 2014. <http://www.japantimes.co.jp/news/2014/08/27/national/fukushima-nuclear-crisis-estimated-to-cost-%C2%A511-trillion-study/>

[28] Compensating individuals was estimated to be 4.91 trillion in 2014 yen. http://www.irs.gov/Individuals/International-Taxpayers/Yearly-Average-Currency-Exchange-Rates.

[29] JCER Economic Research Department. *Impact to Last Decade or More if Existing Nuclear Plants Shut Down: GDP Could Drop 2% on Power Shortages*. Japan Center for Economic Research. 25 April 2011 Web. 27 Jan. 2015. <http://www.jcer.or.jp/eng/research/pdf/pe(iwata20110425)e.pdf>

[30] The Japan Times. *Fukushima nuclear crisis estimate to cost ¥11 trillion: Study*. 27 August 2014. Web. 19 Nov. 2014. <http://www.japantimes.co.jp/news/2014/08/27/national/fukushima-nuclear-crisis-estimated-to-cost-%C2%A511-trillion-study/>

[31] The cost to decommission the reactor was estimated to be 2.17 trillion in 2014 yen.

[32] RT. *$58 billion: Fukushima Decontamination Outlay to Rise by Six Times*. 24 July 2014. Web. 27 Jan. 2015. <http://rt.com/news/fukushima-decontamination-tepco-cost-535/ >

[33] The cost for decontamination was estimated to be between 3.13 trillion in 2013 yen and 5.81 trillion in 2013 ye.

variations in the decontamination scenarios tested (e.g., turning over contaminated soil versus transporting the soil away) and the number of displaced residents that may return to the contaminated area. This includes costs for removing, transporting, and storing the radioactive waste found in the soil and water.[34] More recent research estimates that clean-up of the contaminated territories will cost $23 billion and storing the contaminated soil will cost approximately $9.6 billion.[35,36]

3.4.2 Benefits Associated with Regulatory Efficiency

Under Options 2 and 3, the NRC staff anticipates that the Order-related requirements would result in regulatory efficiency benefits. By placing the requirements in Order EA-12-049 and Order EA-12-051 into the NRC's regulations, they would enhance regulatory efficiency by applying the requirements to all current and future power reactor applicants, and provide regulatory clarity to operating reactors. Operating reactor licensees and two COL holder reactor sites currently are subject to the Order requirements. Any future licensees would not be covered by the Order requirements. In making the requirements of Order EA-12-049 generically-applicable, these options would also consider the reevaluated hazard information from the March 12, 2012, NRC letter issued under 10 CFR 50.54(f) as part of providing reasonable protection for mitigation strategies equipment for external flooding or seismic hazards.

In the absence of this proposed rule, these requirements would need to be implemented for new reactor sites through additional Orders or license conditions (as was done for the Virgil C. Summer and Vogtle COLs), which would impose additional costs on the NRC. The proposed rulemakings under Options 2 and 3 also would enhance regulatory efficiency by reflecting stakeholder feedback and lessons learned from the implementation of the Orders, including any challenges or unintended consequences associated with implementation.

3.5. Disaggregation

This section addresses the proposed rule provisions on a disaggregated basis. The NRC staff disaggregates the collection of provisions that result in incremental costs to industry. To address the guidance provided in Section 4.3.2 of NUREG/BR-0058, Revision 4, the NRC reviewed the incremental costs and benefits of each proposed provision to ensure that the aggregate analysis does not mask the inclusion of individual rule provisions that are not cost-beneficial when considered individually and not necessary to meet the goals of the rulemaking.

Exhibit 3-37 presents each proposed rule provision that results in incremental costs to industry and identifies the costs and benefits associated with the provision.

[34] Japan Daily Press. *Fukushima decontamination and cleanup estimated at $50 billion, five-times gov't budget*. 24 July 2013. Web. 27 Jan. 2015. <http://japandailypress.com/fukushima-decontamination-and-cleanup-estimated-at-50-billion-five-times-govt-budget-2432822/>

[35] The Japan Times. *Fukushima nuclear crisis estimate to cost ¥11 trillion: Study*. 27 August 2014. Web. 19 Nov. 2014. <http://www.japantimes.co.jp/news/2014/08/27/national/fukushima-nuclear-crisis-estimated-to-cost-%C2%A511-trillion-study/>

[36] The cost for the radiation cleanup work was estimated to be 2.48 trillion in 2014 yen and the cost to store contaminated soil was estimated to be 1.06 trillion in 2014 yen.

Exhibit 3-37: Disaggregation of Individual Requirements in the Proposed Rule

Proposed Rule Provision	Industry-wide Incremental Costs			Industry-wide Incremental Benefits
	One-Time Cost	Annual Cost	Present Value (7%)	
Section 50.155(b)(3): SAMGs	$13,000,000	$130,000	$14,000,000	• Provides DID to address uncertainty associated with beyond design basis events
Section 50.155(b)(4): Integration of Procedures	$1,200,000	N/A	$1,200,000	• Supports effective use of emergency procedures by ensuring that strategies and guidelines are useable and cohesive
Section 50.155(b)(6): Command and Control	$170,000	N/A	$170,000	• Ensures adequate command and control and communication for multi-unit events
Section 50.155(e): SAMGs Training	$13,000,000	$1,600,000	$32,000,000	• Allows for the effective use of mitigation strategies and guidelines by enhancing knowledge and abilities of personnel
Section 50.155(f): SAMGs Drills/Exercises	$1,900,000	$200,000	$3,600,000	• Allows demonstration and evaluation of the licensee's capability to execute the integrated response capability
Section 50.155(g): SAMGs Change Control	$880,000	$510,000	$6,800,000	• Maintains the effectiveness of SAMGs over time

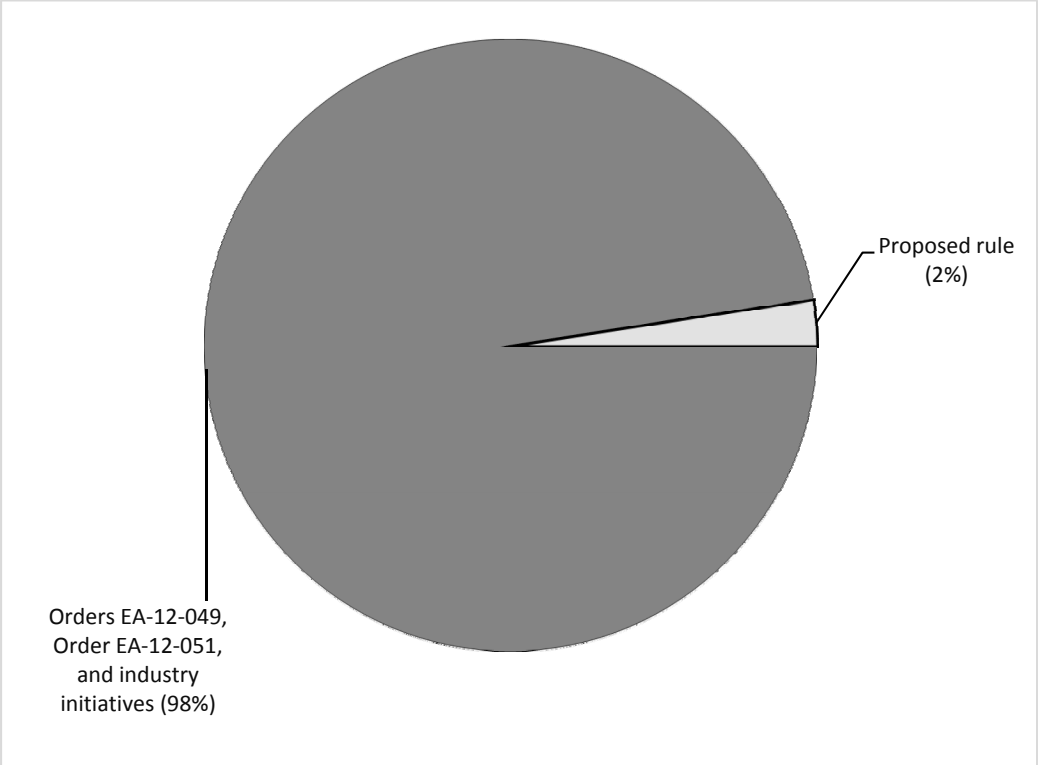
*Results are rounded.
**The annual cost data represents the per year costs incurred by sites during their operating license term.

For a discussion of the benefits of the proposed rule provisions, refer to Section 3.4 of this regulatory analysis. When disaggregated, the proposed rule provisions' qualitative benefits fully justify the costs incurred.

3.6. Sensitivity Analysis

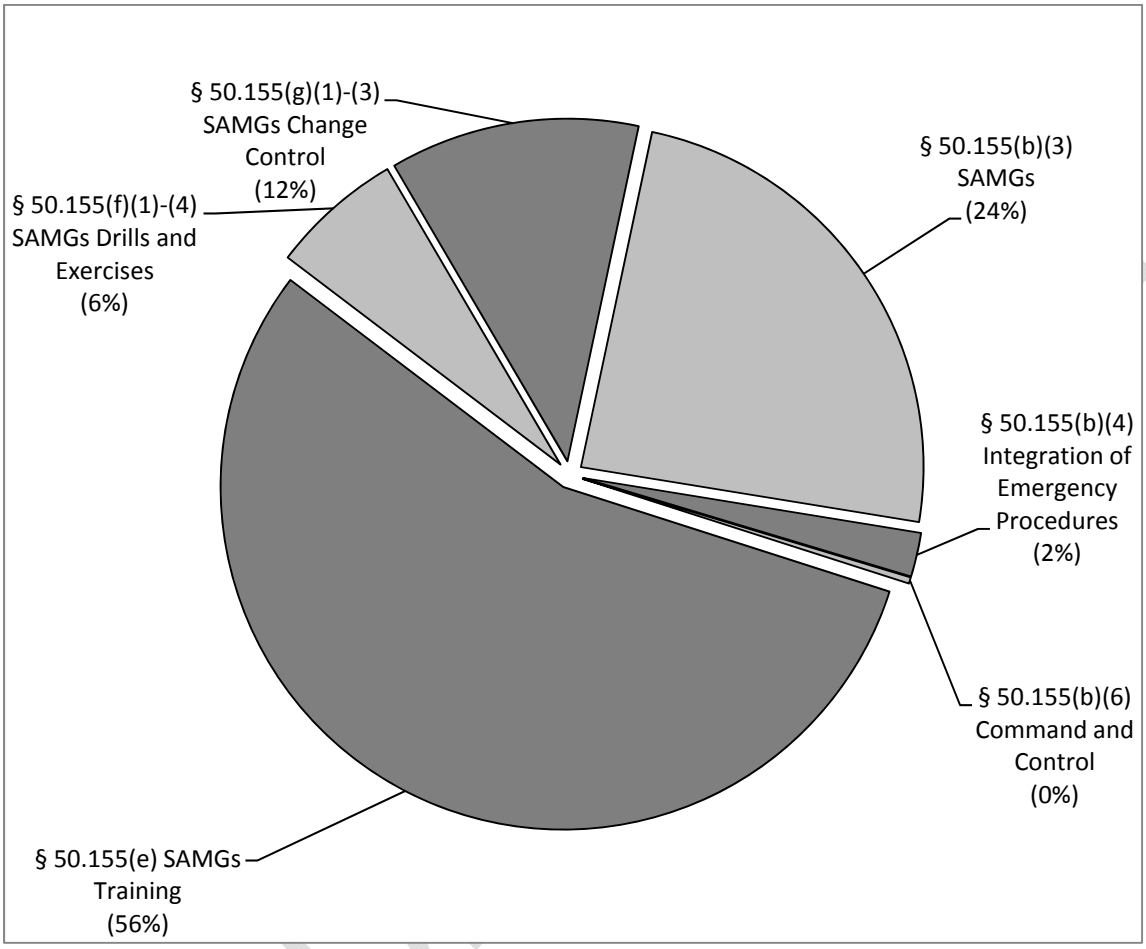
In this section, the NRC staff examines how industry costs change due to uncertainties associated with the staff's analytical assumptions and input data. Using the approach outlined in Section 3.3, the incremental cost that would be incurred by industry as a result of the proposed rule (i.e., SAMGs-related costs) account for 2 percent of total costs when considered in conjunction with the estimated costs of Order EA 12-049, Order EA-12-051, and related industry initiatives, as shown in Figure 3-1.

Figure 3-1. Estimated Industry Cost of the Proposed Rule, Order EA-12-049, Order EA-12-051, and Industry Initiatives (Present Value, 7%)



The NRC staff estimated the SAMGs-related costs by rule provision, as shown in Figure 3-2. SAMGs training requirements in proposed 10 CFR 50.155(e) account for the greatest share of total industry costs. The requirements for site-specific SAMGs in proposed 10 CFR 50.155(b)(3) are the next most costly, followed by the SAMGs change control requirements in proposed 10 CFR 50.155(g)(1)-(3). The proposed requirements in 10 CFR 50.155(f)(1)-(4) (drills or exercises); 10 CFR 50.155(b)(4) (integration of emergency procedures); and 10 CFR 50.155(b)(6) (command and control) are the least costly provisions.

Figure 3-2. Total Present Value of Industry Cost by Rule Provision (7%)



To determine how sensitive these costs are to the assumptions used in the analysis, the NRC staff evaluated the impact that selected assumptions and input data have on the cost estimates in each proposed rule provision. The NRC staff identified a selection of input data for which there is uncertainty and varied the input values by 10 percent, 50 percent, and 100 percent to assess the impact on costs. Exhibit 3-38 presents the results of the sensitivity analysis. The following sections discuss these results for the 10 percent case.

Exhibit 3-38. Sensitivity Analysis Results

	+10% in Input			+50% in Input			+100% in Input		
Input	**Added Cost**	**% Incr. (§)**	**% Incr. (Rule)**	**Added Cost**	**% Incr. (§)**	**% Incr. (Rule)**	**Added Cost**	**% Incr. (§)**	**% Incr. (Rule)**
Section 50.155(b)(3) SAMGs									
LOE to maintain site-specific SAMGs	$150,000	1%	0%	$750,000	5%	1%	$1,500,000	10%	3%
Section 50.155(b)(4) Integration of Emergency Procedures									
LOE to confirm integration with EOPs	$120,000	10%	0%	$590,000	50%	1%	$1,200,000	100%	2%
Section 50.155(b)(6) Command and Control									
LOE to revise command and control procedures	$17,000	10%	0%	$86,000	50%	0%	$170,000	100%	0%
Section 50.155(e) SAMGs Training									
Contractor cost to develop training materials	$1,300,000	4%	2%	$6,500,000	20%	11%	$13,000,000	41%	22%
# of UDMs and NLOs attending in training	$1,000,000	3%	2%	$5,000,000	16%	9%	$10,000,000	31%	17%
Training time (UDMs and NLOs)	$1,000,000	3%	2%	$5,000,000	16%	9%	$10,000,000	31%	17%
LOE to document and update training	$790,000	2%	1%	$4,000,000	13%	7%	$7,900,000	25%	14%
Section 50.155(f)(1)-(4) SAMGs Drills and Exercises									
# of UDMs and NLOs participating in drills/exercises	$150,000	4%	0%	$770,000	21%	1%	$1,500,000	41%	3%
Time spent in drills and exercises	$150,000	4%	0%	$770,000	21%	1%	$1,500,000	41%	3%
Section 50.155(g)(1)-(3) SAMGs Change Control									
LOE to update site specific SAMGs	$580,000	8%	1%	$2,900,000	42%	5%	$5,800,000	85%	10%
TOTAL	**$5,300,000**	**N/A**	**9%**	**$26,000,000**	**N/A**	**45%**	**$53,000,000**	**N/A**	**91%**

*This table reports the present value of all costs using a 7% discount rate. Results are rounded.

Section 50.155(b)(3): SAMGs

Proposed 10 CFR 50.155(b)(3) would impose costs on licensees to develop, implement, and maintain site-specific SAMGs. All of the industry costs for this provision are based on labor costs to perform the identified activities. The NRC staff estimated the LOE required across five labor categories (i.e., executive, manager, staff, clerical, and licensing) for each required activity. To inform the cost estimates for the *development* of site-specific BWR and PWR SAMGs, the NRC staff considered stakeholder feedback provided in response to the Onsite Emergency Response Capabilities Advance Notice of Proposed Rulemaking (77 FR 23161). In contrast, the costs associated with *maintaining* SAMGs over time are based on the NRC staff's professional judgment.

The sensitivity analysis shows that by increasing the LOE input values used to develop the cost estimate for maintaining site-specific SAMGs by 10 percent, the total discounted industry cost of the proposed rule would increase by $150,000, or less than 0.5 percent.

Section 50.155(b)(4): Integration of Emergency Procedures

Proposed 10 CFR 50.155(b)(4) would impose costs on licensees to review their FSGs, EDMGs, and SAMGs to confirm that there is adequate integration with the EOPs. The cost estimate for this proposed provision is based on labor costs to perform this review. For this activity, the NRC staff used professional judgment to develop the LOE estimates across five labor categories (i.e., executive, manager, staff, clerical, and licensing).

The NRC staff found that a 10 percent increase in the LOE assumptions would increase the total discounted industry cost of the proposed rule by $120,000, or less than 0.5 percent.

Section 50.155(b)(6): Command and Control

Proposed 10 CFR 50.155(b)(6) would require licensees to revise procedures to document the supporting organizational structure for directing and performing the FSGs, EDMGs, and SAMGs. The cost associated with this activity is a function of staff time needed to document the information. For this activity, the NRC staff used professional judgment to develop the LOE estimates across five labor categories (i.e., executive, manager, staff, clerical, and licensing).

The sensitivity analysis shows that by increasing the LOE input values by 10 percent, the total discounted industry cost of the proposed rule would increase by $17,000, or less than 0.5 percent.

Section 50.155(e): SAMGs Training

Proposed 10 CFR 50.155(e) would require licensees to develop training materials, train staff, document training attendance, and update training materials.

The NRC staff assumed that training materials would be developed by a contractor. The sensitivity analysis shows that by increasing the contractor cost associated with developing training materials by 10 percent, the total discounted industry cost of the proposed rule would increase by $1.3 million, or approximately 2 percent.

The cost associated with training attendance is a function of number of individuals trained and amount of time spent in training. The NRC staff used professional judgment to determine the number of UDMs and NLOs requiring training in SAMGs, and the number of training hours needed by each. The NRC staff found that increasing the number of individuals requiring training or time spent in training by 10 percent would each increase the total discounted industry cost of the proposed rule by $1 million, or approximately 3 percent.

The NRC staff developed the cost imposed by documenting training attendance and updating training materials based on LOE estimates. The NRC staff found that increasing the LOE assumptions by 10 percent would increase the total discounted industry cost of the proposed rule by $790,000, or approximately 2 percent.

Section 50.155(f)(1)-(4): SAMGs Drills or Exercises

Proposed 10 CFR 50.155(f)(1)-(4) would require licensees to perform SAMGs drills or exercises. The cost of drills or exercises is a function of the number of individuals participating and the time required to participate. The NRC staff developed assumptions for both the number of participants and time needed based on professional judgment. The sensitivity analysis shows that increasing the number of individuals participating in drills or exercises or time spent on these activities by 10 percent would each increase the total discounted industry cost by $150,000, or less than 0.5 percent.

Section 50.155(g)(1)-(3): SAMGs Change Control

Proposed 10 CFR 50.155(g)(1)-(3) would require licensees to update site-specific SAMGs over time. The cost associated with updating site-specific SAMGs is a function of staff time needed to analyze and document changes to the guidelines. For this activity, the NRC staff used professional judgment to develop the LOE estimates across five labor categories (i.e., executive, manager, staff, clerical, and licensing).

The NRC staff found that increasing the LOE assumptions by 10 percent would increase the total discounted industry cost of the proposed rule by $580,000, or approximately 1 percent.

In total, these changes in inputs across the SAMGs-related requirements would increase the total discounted industry cost of the proposed rule by $5.3 million, or approximately 9 percent. Under these adjusted assumptions, there is no discernable change in the incremental cost that would be incurred by industry as a result of the proposed rule (i.e., SAMGs-related costs) when considered in conjunction with the estimated costs of Order EA 12-049, Order EA-12-051, and related industry initiatives (i.e., the share of costs attributable to proposed rule remains 2 percent, while historical costs account for 98 percent, as shown in Figure 3-1).

4. Decision Rationale for Selection of Proposed Action

The NRC staff rejects Option 1, the no action alternative, because it would not achieve the NRC's objectives as stated in Section 1.2.

As a result, this decision rationale focuses on Option 2 and Option 3, discussed in Section 2.2 and 2.3, respectively. Option 2 is to undertake rulemaking to require SAMGs and make Order EA-12-049, Order EA-12-051, including the associated regulatory actions implemented in

conjunction with the orders, generically applicable. Option 3 is the same as Option 2 but removes the SAMGs-related requirements from the rulemaking.

Because the regulatory scope of Option 2 includes the scope set forth in Order EA-12-049, Order EA-12-051, NEI 12-06, Rev. 0, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, (which is the industry's NRC-endorsed guidance document describing one acceptable approach for complying with Order EA-12-049), and other post-Fukushima regulatory actions, the total incremental cost of Option 2 under the no action baseline largely represents the costs associated with the new regulatory requirements for licensees to develop, implement, and maintain SAMGs, as well as the NRC's rulemaking-related costs (Ref. 3).

Recent work by the NRC indicates that the use of SAMGs would result in minimal benefits to public health and safety (see Section 3.4). While the NRC recognizes that available quantitative risk information indicates that SAMGs have a small safety benefit, this information is not a complete measure of SAMG safety benefits. The NRC concludes that SAMG requirements would result in a substantial additional protection for public health and safety based on the qualitative reasons stated in Appendix A to this draft regulatory analysis. Specifically, SAMGs directly support maintenance of containment integrity following severe accidents, and indirectly support the protective action recommendations made by the emergency response organization in such circumstances, and as such, the SAMGs have a very important link to two foundational parts of the NRC's defense-in-depth framework: containment, and emergency preparedness. The proposed SAMGs requirements would ensure that operators and decision makers have an updated set of guidelines to use following the onset of core damage. The availability of updated SAMGs would provide pre-planned guidelines for the best use of all available resources to mitigate an accident.

Relative to the no action alternative baseline, the NRC staff considers SAMGs to be a substantial additional protection for defense-in-depth (i.e., satisfy 10 CFR 50.109(a)(3)). Based on the NRC assessment of the costs and benefits of the proposed rule, the agency has concluded that the proposed rule is justified.

4.1 Safety Goal Evaluation

Safety goal evaluations apply only to regulatory initiatives considered to be generic safety enhancement backfits subject to the substantial additional protection standard at 10 CFR 50.109(a)(3). The SAMGs-related provisions in the proposed rule qualify as backfits.

A safety goal evaluation is intended to eliminate proposed regulatory requirements in cases where the residual risk is already acceptably low. As discussed earlier, NRC staff found that the quantitative benefit of SAMGs to public health and safety likely would not approach thresholds that would justify the costs of the proposed rule (because the low risk of events leading to severe accidents).

While the NRC recognizes that available quantitative risk information indicates that SAMGs have a small safety benefit, this information is not a complete measure of SAMG safety benefits. The NRC concludes that SAMG requirements would result in a substantial additional protection for public health and safety based on the qualitative reasons stated in Appendix A to this draft regulatory analysis. Specifically, SAMGs directly support maintenance of containment integrity following severe accidents, and indirectly support the protective action recommendations made by the emergency response organization in such circumstances, and as such, the SAMGs have

a very important link to two foundational parts of the NRC's defense-in-depth framework: containment, and emergency preparedness. As discussed in detail in Appendix A (Backfitting and Issue Finality), the NRC staff considers SAMGs to be a substantial additional protection for defense-in-depth (i.e., satisfy 10 CFR 50.109(a)(3)). Based on the NRC assessment of the costs and benefits of the proposed rule, the agency has concluded that the SAMGs-related requirements are justified. Therefore, a safety goal evaluation is not appropriate for the proposed rule.

4.2 Committee to Review Generic Requirements (CRGR)

This section addresses regulatory analysis information requirements for rulemaking actions or staff positions subject to review by the Committee to Review Generic Requirements (CRGR). All information called for by the CRGR charter is presented in this regulatory analysis, or in the *Federal Register* notice for the proposed rule. As a reference aid, Table 4-1 provides a cross-reference between the relevant information and its location in this document or the *Federal Register* notice.

Exhibit 4-1. Specific CRGR Regulatory Analysis Information Requirements

CRGR Charter Citation (Ref. 27)	Information Item to be Included in a Regulatory Analysis Prepared for CRGR Review	Where Item is Discussed
Appendix C, (i)	Proposed generic requirement or staff position as it is proposed to be sent out to licensees.	Proposed rule text in *Federal Register* notice.
Appendix C, (ii)	Draft papers or other documents supporting the requirements or staff positions.	*Federal Register* notice for the proposed rule.
Appendix C, (iii)	The sponsoring office's position on each proposed requirement or staff position as to whether the proposal would modify requirements or staff positions, implement existing requirements or staff positions, or relax or reduce existing requirements or staff positions.	Regulatory Analysis, Section 3.2 and Backfit Analysis, Appendix A.
Appendix C, (iv)	The proposed method of implementation.	*Federal Register* notice for the proposed rule.
Appendix C, (vi)	Identification of the category of power reactors, new reactors, or nuclear materials facilities or activities to which the proposed generic requirement or staff position is applicable.	Regulatory Analysis, Section 3.1.
Appendix C (vii) - (viii)	If the proposed action involves a power reactor backfit and the exceptions at 10 CFR 50.109(a)(4) are not applicable, the items required at 10 CFR 50.109(c) and the required rationale at 10 CFR 50.109(a)(3) are to be included (Ref. 5).	Backfit Analysis, Appendix A.

CRGR Charter Citation (Ref. 27)	Information Item to be Included in a Regulatory Analysis Prepared for CRGR Review	Where Item is Discussed
III.	For proposed generic relaxations or decreases in current requirements or staff positions, provide a determination along with the rationale that (a) the public health and safety and the common defense and security would be adequately protected if the proposed relaxations were implemented and (b) the cost savings attributed to each action would be significant enough to justify the action.	*Federal Register* notice for the proposed rule.
Appendix C (xi)	Preparation of an assessment of how the proposed action relates to the Commission's Safety Goal Policy Statement (Ref. 21).	Regulatory Analysis, Section 4.1.

Source: U.S. Nuclear Regulatory Commission, "Charter: Committee to Review Generic Requirements," Revision 8, March 2011, ADAMS Accession No. ML110620618 (Ref. 21).

References

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

2. U.S. Nuclear Regulatory Commission, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," Order EA-12-051, March 12, 2012, ADAMS Accession No. ML12054A682.

3. *U.S. Code of Federal Regulations*, "Domestic Licensing of Production and Utilization Facilities," Part 50, and "License, Certifications, and Approvals for Nuclear Power Plants," Part 52, Chapter I, Title 10, "Energy."

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

5. Executive Order 12866. "Regulatory Planning and Overview." 58 Fed. Reg. 190. September 30, 1993.

6. U.S. Nuclear Regulatory Commission, "Staff Requirements-COMGBJ-11-0002 – NRC Actions following the Events in Japan*,"* Commission Paper SRM-COMGBJ-11-0002 dated March 23, 2011, ADAMS Accession No. ML110820875.

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

8. U.S. Nuclear Regulatory Commission, "Staff Requirements – SECY-11-0124 – Recommended Actions to be Taken Without Delay From the Near Term Task Force Report," Commission Paper SRM-SECY-11-0124, October 18, 2011, ADAMS Accession No. ML112911571.

9. U.S. Nuclear Regulatory Commission, "Staff Requirements – SECY-11-0137 – Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SRM-SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11269A204.

10. U.S. Nuclear Regulatory Commission, "Staff Requirements – 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," Commission Paper SRM-SECY-12-0025 dated March 9, 2012, ADAMS Accession no. ML120690347.

11. U.S. Nuclear Regulatory Commission, "Staff Requirements – SECY-14-0046 – Enclosure 6 – Proposal to Consolidate Post-Fukushima Rulemaking Activities" Commission Paper SECY-14-0046 Enclosure 6, April 17, 2015, ADAMS Accession No. ML14064A544.

12. U.S. Nuclear Regulatory Commission, "Staff Requirements – COMSECY-13-0002 – Consolidation of Japan Lessons Learned Near-Term Task Force Recommendations 4 and 7 Regulatory Activities," Commission Paper SRM-COMSECY-13-0002, March 4, 2013, ADAMS Accession No. ML13063A548.

13. Nuclear Energy Institute document 14-01, "Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents," Revision 0, March 2014, ADAMS Accession No. ML14049A005.

14. U.S. Nuclear Regulatory Commission, "Interim Staff Guidance 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," Revision 0, August 29, 2012, ADAMS Accession No. ML12229A174.

15. Nuclear Energy Institute document 13-06, "Enhancements to Emergency Response Capabilities for Beyond Design Basis Accidents and Events," Revision 0, March 2014, ADAMS Accession No. ML14049A002.

16. U.S. Nuclear Regulatory Commission, "NRC Inspection Manual – Temporary Instructions 2515/184 – Availability and Readiness Inspection of Severe Accident Management Guidelines (SAMGs)," April 29, 2011, ADAMS Accession No. ML11115A053.

17. U.S. Nuclear Regulatory Commission, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," NUREG/BR-0058, Rev. 4, September 2004, ADAMS Accession No. ML042820192.

18. U.S. Nuclear Regulatory Commission, "Generic Cost Estimates," NUREG/CR-4627, Rev. 2. January 1992, ADAMS Accession No. ML13137A259.

19. U.S. Nuclear Regulatory Commission, "2014-2015 U.S. NRC Information Digest," NUREG-1350, vol. 26, August 2014, ADAMS Accession No. ML13143A321.

20. U.S. Nuclear Regulatory Commission, "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," Order EA-13-109, June 6, 2013, ADAMS Accession No. ML12054A736.

21. U.S. Nuclear Regulatory Commission, "Charter, Committee to Review Generic Requirements," Revision 8, March 2011, ADAMS Accession No. ML110620618.

Appendix A: Backfitting and Issue Finality

This Appendix presents the NRC staff's analysis of backfitting and issue finality under the proposed rule. Section A.1 presents the backfitting and issue finality analysis of the requirements that make Order EA-12-049 and Order EA-12-051 generically applicable. These provisions do not constitute backfits and are consistent with issue finality.[37] Section A.2 provides the NRC staff's analysis of backfitting and issue finality for the remaining proposed rule requirements associated with codifying voluntary industry initiatives and SAMGs. These provisions constitute a backfit, but are consistent with issue finality.

A.1 Rule Provisions that Do Not Constitute Backfits

The requirements in the proposed rule that make Order EA-12-049 and Order EA-12-051 generically applicable do not qualify as backfits. Appendix B to the regulatory analysis evaluates the costs of these provisions (i.e., the historical cost analysis). This section discusses why these regulatory requirements do not constitute backfits. Due to differences in the application of the backfit rule to licensees, entities with existing design certifications (DCs), and future applicants for COLs, DCs, manufacturing licenses (MLs), and standard design approvals (SDAs), the NRC staff addresses each class separately.

Existing Licensees

The NRC's backfit provisions for holders of operating licenses and construction permits (CPs) are found in the regulations at 10 CFR 50.109, which defines backfitting as:

> [T]he modification of or addition to systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct or operate a facility; any of which may result from a new or amended provision in the Commission's regulations or the imposition of a regulatory staff position interpreting the Commission's regulations that is either new or different from a previously applicable staff position […].

The NRC staff determined the requirements in the proposed rule that would make generically applicable the requirements in Order EA-12-049, Order EA-12-051, and the supporting guidance as applied to existing licensees to whom Order EA-12-049 and Order EA-12-051 were directed, would not constitute a new instance of backfitting under 10 CFR 50.109, or an additional inconsistency with the issue finality provisions applicable to holders of COLs in 10 CFR 52.98. Any backfitting and issue finality issues for this rulemaking were addressed as part of the issuance of Order EA-12-049, Order EA-12-051, and the associated guidance. The proposed requirements limited to mitigation measures in Order EA-12-049, SFP level instrumentation requirements in Order EA-12-051, and associated guidance (e.g., NEI 12-06) would introduce no new backfitting and issue finality matters apart from those addressed in the underlying Orders and guidance. Therefore, the NRC's consideration of backfitting and issue finality matters for the Orders and the associated guidance also serves as the NRC's

[37] In 10 CFR Part 50, Appendix E, Section VI., the proposed rule removes references to the use of modems in order to make the ERDS requirements technology-neutral. The NRC considers this revision a minor administrative change to make the NRC's regulatory requirements consistent with a technological initiative that has already been implemented by industry. Therefore, this proposed requirement is justified under the backfit rule.

consideration of the same backfitting and issue finality matters for the proposed rule with respect to mitigation measures and SFP level instrumentation.

Existing Design Certifications

The issues that may be resolved in a DC and accorded issue finality may not include operational matters, such as the mitigating strategies and SFP level instrumentation that would be required under the proposed rule. Therefore, these elements of the proposed rule are consistent with the issue finality provision in 10 CFR 52.63.

Current and Future Applicants

Applicants and potential applicants (of licenses, permits and regulatory approvals, such as DCs) 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 that substantially changes the expectations of current and future applicants.

The exceptions to this general principle may apply when an applicant references a Part 52 license (e.g., an early site permit) and/or NRC regulatory approval (e.g., a DC rule) with specified issue finality provisions. The issues which are resolved in an early site permit or a DC and accorded issue finality may not include operational matters, such as the mitigating strategies and SFP level instrumentation that would be required under the proposed rule. Therefore, the proposed rule provisions limited to mitigation strategies and SFP level instrumentation likely would be consistent with the issue finality provisions applicable to early site permits and DCs. In addition, because the issues that are resolved in an early site permit or a DC and accorded issue finality may not address mitigating strategies and SFP level instrumentation, a COL applicant referencing either an early site permit or DC may not be protected by the issue finality provision applicable to COL applicants (10 CFR 52.83) with respect to compliance with a rule setting forth requirements for mitigation strategies and SFP level instrumentation.

A.2 Backfit Analysis of Rule Provisions that Constitute Backfits

The following requirements in the proposed rule qualify as backfits. Section 3 of the regulatory analysis quantitatively estimates the incremental costs and benefits of these provisions.

- Emergency communication and staffing evaluations. The proposed rule includes requirements for conducting staffing analyses and communications system assessments. These proposed requirements are based on the NRC's information requests pursuant to 10 CFR 50.54(f) and NRC-endorsed guidance in NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, and NEI 12-01, *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities*. Industry analyses and efforts that meet this guidance would satisfy the requirements of the proposed rule. Because the NRC does not anticipate any further costs associated with the communications and staffing evaluations for power reactor licensees and applicants, these requirements are justified under the backfit rule.

- Multi-source dose assessment. The proposed rule includes a requirement for licensees to establish the capability to perform offsite dose assessments during an event involving concurrent radiological releases from all onsite units and SFPs, and for multiple release points. Industry is currently voluntarily implementing multi-source dose assessment. Although incorporation of these widespread industry practices are considered backfits, the proposed rule requirements would not impose any incremental costs on licensees because of the efforts undertaken by industry in the baseline. Because the NRC does not anticipate any further costs associated with the multi-source dose assessment requirements for power reactor licensees and applicants, these requirements are justified under the backfit rule.

- SAMGs and supporting requirements (e.g., SAMG-related training, drills and exercises, command and control, change control). The remainder of this section discusses the backfitting issues related to SAMGs and their supporting requirements. Due to differences in the application of the backfit rule to licensees, entities with existing DCs, and future applicants for COLs, DCs, MLs, and SDAs, the NRC staff addresses each class separately.

Existing Licensees

The NRC previously considered the need to require SAMGs. This effort is relevant to the backfit analysis for this proposed rule because the NRC determined that severe accident risk was not at a level that would warrant regulatory action for adequate protection of public health and safety. The following section provides background on these deliberations. Following the background, the NRC staff provides the basis for reconsidering the need to impose SAMGs requirements.

Background: Previous Commission Deliberations Related to this Backfitting Consideration

The Severe Accident Policy Statement was issued in 1985 (50 FR 32138) and it describes the Commission's policy to resolve safety issues for events more severe than design basis accidents. While the main focus is on the criteria and procedures the Commission uses to certify new reactor designs, the policy also provided guidance on decision and analytical procedures for the resolution of severe accident issues for existing plants.

In this policy statement, the Commission states with regard to existing plants:

> On the basis of currently available information, the Commission concludes that existing plants pose no undue risk to public health and safety and sees no present basis for immediate action on generic rulemaking or other regulatory changes for these plants because of severe accident risk.

Later the policy states:

> Should significant new safety information become available from whatever source to question the conclusion of "no undue risk" then the technical issues this identified would be resolve by the NRC under its backfit policy and other existing procedures, including the possibility of generic rulemaking where this is justified.

In section C "Policy for Existing Plants" the Commission provides more detailed guidance:

> In light of the above principles and conclusions, the Commission's policy for operating reactors includes the following guidance:
>
> Operating nuclear power plants require no further regulatory action to deal with severe accident issues unless significant new safety information arises to question whether there is adequate assurance of no undue risk to public health and safety.
>
> In the latter event, a careful assessment shall be made of the severe accident vulnerability posed by the issue and whether this vulnerability is plant or site specific or of generic importance.
>
> The most cost-effective options for reducing this vulnerability shall be identified and a decision shall be reached consistent with the cost effectiveness criteria of the Commission's backfit policy as to which option or set of options (if any) are justifiable and required to be implemented.
>
> In those instances where the technical issue goes beyond current regulatory requirements, generic rulemaking will be the preferred solution. In other cases, the issue should be disposed of through the conventional practice of issuing bulletins and Orders or generic letters where modifications are justified through backfit policy, or through site-specific decision making along the lines of the Integrated Safety Assessment Program (ISAP) conception.
>
> Recognizing that plant-specific PRAs have yielded valuable insight to unique plant vulnerabilities to severe accidents leading to low-cost modifications, licensees of each operating reactor will be expected to perform a limited-scope, accident safety analysis designed to discover instances (i.e., outliers) of particular vulnerability to core melt or to unusually poor containment performance, given core melt accidents. These plant-specific studies will serve to verify that conclusions developed from intensive severe accident safety analyses of reference or surrogate plants can be applied to each of the individual operating plants. During the next two years, the Commission will formulate a systematic approach, including the development of guidelines and procedural criteria, with an expectation that such an approach will be implemented by licensees of the remaining operating reactors not yet systematically analyzed in an equivalent or superior manner.

In 1986, the Safety Goal Policy was issued and has several relevant statements concerning impositions of SAMGs as requirements:

> Severe core damage accidents can lead to more serious accidents with the potential for life-threatening offsite release of radiation, for evacuation of members of the public, and for contamination of public property. Apart from their health and safety consequences, severe core damage accidents can erode public confidence in the safety of nuclear power and can lead to further instability and unpredictability for the industry. In order to avoid these adverse consequences, the Commission intends to continue to pursue a regulatory program that has as its objective providing reasonable assurance, while giving

> appropriate consideration to the uncertainties involved, that a severe core damage accident will not occur at a U.S. NPP.
>
> The Commission recognizes the importance of mitigating the consequences of a core-melt accident and continues to emphasize features such as containment, siting in less populated areas, and emergency planning as integral parts of the DID concept associated with its accident prevention and mitigation philosophy.

An "Integration Plan" for closure of severe accident issues (SECY-88-147, dated May 25, 1988) was developed to integrate and close severe accident issues. This plan included a program to ensure that licensees develop and implement severe accident management programs at their plants. In SECY-89-12, "Staff Plans for Accident Management Regulatory and Research Programs," the NRC staff described the goals, framework, and elements of NRC's accident management program, which evolved into SAMGs. In SECY-89-12, the staff describes accident management as follows:

> Accident Management encompasses those actions taken during the course of an accident by the plant operation and technical staff to: (1) prevent core damage, (2) terminate the progress of core damage if it begins and retain the core within the reactor vessel, (3) maintain containment integrity as long as possible, and (4) minimize offsite releases. Accident management, in effect extends the DID principle to plant operating staff by extending the operating procedures well beyond the plant design basis into severe fuel damage regimes, with the goal of taking advantage of existing plant equipment and operator skills and creativity to find ways to terminate accidents beyond the design basis or to limit offsite releases.

Regarding the importance of accident management to safety, SECY-89-12 states:

> The NRC staff has concluded, based upon PRAs and severe accident analyses, that the risk associated with severe core damage accidents can be further reduced through effective accident management. In this context, effective accident management would ensure that optimal and maximum safety benefits are derived from available, existing systems and plant operating staff through pre-planned strategies. Furthermore, the International Nuclear Safety Advisory Group (INSAG) in its report on Basic Safety Principles for Nuclear Power Plants concluded that accident management and mitigation measures can significantly reduce risk. Accordingly, accident management is considered to be an essential element of the severe accident closure process described in the Integration Plan for Closure of Severe Accident Issues (SECY-88-147) and the Generic Letter on the Individual Plant Examination (Generic Letter 88-20).

GL 88-20 supplement 2 was issued on April 4, 1990, and in the summary it states:

> Over the past several years, the NRC has performed and reviewed numerous probabilistic risk assessments (PRAs) and severe accident studies. From this experience, it has become evident that it is possible to implement certain actions, or accident management strategies, that have significant potential for recovering from a wide variety of accident scenarios. These accident management strategies typically involve the use of equipment that already exists at plants.

> The NRC staff has compiled a list of such accident management strategies. The purpose of this letter is to forward these strategies to industry so that licensees can evaluate these or similar strategies for applicability and effectiveness at each of their plants as part of conducting the Individual Plant Examination (IPE) called for in Generic Letter 88-20: "Individual Plant Examination for Severe Accident Vulnerabilities." This generic letter supplement also transmits for information the enclosed NUREG/CR-5474, which contains a technical assessment of these accident management strategies.
>
> This generic letter supplement does not establish any requirements for licensees to take the specific accident management strategies into account as part of the IPE or to implement any of the strategies. Adoption on the part of a licensee of any accident management strategies in response to this supplement *is voluntary*. (emphasis added)

The SAMGs were strictly voluntary. Between 1989 and 1998, following the issuance of this GL, there were yearly progress reports to the Commission on the status of implementation of the Integration Plan. SAMGs implementation at licensee facilities was completed at the end of 1998.

Conclusions Drawn from Previous Commission Deliberations on SAMGs

1. Severe accident risk was not viewed by the Commission to be at a level that would warrant regulatory action for adequate protection of public health and safety (1985 severe accident policy statement).

    a. SAMGs, which are the guideline set used by licensee personnel to mitigate the consequences of events and accidents after the onset of core damage, as a direct result, also would not be considered necessary for adequate protection of public health and safety to mitigate severe accident risk .e., if that were the case, then new SAMG requirements would have been immediately imposed) . Accordingly, SAMGs were not imposed as requirements on licensees. This remains the position today (prior to the current rulemaking).

2. Industry, through a voluntary initiative, involving the Electric Power Research Institute (EPRI), owners groups, NUMARC (now NEI) and the licensees implemented SAMGs by the end of 1998, with full cognizance and agreement of the Commission.

3. SAMGs were viewed as being significant in terms of enhancing safety but the NRC never quantified this benefit or conducted a backfit analysis to reach a conclusion as to whether SAMGs could be imposed as requirements. It is reasonable to attribute this in part, to the voluntary efforts of the industry, which were extensive, and the fact that in the late 1990s NRC policy was to credit industry voluntary initiatives (i.e., such that if there was a substantial benefit to SAMGs, crediting the industry initiative would remove that benefit and the backfit criteria would be very unlikely to be satisfied).

With this background, the following discussion represents the NRC's backfit analysis for reconsidering the need to impose SAMGs requirements in the aftermath of the Fukushima Dai-ichi accident.

(1) *Statement of the specific objectives that the backfit is designed to achieve*

Basis for Reconsidering the Need to Impose SAMGs[38] Requirements

There are two principal factors that cause the NRC staff to reconsider its view of imposing SAMGs requirements:

- A greater appreciation of external event uncertainty and the consequences that can occur as a result of an inadequate facility design basis for external events (i.e., this recognizes that the current regulatory effort stems from the Fukushima event and the recommendations of the NTTF).

- The SAMGs voluntary initiative was not entirely successful, in that it did not result in licensees consistently maintaining SAMGs across the industry (although all licensees have SAMGs). The voluntary initiative did not compel all licensees to update and maintain SAMGs.

Greater Appreciation for External Event Uncertainty

After the Fukushima event there is a greater appreciation that some external events have significant uncertainty in terms of the known return frequency and associated event conditions. In fact, this greater appreciation for external event uncertainty was the fundamental basis for the Commission's issuance of Order EA-12-049 requirements to have increased defense-in-depth mitigation measures for BDBEEs.

After Fukushima, the NRC staff mindset changed. Today, the NRC staff would more likely conclude that the deterministic external event design bases (which are dated) are not always robust. Further, the staff notes that these phenomena are better understood today than in the 1960s when the majority of the current operating plants were being sited. So while General Design Criteria (GDC)-2 of 10 CFR Part 50 and its predecessor GDC recognized the need for understanding the regional history concerning external events, including the need to have margin in the design of power reactor facilities for such events, the GDC did not account for the potential that better knowledge would be acquired in the future concerning external events. Of course this eventuality is accounted for under the NRC's Backfit Rule, hence the current analysis. In terms of some external events such as floods, it can be difficult to obtain historical information regarding recurrence frequency and event magnitude that support making a determination for the need for regulatory action (because the risk remains much less well-known). As such there is more uncertainty for these sites, which places greater importance on mitigation strategies and SAMGs.

In terms of SAMGs requirements, the Fukushima event demonstrates that beyond design basis external events can occur and lead to core damage with the subsequent need to implement SAMGs. Further, when external events exceed the facility protection level, extensive damage to

[38] SAMGs requirements for the purposes of this backfit discussion includes a requirement for the SAMGs itself, and supporting requirements to ensure that the guideline set is integrated with other procedures and guideline sets as applicable, that the SAMGs are maintained within the configuration management program of the facility, that changes to the SAMGs are controlled, that there are drills and/or exercises to provide a sufficient level of assurance that the SAMGs can be implemented, that there is training for key personnel that make decisions and direct the implementation of the SAMGs.

the facility can result and complicate mitigation efforts, placing greater importance on mitigation approaches that are flexible and adaptable, and include pre-planned strategies.

Voluntary Industry Initiative

The second significant new piece of information is that that the industry's voluntary initiative was not entirely successful in ensuring that all licensees adopted SAMGs, maintained the capability to implement SAMGs effectively, and updated SAMGs. While SAMGs were in place at all sites, they were not always reflective of the most up-to-date owners group SAMG versions. This leads to the conclusion that absent requirements for SAMGs, the NRC cannot have a sufficient level of regulatory assurance that SAMGs will be updated and maintained over time and that licensees will maintain their capability to effectively implement SAMGs.

(2) ***General description of the activity that would be required by the licensee or applicant in order to complete the backfit***

The proposed rule would require licensees to:

- Develop, implement, and maintain site-specific SAMGs.
- Verify that SAMGs are integrated with existing emergency procedures .
- Verify their supporting organizational structure is adequate to perform the activities called for in the SAMGs.
- Ensure adequate training of personnel that perform SAMGs by developing new training materials and delivering training to the appropriate individuals onsite.
- Conduct drills or exercises to demonstrate the capability to implement SAMGs.
- Develop change control policies and procedures, and provide annual updates to site-specific SAMGs.

(3) ***Potential change in the risk to the public from the accidental offsite release of radioactive material***

The following discussion provides a better understanding of the safety importance of SAMGs and considers whether the current regulatory state for SAMGs (i.e., voluntary SAMGs not updated and maintained in all cases by all licensees) impacts safety and therefore warrants imposition of SAMGs requirements.

How important are SAMGs for public health and safety (i.e., assuming that no SAMGs existed)?

Without SAMGs, it is likely that informed decisions would not be made for the best use of human and equipment resources following core damage. Decisions regarding containment, and specifically maintaining containment integrity under human control, minimization of radiological releases (including action that might halt the core damage progression) would be more ad hoc and less effective. The SAMGs, by providing information that informs decisions made by the emergency response organization helps to support more informed protective action recommendations (e.g., potential impending loss of a fission product barrier). It is not reasonable to assume that the site staff could create SAMGs strategies and give proper consideration to the effects of core damage during an event due to the complexity of core damage events and the associated phenomena that occur. The SAMGs document more than

20 years of research and analysis. They are a guideline set that supports informed decision-making.

A more important question is whether there is sufficient severe accident risk that SAMGs would then substantially reduce, such that this proposed imposition can be supported. There are sound reasons to conclude that the current risk of severe accidents is much less than existed in 1985, when the Commission concluded that severe accident risk did not warrant immediate regulatory action. There are 30 additional years of regulations now in place, and those additional regulations have collectively and substantially lowered the risk (i.e., the regulations issued as either adequate protection requirements or substantial additional protection requirements should have individually and collectively reduced risk). One important and relevant example is the SBO rule (10 CFR 50.63). This rule was a cost-justified substantial safety enhancement that reduced risk through the removal of approximately 75 percent of the existing core damage frequency stemming from blackouts. At the time the SBO rule went into effect (1988), station blackout was a dominant contributor to risk for many plants (e.g., refer to NUREG-1776, "Regulatory Effectiveness of the Station Blackout Rule," dated August 2003 section 3.2.1). The recent post-Fukushima requirements imposed by Order EA-12-049 have as an important benefit the virtual elimination of the remaining station blackout risk (i.e., residual risk stemming from a loss of offsite power (LOOPs) with coincident onsite emergency ac power source failure) by providing power reactors with "indefinite" station blackout coping capability. For the events that 10 CFR 50.63 addressed (i.e., those not stemming from BDBEEs), the Order EA-12-049 mitigation strategies that would be made generically-applicable by this proposed rule, are very likely to be successful. The result of just these two regulatory actions alone has substantially reduced risk to well below the levels that existed in 1985.

The NRC sought to make use of any applicable quantified risk information that might help inform this justification. In this regard, the NRC looked at its recent work performed in support of the Containment Protection and Release Reduction (CPRR) rulemaking regulatory basis. This risk work estimates the potential benefits of strategies used after the onset of core damage (i.e., these post-core-damage strategies would be implemented by the SAMGs and as such are indicative of relative risk benefit that might be obtained by SAMG requirements). This risk work also includes consideration of the recent post-Fukushima regulatory efforts (i.e., it also accounts for the safety benefits that occur due to implementation of the Order EA-12-049 mitigation strategies which result in a reduction in core damage frequency). The NRC acknowledges that the CPRR risk work does not provide a complete quantitative measure of the possible risk benefits of SAMGs, particularly with regard to how SAMGs might benefit maintenance of containment integrity or support more informed protective action recommendations by the emergency response organization following core damage. However, this work does provide valuable risk insights that the NRC concluded were important to fully inform the decision on this matter, and which additionally influenced the NRC's development of the proposed SAMG framework.

The CPRR risk work shows that under a bounding set of assumptions the maximum benefits that could be obtained through the post-core damage strategies at Mark I and Mark II facilities would be a full order of magnitude below the quantitative health objective (i.e., a level of risk that equates to 1/10 of 1 percent of the individual latent cancer fatality risk). More refined risk estimates, from the same work, push this benefit significantly lower. In fact, the key risk insight obtained from this work and applicable to the proposed SAMG requirements in this rulemaking for any power reactor design is that it does not appear reasonable to expect that post-core damage strategies, including the guidelines that implement those strategies (i.e., the SAMGs)

would result in a safety benefit that could be justified under the Commission's backfitting requirements. This result, as expected, demonstrates the benefits of the Commission's regulations to both effectively keep the frequency of core damage very low, and to ensure that through emergency preparedness requirements the surrounding population is less likely to experience health effects from the effluents.

Following the onset of core damage, SAMGs are valuable at providing important information to decision makers that support more informed decisions and actions on the use of resources in a severe accident. Typically the SAMGs support decision makers as they work to minimize, reduce, and delay the releases of fission products. Furthermore, there are some accident sequences for which SAMGs actions may be successful in halting the progression of the accident (i.e., providing a much larger benefit for those sequences). Recognizing the substantially increased mitigation capabilities stemming from the implementation of Order EA-12-049 requirements and additionally noting the flexible and adaptable nature of the strategies to include the potential for offsite resources to assist with mitigation, it is more likely that the opportunities for halting a core melt progression have increased. Despite the available risk information, the NRC proposes that SAMGs should be requirements based on qualitative reasons described in greater detail below.

How important to safety are updated SAMGs subject to NRC oversight relative to the current voluntary approach?

Updating the SAMGs enables about 20 years of additional insights to be considered including Fukushima insights. This enhances the candidate high level actions (five new candidate high level actions are added to reflect lessons learned from Fukushima), results in an improved SAMGs decision-making process, and leads to better post core damage decisions and actions. Requiring SAMGs (i.e., requiring licensees to develop, implement, and maintain site-specific SAMGs that would reflect the recent generic efforts and the plant specific features, including a nominal level of training and drills) would specifically result in more informed decisions and actions (when compared to a presumed state of voluntary SAMGs that are not up to date and may not reflect the current plant configuration) involving:

- Containment;
- Minimization and delay of radiological releases;
- Use of all equipment including the mitigation equipment of Order EA-12-049;
- Use of Order EA-13-109 EPG/SAGs for Mark I and II designs;
- Decisions made by the ERO following core damage.

SAMGs directly support maintenance of containment integrity following severe accidents, and indirectly support the protective action recommendations made by the emergency response organization and as such are considered to support two key, defense-in-depth foundational elements of the NRC's regulatory framework: Containment and Emergency Preparedness. These features and requirements have their greatest importance to safety after the onset of core damage (i.e., when fission products are present), at which time the plant transitions to SAMGs, which then serve as the operative guideline set for decisions and actions concerning the use of containment (to minimize and delay of fission product releases) and support to emergency response (to inform the ERO regarding fission product barrier integrity).

Updated, site-specific SAMGs would:

1. Provide a more complete and improved set of actions (e.g., new candidate high level actions as reflected in the updated SAMGs) for consideration following core damage;
2. Provide a more complete set of equipment and strategies for use in mitigating the effects of core damage (i.e., the mitigation strategies equipment imposed by Order EA-12-049);
3. Reflect the current plant configuration to facilitate the use and consideration of new candidate high level actions reflected in the updated SAMGs (per number 1 above) and mitigation equipment (per number 2 above).

If it is assumed that the current worst case situation is voluntary SAMGs that are outdated, not updated to reflect the industry efforts and not maintained so as to reflect the plant's current configuration, imposition of SAMGs requirements (versus a continuing voluntary initiative) would not likely reduce severe accident (known) risk in a substantial manner. In this worst case assumed condition, the SAMGs would still provide benefit to decision makers should an event occur and lead to core damage. More importantly, the practical reality is that in a real event, if there is time and communications capability, then experts would be assisting the plant staff in making post core damage decisions (i.e., similar to the recent experience for the Fukushima Dai-ichi event). In fact, the plant personnel, given their experience with mitigation strategies would likely be able to implement strategies (even with outdated SAMGs because of the recent efforts to implement Order EA-12-049) that would be effective. As such, imposing SAMGs, while beneficial, would result in well maintained and updated SAMGs, but is not likely to result in measureable reductions in risk.

What are the qualitative benefits of imposing SAMGs requirements?

As already discussed above, the quantitative risk information that is available, albeit limited in terms of whether it provides a full measure of the benefits of SAMGs, does not support imposition of new SAMGs requirements. This section summarizes the qualitative arguments that support SAMGs requirements.

The NRC's regulatory framework reflects a philosophy of defense-in-depth. One important element of defense-in-depth is to maintain a balance that includes prevention of core damage, prevention of containment failure or bypass, and mitigation of the consequences of accidents. As discussed above, SAMGs have their safety benefit after the onset of core damage and as such contribute to the prevention of containment failure and provide information that optimizes the decision process for the mitigation of accident consequences. There is a sound basis for concluding that the risk of severe accidents is very low (which in turn reduces the benefits of SAMGs). However, when SAMGs are viewed from the larger perspective of defense-in-depth and the need to maintain a balance that includes prevention of containment failure and the mitigation of accident consequences, then SAMGs become a very important part of defense-in-depth. After core damage, SAMGs are the guidelines employed to make the key decisions to mitigate the consequences of the accident. From this perspective, SAMGs are, after core damage, the equivalent of the EOPs, prior to core damage. All of the decisions and associated mitigation actions following the onset of core damage are informed by, or stem directly out of, the SAMGs. SAMGs support actions and decisions to:

1. Halt the progression of the accident (if possible);
2. Minimize or delay the release of fission products (including making best use of the containment);

3. Cope with the radiological conditions, make decisions regarding onsite mitigation, make notifications to offsite organizations, and make recommendations regarding offsite protective actions.

For example, decisions regarding containment (i.e., to open, close, or cool containment, in order to reduce the chance of the loss of containment integrity due to a structural failure) after core damage occurs when containment serves its principle function as a fission product barrier, are made using the SAMGs. For this reason alone, the SAMGs are very important from a defense-in-depth standpoint. In addition, the SAMGs inform the actions of the ERO (i.e., providing information to that organization regarding the status of fission product barriers which in turn can influence both onsite and offsite protective action recommendations). This link between SAMGs and emergency preparedness actions provides another defense-in-depth layer and as such supports another fundamental part of the NRC's regulatory infrastructure: emergency preparedness.

Finally, SAMGs requirements could have an additional benefit for facilitating a more complete treatment of external event uncertainties. As previously discussed, an important new piece of information that informs the current perspective on SAMGs requirements is the greater appreciation for external event uncertainties that stems from the Fukushima event. The Commission recognized the need to address this uncertainty and imposed mitigation strategies on power reactor licensees to provide an additional capability for the mitigation of BDBEEs. Complete implementation of Order EA-12-049 could be viewed as involving the updating of SAMGs to reflect the availability and use of this equipment to implement similar strategies in the post-core damage environment. While licensee may in fact make these kinds of changes to their current SAMGs without SAMGs being requirements, these updates would definitely occur if SAMGs were imposed as requirements.

(4) ***Potential impact on radiological exposure of facility employees***

The discussion under Item 3 also applies to the potential impact on radiological exposure of facility employees.

(5) ***Installation and continuing costs associated with the backfit, including the cost of facility downtime or the cost of construction delay***

The industry through EPRI and the BWROG and PWROG have spent considerable effort and resources updating the SAMGs and producing an updated version that is a significant improvement over the original SAMGs developed during the 1990s. Licensees would still incur a cost to take the new owners groups' SAMGs and adapt them to their sites to reflect site-specific features and current site configuration. This cost is estimated in the supporting regulatory analysis to this proposed rulemaking.

This estimated impact is considered to be most significant for PWR licensees, which due to the effort to produce a single SAMG for all three vendors means that some licensees will have a larger task to produce the site-specific version (i.e., the new generic PWR SAMG may deviate significantly from the version that the licensee voluntarily implemented at the end of 1998).

The estimated one-time industry cost associated with the backfits would be approximately $30 million, and the annually recurring cost would be approximately $2.4 million. Combining these initial and annual costs, this analysis estimates that the backfits associated with the

proposed rule would cost industry approximately $58 million (present value, assuming a 7 percent discount rate) to $72 million (present value, assuming a 3 percent discount rate).

This estimate also reflects the NRC staff's effort to develop the proposed SAMG regulatory framework in a manner that is informed by these risk insights as follows:

1. The proposed requirements would be limited to requiring the SAMG guideline sets, and not extended to require NRC review and approval of SAMG strategies, use of the equipment within the SAMGs, or for NRC to require that licensees re-assess the work that industry has completed over 20 plus years to develop the SAMGs, including the recent effort to update and revise the SAMGs to reflect the Fukushima lessons learned.
2. The proposed requirements would be intended to address the problem identified with the SAMG voluntary initiative after Fukushima, and to require that SAMGs be updated and maintained. Specifically, this would mean that the plant-specific SAMGs would be maintained within the plant configuration management system and be updated to reflect generic industry improvements at a reasonable frequency.
3. The proposed requirements and supporting endorsed guidance would be intended to result in an integration of the SAMGs with the other guideline sets and the symptom-based EOPs, consistent with proposed 10 CFR 50.155(b). The NRC's intent would be to verify that this integration is in place through inspection.

(6) ***The potential safety impact of changes in plant or operational complexity, including the relationship to proposed and existing regulatory requirements***

The discussion under Item 3 also applies to the potential safety impact of the proposed requirements.

(7) ***The estimated resource burden on the NRC associated with the backfit and the availability of such resources***

The NRC would oversee licensee implementation of site-specific SAMGs, drills and exercises, and the change control process. In addition, the NRC would develop the final rule package.

The estimated one-time cost to the NRC associated with the backfits would be approximately $1.1 million, and the annually recurring cost would be approximately $170,000. Combining these initial and annual costs, this analysis estimates that the backfits associated with the proposed rule would cost the NRC approximately $3.1 million (present value, assuming a 7-percent discount rate) to $4 million (present value, assuming a 3-percent discount rate).

As discussed above, the proposed SAMG regulatory framework does not include NRC review and approval of either the generic or plant-specific SAMGs.

(8) ***The potential impact of differences in facility type, design or age on the relevancy and practicality of the backfit***

The costs attributable to the proposed rule would vary for a variety of site-specific reasons, including the nuclear power reactor's facility type, design, or age. These variations have are reflected in the estimates provided in Section 3 of the regulatory analysis. However, the additional protection for DID that results from the SAMGs requirements in the proposed rule is

expected to be consistent across industry, and would not directly relate to the facility type, design, or age.

(9) *Whether the backfit is interim or final and, if interim, the justification for imposing the backfit on an interim basis*

The backfit is final.

Conclusion

If this backfit decision were based solely on known (quantified) risk, then the NRC staff's recent regulatory efforts associated with the CPRR regulatory basis would cause the NRC to conclude that imposition of SAMGs requirements would not result in a substantial safety benefit to public health and safety. As such, SAMG requirements would not satisfy the standard of 10 CFR 50.109(a)(3).

However, if a broader view of the SAMGs is taken that reflects the value of these guideline sets, in terms of resolving the issues identified with the voluntary initiative (i.e., to put in place requirements for SAMGs that ensure they are updated to reflect recent efforts by industry and reflect the plant's configuration), then there are valid arguments for requiring SAMGs for defense-in-depth purposes. Important actions concerning minimization of fission product releases, delay of fission product release, and the use of containment in this regard, are supported with SAMGs. The SAMGs can potentially support more informed recommendations made by the ERO in terms of protective actions for both onsite and offsite personnel. The SAMGs provide a set of information and considerations for mitigation in a post-core damage environment that directly support these key defense-in-depth elements of the NRC's regulatory framework.

The SAMGs are an essential part of the regulatory framework for the mitigation of the consequences of accidents. Imposition of SAMGs requirements (versus a continuation of the voluntary initiative) would ensure that SAMGs are maintained as an effective guideline set. Accordingly, the proposed SAMGs requirements would be a substantial additional protection for the qualitative reasons discussed. and would therefore satisfy the backfitting requirements in 10 CFR 50.109(a)(3). Based on the NRC assessment of the costs and benefits, summarized above in item 5, of the proposed rule, the NRC concludes that the costs are justified in view of this substantial additional protection. Accordingly, the agency concludes that the portions of the proposed rule that would be new impositions are justified.

Existing Design Certifications

The issues that are resolved in a DC and accorded issue finality do not include operational matters, such as SAMGs that would be required under the proposed rule. The SAMGs within the proposed rule would not be applied to existing (or future) DCs. Therefore, the SAMGs-related requirements in the proposed rule are consistent with the issue finality provision in 10 CFR 52.63.

Current and future applicants

Applicants and potential applicants (of licenses, permits and regulatory approvals, such as DCs) 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 that 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 DC rule) with specified issue finality provisions. The issues which are resolved in an early site permit or a DC and accorded issue finality do not include operational matters, such as the SAMGs that would be required under the proposed rule. Therefore, the proposed rule provisions limited to SAMGs would be consistent with the issue finality provisions applicable to early site permits and DCs. In addition, because the issues that are resolved in an early site permit or a DC and accorded issue finality do not address SAMGs, a COL applicant referencing either an early site permit or DC would not be protected by the issue finality provision applicable to COL applicants (10 CFR 52.83) with respect to compliance with a rule setting forth requirements for SAMGs.

References

NRC Policy Statement, "Severe Reactor Accidents Regarding Future Designs and Existing Plants" (Volume 50, page 32138, of the Federal Register (50 FR 32138) dated August 8, 1985)

NRC Policy Statement, "Safety Goals for the Operations of Nuclear Power Plants" (51 FR 28044 dated August 4, 1986)

SECY-88-147, "Integration Plan for Closure of Severe Accident Issues," May 25, 1988.

SECY-89-012, "Staff Plans for Accident Management Regulatory and Research Programs," January 18, 1989.

Generic Letter 88-20 Supplement 2 "Accident Management Strategies for Consideration in the Individual Plant Examination Process (Generic Letter 88-20 Supplement No. 2)," April 4, 1990.

EPRI Report TR-101869 "Severe Accident Management Guidance Technical Basis Report," dated December 1992.

NEI 91-04 revision 1 (formerly NUMARC 91-04) "Severe Accident Issue Closure Guidelines," December 1994.

NRC Letter dated June 20, 1994 to William Rasin (NEI) accepting NEI 91-04 as meeting the objectives of SECY-89-012.

There were numerous progress SECYs (every year) – reporting on implementation of SAMGs including: SECY-89-308, SECY-90-180, SECY-90-384, SECY-94-166, SECY-95-004, SECY-96-088, SECY-97-132, and SECY-98-131

NRC Policy Statement, "The Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities" (60 FR 42622 dated August 16, 1995)

Staff Requirements – 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 (Mar. 9, 2012) ("SECY-12-0025 SRM").

<u>New Reactor Related:</u>

10 CFR Part 52, "Early Site Permits; Standard Design Certification; and Combined Licenses for Nuclear Power Plants"

SECY-90-016, "Evolutionary Light-Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," issued January 12, 1990, and the corresponding SRM, issued June 26, 1990

SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs," issued April 2, 1993, and the corresponding SRM, issued July 21, 1993

SECY-96-128, "Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," issued June 12, 1996, and the corresponding SRM, issued January 15, 1997

SECY-97-044, "Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," issued February 18, 1997 and the corresponding SRM issued June 30, 1997.

Appendix B. Historical Cost Analysis

In this appendix, the NRC staff estimates the costs associated with Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, Order EA-12-051, *Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*, and related activities undertaken by industry following Fukushima (Refs. 1 and 2). The NRC staff analyzed these historical costs for informational purposes – to inform both the Commission and the public regarding some of the activities that have been undertaken since the Fukushima accident. These costs are attributable to Order EA-12-049, Order EA-12-051, and related activities, rather than the proposed rule. However, the proposed rule includes provisions that require the activities described in the following section.

B.1 Methodology and Assumptions

As mentioned above, the historical cost analysis estimates the costs resulting from Order EA-12-049, Order EA-12-051, and industry initiatives. This analysis *does not* account for all of the costs incurred by industry and the NRC post-Fukushima. The following sections describe the methodology used to estimate the costs associated with Order EA-12-049, Order EA-12-051, and related industry initiatives, which have been or will be incurred prior to the proposed rule's effective date.

B.1.1 Methodology for Estimating the Costs of Order EA-12-049

Order EA-12-049 requires licensees and COL holders to develop guidance and strategies to be implemented in response to BDBEEs. The NRC staff discusses the historical costs of Order EA-12-049 according to activities required by the Order.

Affected Universe

Order EA-12-049 affects both current and new NPP licensees. There are some differences in how licensees are affected depending on the operational state of their reactors (e.g., operating, under construction, and new designs). This section describes how the estimates and evaluations of costs differ between these categories.

The NRC staff estimates costs on a per-site basis. The cost analysis includes three reactor types: BWR, PWR, and AP1000. Due to reactor differences, activities undertaken to come into compliance with the requirements set forth by Order EA-12-049 differed among these reactor types. Therefore, the NRC staff evaluates the costs separately for each reactor type (see the Cost Estimation section below for the NRC staff's cost estimating approach). In all, the NRC staff estimates the costs for 64 sites (62 operating reactor sites plus 2 AP1000 sites) to separately account for the costs associated with the AP1000 reactors which will differ from the costs incurred by the co-located PWRs (i.e., Virgil C. Summer and Vogtle).[39] Costs also differ depending on how many reactor units are located on each site. Therefore, the NRC staff further differentiates the affected universe by the number of units on each BWR, PWR, and AP1000 site. Exhibit B-1 shows the total number of sites accounted for costs in the historical cost analysis due to Order EA-12-049 by reactor type and number of units.

[39] Because the costs related to Order EA-12-049 are significantly lower for sites with AP1000 reactors, the NRC staff modelled these two sites as four sites, two of which will incur costs only for the PWRs and two of which will incur costs only for the AP1000 reactors.

Exhibit B-1. Site Counts by Number of Units and Reactor Types

	BWRs	PWRs	AP1000s	Total Sites
One Unit	14	12	0	**26**
Two Units	9	24	2	**35**
Three Units	1	2	0	**3**
Total Sites	**24 Sites**	**38 Sites**	**2 Sites**	**64 Sites**

The cost analysis of Order EA-12-049 accounts for 24 BWR sites. There are 14 1-unit, nine 2-unit, and one 3-unit BWR sites. Two of the 1-unit BWR sites are decommissioning sites (i.e., Oyster Creek and Vermont Yankee). Exhibit B-2 lists each BWR site included in the historical cost analysis related to Order EA-12-049 by its number of units.

Exhibit B-2. List of BWR Reactor Sites Included in the Analysis by Number of Units

1-Unit BWR Sites	2-Unit BWR Sites	3-Unit BWR Sites
Clinton	Brunswick	Browns Ferry
Columbia	Dresden	
Cooper	Edwin I. Hatch	
Duane Arnold	LaSalle County	
Fermi	Limerick	
Grand Gulf	Nine Mile Point	
Hope Creek	Peach Bottom	
James A. FitzPatrick	Quad Cities	
Monticello	Susquehanna	
Perry		
Pilgrim		
River Bend		
Oyster Creek		
Vermont Yankee		
14 Sites	**9 Sites**	**1 Sites**

The analysis of Order EA-12-049 also accounts for 38 PWR sites. There are 12 1-unit, 24 2-unit, and two 3-unit PWR sites. Exhibit B-3 lists each affected PWR site by its number of units. Because the NRC rescinded the Order requirements for three decommissioning sites (i.e., Crystal River, Kewaunee, and San Onofre), these sites are no longer required to comply with the Order requirements and are not included in the cost analysis of Order EA-12-049.

Exhibit B-3. List of PWR Reactor Sites Included in the Historical Cost Analysis by Number of Units

1-Unit PWR Sites	2-Unit PWR Sites	3-Unit PWR Sites
Callaway	Arkansas Nuclear One	Oconee
Davis-Besse	Beaver Valley	Palo Verde
Fort Calhoun	Braidwood	

1-Unit PWR Sites	2-Unit PWR Sites	3-Unit PWR Sites
H.B. Robinson	Byron	
Palisades	Calvert Cliffs	
R. E. Ginna	Catawba	
Seabrook	Comanche Peak	
Shearon Harris	Donald C. Cook	
Three Mile Island	Diablo Canyon	
Virgil C. Summer	Indian Point	
Waterford	Joseph M. Farley	
Wolf Creek	McGuire	
	Millstone	
	North Anna	
	Point Beach	
	Prairie Island	
	St. Lucie Plant	
	Salem	
	Sequoyah	
	South Texas Project	
	Surry	
	Turkey Point	
	Vogtle	
	Watts Bar	
12 Sites	**24 Sites**	**2 Sites**

The analysis of Order EA-12-049 includes two AP1000 sites. Both are 2-unit sites and are listed in Exhibit B-4. The AP1000 sites are still under construction. However, the NRC imposed requirements on these construction sites via Order EA-12-049 (Vogtle Units 3 and 4) and license condition (March 30, 2012, Memorandum and Order, CLI-12-09 (Ref. 3), Virgil C. Summer Units 2 and 3). The analysis of Order EA-12-049, therefore, estimates the costs associated with the Order requirements for both AP1000 sites.

The AP1000 reactors possess several safety design features and onsite equipment that allow the reactors to cope longer during an SBO event than BWRs and PWRs. Because of its design features, the impact of the Order requirements on the AP1000 sites is smaller than that on the BWR and PWR sites (see Section B.2.1 for additional discussion of these costs).

Exhibit B-4. List of AP1000 Reactor Sites Included in the Historical Cost Analysis by Number of Units

1-Unit AP1000 Sites	2-Unit AP1000 Sites	3-Unit AP1000 Sites
	Virgil C. Summer	
	Vogtle	
0 Sites	**2 Sites**	**0 Sites**

Cost Estimation

The NRC staff's used information from sites' Overall Integrated Plans (OIPs) to estimate the costs of the Order. These plans laid out how compliance with the Order will be achieved.

Data Sources for Inputs

The NRC staff gathered equipment cost data from multiple sources. The staff gathered unit cost data from suppliers and industry sources. In addition, the NRC staff used the RSMeans cost reference books, *Building Construction Cost Data* and *Facilities Construction Cost Data*, for certain compliance activities (Refs. 4 and 5). An EPRI study, *Costs of Utility Distributed Generators, 1-10 MW: Twenty-Four Case Studies* also provided costs for generators, switchgears, and transformers (Ref. 6). In addition, the NRC staff consulted with industry experts to estimate certain cost data.

The NRC staff estimated loaded labor costs according to data provided by the BLS and wage rates used in related NRC regulatory analysis. The NRC staff used the 2013 Occupational Employment and Wages data. Note that all costs presented in this analysis are in 2013 dollars. As per NUREG/CR-4627, *Generic Cost Estimates*, direct wage rates are loaded using a multiplier of 2 to account for licensee and contractor labor and overhead (i.e., fringe, benefits, general administration, and profit) (Ref. 7). A loading factor of 2 is considered conservative. Exhibit B-5 presents the labor rates used throughout this analysis.

Exhibit B-5. Labor Rates Used in the Historical Cost Analysis

Labor Category	Mean Wage Rate	Loaded Wage Factor	Loaded Wage Rate
	a	b	c = a x b
Mechanical Engineers	$41.31	2	$82.62
Electricians	$25.75		$51.50
Plumbers, Pipefitters, and Steamfitters	$25.88		$51.76
Control and Valve Installers and Repairers, Except Mechanical Door	$25.95		$51.90
Electrical and Electronic Equipment Assemblers	$15.07		$30.14
Industry Staff	$41.93		$83.85

*The loaded wage rate for Industry Staff was based on recent NRC regulatory analysis.
**The mean wage rate for Mechanical Engineers (SOCI 17-2141), Electricians (SOC 47-2111), Plumber, Pipefitters, and Steamfitters (SOC 47-2152), Control Valve Installers and Repairers, Except Mechanical Door (49-9012), and Electrical and Electronic Equipment Assemblers (SOC 51-2022) were provided by BLS.

Estimating Quantity of Equipment Needed

Working from a sampling of the 1-unit reactor sites' OIPs, the NRC staff estimated how many pieces of equipment and supplies were required. The NRC staff referenced these BWR and PWR OIPs to estimate the quantities needed at a "typical" 1-unit site. The NRC staff estimated the quantity of equipment needed for 2- and 3-unit sites from the 1-unit site data (the assumptions used to estimate quantities are described in more detail in the following section, Description of Assumptions Used in the Analysis).

The NRC staff also used sources outside of the OIPs in cases where the OIPs did not provide sufficient detail to estimate quantities. For example, communications gear is required equipment under the Order, but the OIPs do not specify the number or type of communication equipment that needed to be procured. Instead, the NRC staff referred to a document prepared by FirstEnergy Nuclear Operating Company (FENOC) in response to an NRC request for information pursuant to 10 CFR 50.54(f) in which the licensee identified the number and types of communication equipment shared by three FENOC sites (Ref. 8). The NRC staff used these data to approximate the quantity of additional communication equipment needed to comply with the Order.

Appendices E through M provide a list of assumptions and data sources used in the regulatory analysis.

Description of Assumptions Used in the Analysis

The NRC staff applied the following assumptions in this analysis.

Compliance Activities and Equipment Needs

The NRC staff developed a "model" reference site for each reactor type (i.e., BWR, PWR, and AP1000). The models include a list of compliance activities that must be performed to comply with the Order. The NRC staff used these models, which are based on the contents of a sampling of OIPs (see Exhibit B-7 for a list of the sampled sites) to approximate the cost of the Order.

The NRC staff reviewed OIPs from a sampling of 1-unit sites to identify the quantities of equipment needed at a "typical" 1-unit site. For 2- and 3-unit sites, the NRC staff derived quantities of equipment by adjusting the 1-unit site estimates. Required quantities of some of the FSGs equipment depends on the number of reactors onsite (i.e., "N"). As stated in NEI 12-06, Rev. 0, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, an N + 1 equipment capability applies to portable FLEX equipment (i.e., that equipment that directly supports maintenance of the key safety functions) (Ref. 9). Any other support equipment only requires an N capability. Exhibit B-6 shows how the NRC staff adjusted equipment needs according to the number of reactors onsite.

Exhibit B-6. Assumptions for Equipment Needs at 2- and 3-Unit Sites

	1-Unit Site (N + 1 = 2)	2-Unit Site (N + 1 = 3)	3-Unit Site (N + 1 = 4)
Sets of portable, onsite FLEX equipment	2X	3X	4X
Sets of other equipment	X	2X	3X

*N is the number of units and X is the number of sets of equipment needed.

Time Period of Analysis

The NRC staff assumes that operating BWR and PWR licensees and newly-constructed AP1000 licensees will incur savings and costs over a 24-, 26-, and 63-year period, respectively. Decommissioning BWR sites will incur costs and benefits over a 3-year period. These timeframes represent the average operating license term life plus a 2-year period during which fuel will be removed from the SFP during decommissioning of the 64 sites included in the analysis. The time period during which each site will operate depends on the term of the operating license and how long the licensee chooses to operate within the term. The NRC staff assumed that each licensee of an operating or newly-constructed reactor will apply for and receive a 20-year license extension beyond the original 40-year license term. The NRC staff assumed that each site will incur costs to comply with the Order over the first two years following the end of the license extension (to cover compliance with Order EA-12-049 during decommissioning).

Present Value Calculation

The NRC staff calculated the present value of the costs a licensee would incur beginning in 2012 and extending over its average remaining operating license term.

Categorization of Costs

The NRC staff mapped the activities described in the OIPs to overarching categories that best described their function.[40] Each overarching category is described below:

1. *Initial response*: The initial response category captures activities needed to support the initial coping phase during an SBO event. This initial coping phase requires use of only installed onsite equipment. These activities typically consist of modifying installed equipment to gain additional time to install portable equipment during an event. Examples of initial response activities include hardening and protecting water sources and piping, as well as installing low-leakage reactor coolant pump (RCP) seals.

2. *Onsite portable equipment*: The onsite portable equipment category includes procuring SBO mitigation equipment that is stored onsite and deployed prior to the availability of offsite assistance. Portable equipment includes generators, fans, communications gear, fuel containers, pumps, and food and water commodities, among others. Activities associated with this category involve modifying existing connections to allow for the use of portable equipment, as well as procuring the portable equipment.

3. *Offsite portable equipment*: The offsite portable equipment category reflects the activities needed to prepare the RRCs. This includes one-time costs to stock critical equipment and to staff and train the organization running the RRCs. Under the implementation of Order EA-12-049, the industry established two RRCs located near Memphis, Tennessee, and Phoenix, Arizona. The RRCs would be capable of delivering supplemental emergency equipment to any U.S. nuclear energy facility within 24 hours. The equipment and materials provided by the RRCs supplement the additional portable equipment purchased at each U.S. nuclear energy facility.

[40] The NRC staff used the OIPs submitted by licensees in the February 2013 timeframe.

4. *Supporting functions*: The supporting functions category captures activities that support the first three categories listed. For example, upgrading emergency lighting, as well as analyzing fuel storage needs and consumption rates, fall within the supporting functions category.

5. *External event considerations*: The external event considerations category includes activities related to the storage and staging of onsite and offsite portable equipment in a manner that protects the equipment from site-specific external events and allows for deployment of the portable equipment under extreme onsite conditions.

6. *Programmatic controls*: The programmatic controls category involves activities related to maintenance and testing of portable equipment, FSGs change control, and the periodic training of personnel. For example, this category includes developing an OIP, conducting staffing analyses, and modifying plant procedures. The category also includes the ongoing costs related to operating the RRCs (e.g., staffing, rent, testing and maintenance, and transportation capabilities). These costs are shared across industry.

Other Cost Variations Considered

Analysis of the OIPs revealed that some activities vary depending on the site's characteristics. For the cost analysis of Order EA-12-049, the NRC staff focused on variations that posed significant cost implications for the analysis. The NRC staff identified two variations that affected cost most significantly: reactor type (i.e., BWR, PWR, AP1000) and number of units (i.e., one, two, or three). With regard to reactor type, the differences between BWR, PWR, and AP1000 facilities in terms of the structures, systems, and components (SSCs) required to mitigate an SBO event are significant enough to warrant this distinction. (Subdividing the BWRs and PWRs to acknowledge the differences in plant vintage and mitigation strategies was considered; however, the number and significance of such variations was not sufficient to warrant additional analysis.) With regard to number of units per site, the NRC staff accounted for cost differences between 1-, 2-, and 3-unit sites because, for example, "N + 1" sets of some SBOMS equipment, where N is the number of reactor units onsite, must be available onsite (which can have a significant impact on costs).

The NRC staff identified representative compliance activities from the OIPs submitted by several BWR and PWR plants, as identified in Exhibit B-7.[41] The OIPs described site-specific activities (e.g., relating to specific buses, switchgear, and locations). For this analysis, the NRC staff extrapolated from these site-specific activities to identify generic actions and equipment needed. The NRC staff's selection of OIPs covered a variety of site characteristics including NSSS type, containment type, operator, and applicable hazards. Because the approach uses selected examples of specific activities from a sampling of sites to estimate industry-wide costs, it could skew cost estimates. However, the NRC staff believes the number of activities analyzed is sufficiently high so that any potential for bias averages out in the final cost estimate.

Exhibit B-7. Sites Used to Develop the Lists of Compliance Activities and Quantities of Equipment Used

BWR Model	PWR Model	AP1000 Model
Brunswick	Davis-Besse	Virgil C. Summer

[41] The NRC staff considered including sites with Mark II containments, but determined that the activities described in those OIPs would not serve as suitable models from which to generalize costs industry-wide.

BWR Model	PWR Model	AP1000 Model
Grand Gulf	Donald C. Cook	Vogtle
Duane Arnold	Joseph M. Farley	
Edwin I. Hatch	Shearon Harris	
Dresden*	Braidwood*	
Monticello*	Calvert Cliffs*	
Vermont Yankee*[42]	McGuire*	
	Millstone*	
	R. E. Ginna*	
	Sequoyah*	

*These sites were used for estimating equipment quantity – not for developing the list of compliance activities – because of the level of detail in the OIPs regarding equipment types and quantity.

Cost Variations Not Accounted for in the Analysis

The analysis presents the estimated cost of imposing the Order EA-12-049 requirements for two significant variations: design type (BWR, PWR and AP 1000) and number of units per site. In addition to these variations, the staff considered whether there were other design or operational differences that could cause the cost to vary for individual sites. The NRC staff assessed whether differences could arise due to variations in NSSS vendor, architectural-engineering firm, plant vintage, individual plant modifications or core power. Although there are design and operational differences among these categories, there is similarity in ac power systems. The staff used their professional judgment to identify eight additional variations (other than reactor type and number of units) that could affect the costs incurred related to Order EA-12-049.

The following discussion explains the NRC staff's consideration of these additional sources of variation relative to their impact on the total costs of Order EA-12-049.

1. **Initial response mitigation strategy differs from NEI-12-06 guidance**.

Source of the variation: In their OIPs, some sites departed from NEI 12-06 by either (1) crediting existing onsite ac power sources for the initial response (this includes crediting hardened, dedicated shutdown systems for ELAP mitigation) or (2) defining what constitutes a "robust" structure with respect to seismic events differently than NEI 12-06.

Impact on implementation or operational activities resulting from the variation: Crediting existing ac power sources at the site would reduce a site's need to procure some onsite portable equipment that would provide a similar function. Further, this strategy may allow the licensee to credit motor-driven seismic Category I pumps and piping that exist at the plant to help with the initial response. Sites using this approach would incur relatively *lower* costs as a result of the Order. With regard to the definition of "robust" structure, a less stringent set of codes or criteria for determining what constitutes an adequate design to withstand an extreme seismic event would result in significant cost savings for sites.

Significance of cost impact on implementation or operational activities: The NRC staff concluded that variations found in OIPs related to the initial response could result in some

[42] The OIP issued by Vermont Yankee was issued prior to the announcement of its shutdown. The NRC staff believes its OIP is a relevant model.

savings for sites choosing to depart from NEI 12-06. The NRC staff does not estimate the cost savings of these alternative approaches, however, because the impact on the overall cost of the Order is expected to be insignificant.

2. Design limitations affect ability to cope during initial response.

Source of the variation: Some design aspects may be inadequate when challenged by an ELAP event (most likely seismic or high winds events).

Impact on implementation or operational activities resulting from the variation: The design inadequacies with respect to an ELAP event would need to be remedied. Such inadequacies could result in activities such as constructing a seismically qualified or tornado missile-proof tank(s) to provide water inventory. Alternatively, if a site has inadequately qualified equipment to transfer the water inventory via pumps (e.g., backup instrumentation, piping, and valves), then these systems would need to be upgraded to appropriately qualify and protect them.

Significance of impact on implementation or operational activities: The costs involved with addressing design limitations could range from insignificant to substantial. For example, the construction of seismically qualified or tornado missile-proof tanks with adequate capacity to meet the needs of an ELAP event could result in significant costs. The design, labor, and materials costs would be substantial. In addition, sites would need to engage a highly skilled workforce to connect the new tanks to the existing auxiliary feedwater/emergency feedwater/reactor core isolation cooling (AFW/EFW/RCIC) system and procure highly qualified components, such as N-stamp valves. However, the NRC staff believes that very few sites face design limitations to the degree that would require substantial, costly modifications. The NRC staff, therefore, estimated the costs associated with addressing design limitations that are most typical among the current fleet.

3. Limited battery capacity

Source of the variation: Some sites have only two hours of battery capacity to carry necessary electrical loads following an SBO event, while other sites have up to eight hours of battery capacity.

Impact on implementation or operational activities resulting from the variation: Even when taking into account extended load shedding, limited-capacity batteries are unlikely to provide adequate voltage for much longer than four hours. Sites with limited-capacity batteries would need to transition from the initial response phase to the use of onsite portable equipment in a shorter period of time than sites with greater battery capacity. To achieve a quicker transition, sites would need additional response staff to move and install onsite portable equipment.

Significance of impact on implementation or operational activities: The need for additional response staff would result in additional costs. Alternatively, sites with limited battery capacity could procure additional batteries (and potentially battery chargers). Additional batteries would require additional testing and evaluations of capacity, seismic capacity, room ventilation needs, and instrumentation, for example. The costs involved with addressing limited battery capacity could range from insignificant to substantial. The NRC staff accounted for some battery capacity-related costs, but could not account for all potential variation in costs across the industry because the sampled OIPs do not provide sufficient information on the extent of variation across the industry.

4. Dewatering pumps for flooded areas that require access

Source of the variation: Due to the potential for internal and external flooding, some sites require additional equipment (e.g., diesel-driven pumps, hoses, and screens) to dewater flooded areas in the plant that should be accessible following an ELAP event or where flooding could disable equipment important to ELAP mitigation.

Impact on implementation or operational activities resulting from the variation: To dewater areas of the site, licensees would need to procure additional equipment, such as diesel-driven pump(s). In addition, licensees would need to write associated procedures, perform additional testing, and train personnel. Some plants may need large dewatering pumps due to the higher potential leak rate and the larger size of the leaking water source.

Significance of impact on implementation or operational activities: Sites that require dewatering pumps may be able to use commercial pumps regularly used in agriculture or mining to provide dewatering needs. Costs for commercial pumps are expected to be somewhat less than the cost of a FLEX pump that provides flow to a depressurized steam generator (SG) or the reactor coolant system (RCS). This historical analysis accounts for some dewatering-related costs, but cannot account for all potential variation in costs across the industry because the sampled OIPs do not provide sufficient information on the extent of variation across the industry.

5. Westinghouse RCP low-leakage seals

Source of the variation: Recent testing of Westinghouse RCP low-leakage seals at an operating reactor led NRC to issue a Part 21 Notice that questioned the capability of the new seal design to significantly lower the leak rate when cooling is lost.

Impact on implementation or operational activities resulting from the variation: There are multiple vendors attempting to develop RCP low leakage seals and to seek affirmation from the NRC as to the efficacy of the seals. In some PWR OIPs, licensees relied on a low (assumed) rate of RCP seal leakage (i.e., approximately 1 gallon per minute (gpm) per pump). This rate affected the timing of both RCS depressurization and boron injection. In addition, this rate could possibly affect the size of portable pumps procured by the licensee. If the RCP seals leak at a significantly higher rate than assumed in the OIPs, licensees may need to depressurize the RCS and replenish the RCS inventory earlier in the course of an ELAP event. Licensees also may need additional staff to meet the additional mitigation demands. Alternatively, a licensee may need newly designed and tested RCP seals to provide a seal leakage rate similar to that assumed in the OIPs. These seals could be purchased and installed by the licensee.

Significance of impact on implementation or operational activities: If the rate of the RCP seal leakage determined by testing is found to be significantly higher than assumed in a site's OIP, then the licensee may need to re-work the mitigation strategies described in the OIP. The timing of events and mitigation strategies would need to be recalculated, which could lead to the need for additional staff and equipment (e.g., larger pumps may be needed to keep the core covered due to RCS inventory loss and shrinkage during RCS cool down). Or, a licensee may choose to replace the RCP seal to provide a low leakage rate when the seal cooling is lost. The costs involved with addressing RCP low-leakage seals could range from insignificant to substantial. The NRC staff accounted for some RCP seal leakage-related costs, but cannot account for all potential variation in costs across the industry because the sampled OIPs do not

provide sufficient information on the extent of variation across the industry. Third generation Westinghouse low leakage RCP shutdown seals are currently installed at a PWR site and are planned to be removed and tested in October 2015. The NRC is reviewing a topical report *PRA Model for Generation III Westinghouse Shutdown Seal*, July 2014, PWROG-14001-P/NP, Rev. 1, which supports the Generation III seals (Ref. 10). In addition, other vendors are developing low leakage seal designs and Flowserve has submitted a white paper on its seal design that is under review by the NRC.

6. Provide backup power to igniters (PWR ice condenser/BWR Mark III containments)

Source of the variation: Igniters are required in ice condensers and Mark III BWRs because these containments rely on steam condensation to control containment pressure and therefore experience rapid development of flammable hydrogen concentrations. Mark I and Mark II containments also rely on steam condensation, but they control the hydrogen threat by inerting the wetwell atmosphere. To prevent containment failure, igniters are installed in strategic locations in ice condenser and Mark III containment designs to burn off the hydrogen gas before it can reach a concentration resulting in an explosion that could cause containment failure. Many igniters are electrically powered.

Impact on implementation or operational activities resulting from the variation: Igniters may lose power during an ELAP event. To assure that containment integrity is maintained, the power source for these igniters may need to be rewired to provide an alternative electrical source, such as portable batteries, small diesel and gas generators, or larger FLEX generators. Licensees may need to make use of new or unused containment penetrations to meet wiring needs. Alternatively, igniters that do not require electrical power could be installed inside containment at appropriate locations. Some PWR ice condenser or BWR Mark III plants already may have addressed these concerns during implementation of the 10 CFR 50.54(hh)(2) requirements, although 10 CFR 50.54(hh)(2) does not require the licensee to protect against extreme external events.

Significance of impact on implementation or operational activities: Significant costs could result from the need for a new containment penetration (and all the attendant evaluations and qualifications), as well as new igniters that do not require electric power. The installation of new igniters would involve containment entry and possible dose accumulation. Some sites may have igniters that can be manually ignited with portable batteries at the electrical penetration location(s) following an ELAP event. This historical analysis accounts for some igniter-related costs, but cannot account for all potential variation in costs across the industry because the sampled OIPs do not provide sufficient information on the extent of variation across the industry.

7. Diversity of water sources (location and type)

Source of the variation: Some plants have limited water sources, in terms of diversity and redundancy, for core cooling, SFP cooling, and makeup to the RCS and SFP.

Impact on implementation or operational activities resulting from the variation: Plants with limited diversity of water sources (e.g., the plant's only water sources are a condensate storage tank (CST) and a river) are more vulnerable. These plants may have to provide additional, protected water sources, such as a hardened tank. At present, these sites rely on having redundant or diverse paths from the water source (i.e., river, lake, ocean, or pond) to pumps, rather than providing redundant water sources.

Significance of impact on implementation or operational activities: Large hardened tanks are costly. The most costly tanks would be those that need to be protected against seismic, tornado missile, and hurricane events. The NRC staff accounted for some costs associated with upgrading water sources, but could not account for all potential variation in costs across the industry because the OIPs do not provide sufficient information on the extent of variation across the industry.

8. Revised seismic or flood hazard (per response to 10 CFR 50.54(f) letter)

Source of the variation: Licensees currently are re-evaluating seismic and flooding hazards using the most up-to-date seismic and external flood methods and information. This action, which was prompted by NRC's 10 CFR 50.54(f) letters, may lead to the discovery of seismic hazards (e.g., ground motion) or flood hazards (e.g., potential height of an extreme flood) that significantly exceed design basis.

Impact on implementation or operational activities resulting from the variation: If revised hazards are significantly higher than the design basis, the Commission may require plants to mitigate the risks associated with these hazards. For example, if the revised maximum height of an external flood at a site is significantly higher than the design basis flood height, licensees may need to upgrade existing plant equipment, tanks, and structures to comply with the revised flood heights.

Significance of impact on implementation or operational activities in terms of cost: To date, the integrated assessments submitted to the NRC under JLD-ISG-12-05, *Draft Interim Staff Guidance on Performance of an Integrated Assessment for Flooding* have not reflected a significant impact on the FSGs developed in response to Order EA-12-049 (Ref. 11). Any costs resulting from the re-evaluations performed under NTTF Recommendation 2.1 are not attributable to the Order.

B.1.2 Methodology for Estimating the Costs of Order EA-12-051

Order EA-12-051 required licensees and COL holders to install equipment to reliably monitor the water level in SFPs in order to ensure it is adequate to support SFP cooling, to provide radiation shielding for an operator on the SFP operating deck, and to cover the spent fuel.

The methods and assumptions applied to the analysis of Order EA-12-051 largely align with those used in the regulatory analysis, except as discussed below.

Affected Universe

The NRC staff estimates the costs incurred by 60 operating sites that installed SFP instrumentation as a result of Order EA-12-051, as shown in Exhibit B-8. The NRC exempted three decommissioning sites (i.e., Crystal River, Kewaunee, and San Onofre) from the requirements set forth by Order EA-12-051. Vermont Yankee submitted a rescission letter to the NRC that is currently pending approval, and Oyster Creek has announced intentions to decommission. The NRC staff assumes in this analysis that the NRC will approve both sites'

rescission letters.[43] Therefore, the analysis does not include any costs for these five sites. Based on data assembled by the NRC staff, Exhibit 3-9 also shows the NRC staff's estimate for the number of sites that would purchase either two, four, or six SFP instruments.

Exhibit B-8. Number of Sites Purchasing and Installing SFP Instruments

	Number of Sites
Two instruments	40
Three instruments	1
Four instruments	17
Six instruments	2
Total	**60 Sites**

B.1.3 Methodology for Estimating the Cost of Related Industry Initiatives

The NRC staff estimates the costs of related industry initiatives initiated following Fukushima using the methods and assumptions applied to the regulatory analysis, except as discussed below.

Time Period of Analysis

Industry initiatives include costs to affected entities that have been or will be incurred prior to 2017. Specifically, costs associated with voluntary industry initiatives began as early as 2012.

B.2 Analysis of the Cost of Order EA-12-049, Order EA-12-051, and Related Industry Initiatives

This section describes the costs incurred by industry and the NRC as a result of Order EA-12-049, Order EA-12-051, and related industry initiatives. Note that all costs presented in this analysis are rounded to two significant figures. Appendices C through K provide the detailed calculations used to estimate these costs.

Exhibit B-9 summarizes the monetized costs of Order EA-12-049, Order EA-12-051, and related industry initiatives.

Exhibit B-9. Summary of Industry and NRC Costs: Historical Cost Analysis

	Average Cost Per Site		**Total Costs**				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
EA-12-049							
Industry	$24,000,000	$20,000	$1,600,000,000	$1,600,000	$2,200,000,000	$1,500,000,000	$1,500,000,000
NRC	N/A	N/A	$530,000	$1,600,000	$2,100,000	$1,800,000	$2,000,000
Subtotal	*$24,000,000*	*$20,000*	*$1,600,000,000*	*$3,200,000*	*$2,200,000,000*	*$1,500,000,000*	*$1,500,000,000*
EA-12-051							

[43] See SECY 14-0114 for more information regarding the exemption of decommissioning sites from compliance with Order EA-12-051.

	Average Cost Per Site		Total Costs				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Industry	$3,800,000	$15,000	$250,000,000	$1,000,000	$250,000,000	$210,000,000	$230,000,000
NRC	N/A	N/A	$390,000	$150,000	$840,000	$730,000	$790,000
Subtotal	*$3,800,000*	*$15,000*	*$250,000,000*	*$1,200,000*	*$250,000,000*	*$210,000,000*	*$230,000,000*
Other Industry Initiatives							
Industry	$730,000	$8,500	$47,000,000	$550,000	$63,000,000	$25,000,000	$37,000,000
NRC	N/A	N/A	$8,500,000	$15,000	$9,500,000	$2,500,000	$4,900,000
Subtotal	*$730,000*	*$8,500*	*$55,500,000*	*$570,000*	*$73,000,000*	*$28,000,000*	*$42,000,000*
Total							
Industry	$29,000,000	$40,000	$1,900,000,000	$3,200,000	$2,500,000,000	$1,700,000,000	$1,800,000,000
NRC	N/A	N/A	$9,400,000	$1,800,000	$12,000,000	$5,000,000	$7,700,000
Total	**$29,000,000**	**$40,000**	**$1,900,000,000**	**$5,000,000**	**$2,500,000,000**	**$1,700,000,000**	**$1,800,000,000**

*Results are rounded.

B.2.1 Costs of Order EA-12-049

Exhibit B-10 summarizes the monetized costs related to Order EA-12-049, which resulted in a cost of approximately $1.5 billion (using a 7 percent and 3 percent discount rate). These monetized costs are described in more detail in the following sections.

Exhibit B-10. Summary of Costs for Order EA-12-049: Historical Cost Analysis

	Cost Per Site		Total Costs				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Industry							
Initial Response	$4,200,000	N/A	$270,000,000	N/A	$270,000,000	$250,000,000	$260,000,000
Onsite Portable Equipment	$6,900,000	N/A	$450,000,000	N/A	$450,000,000	$420,000,000	$440,000,000
Offsite Portable Equipment	$2,000,000	N/A	$130,000,000	N/A	$130,000,000	$120,000,000	$120,000,000
Supporting Functions	$2,300,000	N/A	$150,000,000	N/A	$150,000,000	$140,000,000	$150,000,000
External Event Considerations	$6,800,000	N/A	$440,000,000	N/A	$440,000,000	$420,000,000	$430,000,000
Programmatic Controls (One-time)	$2,000,000	N/A	$130,000,000	N/A	$130,000,000	$120,000,000	$130,000,000
Programmatic Controls (Annual)	N/A	$20,000	N/A	$1,600,000	$650,000,000	$1,300,000	$1,500,000
Subtotal	*$24,000,000*	*$20,000*	*$1,600,000,000*	*$1,600,000*	*$2,200,000,000*	*$1,500,000,000*	*$1,500,000,000*
NRC							
Licensing	N/A	N/A	$530,000	N/A	$530,000	$490,000	$510,000

	Cost Per Site		Total Costs				
	One-Time Costs	Annual Costs	One-Time Costs	Annual Costs	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
activities							
Inspection activities	N/A	N/A	N/A	$1,600,000	$1,600,000	$1,300,000	$1,500,000
Subtotal	*N/A*	*N/A*	*$530,000*	*$1,600,000*	*$2,100,000*	*$1,800,000*	*$2,000,000*
TOTAL							
Industry	$24,000,000	$20,000	$1,600,000,000	$1,600,000	$2,200,000,000	$1,500,000,000	$1,500,000,000
NRC	N/A	N/A	$530,000	$1,600,000	$2,100,000	$1,800,000	$2,000,000
Total	**$24,000,000**	**$20,000**	**$1,600,000,000**	**$3,200,000**	**$2,200,000,000**	**$1,500,000,000**	**$1,500,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

B.2.1.1 Industry Implementation

Exhibit B-11 lists the upfront costs to industry to implement Order EA-12-049, which amount to a total one-time cost of approximately $1.6 billion. The total present value of these costs is approximately $1.5 billion (using a 7 percent or 3 percent discount rate). The average cost per site is estimated at $24.0 million (based on 65 affected sites).[44]

Exhibit B-11. Present Value of Industry's Implementation Cost

Section	Cost per Site	Total Cost		
	One-Time Cost	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
Initial Response	$4,200,000	$270,000,000	$250,000,000	$260,000,000
Onsite Portable Equipment	$6,900,000	$450,000,000	$420,000,000	$440,000,000
Offsite Portable Equipment	$2,000,000	$130,000,000	$120,000,000	$120,000,000
Supporting Functions	$2,300,000	$150,000,000	$140,000,000	$150,000,000
External Event Considerations	$6,800,000	$440,000,000	$420,000,000	$430,000,000
Programmatic Controls (One-time)	$2,000,000	$130,000,000	$120,000,000	$130,000,000
Total	**$24,000,000**	**$1,600,000,000**	**$1,500,000,000**	**$1,500,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The costs in Exhibit 3-40 are derived from the combined costs of the Order EA-12-049 compliance activities applicable to each reactor type (i.e., BWR, PWR, AP1000s). Because the

[44] Although Order EA-12-049 only imposed costs on 62 sites, the NRC staff used 65 sites as the basis to calculate the average one-time costs per site so that the cost estimate is comparable to the one-time costs per site in the remainder of the historical analysis.

compliance activities differ between reactor types, the following sections provide the implementation costs for each individual reactor type.

BWRs

The following sections detail the initial compliance activities required of a BWR site (i.e., initial response, onsite equipment, offsite equipment, supporting functions, external event considerations, and programmatic controls). These exhibits also provide the compliance activity cost estimates for affected 1-unit, 2-unit, and 3-unit BWR sites.

Exhibit B-12 contains the upfront costs that resulted from the initial response compliance activities. The initial response compliance activities include constructing, installing, and modifying equipment for coping strategies to maintain SFP cooling. The NRC staff estimates that the undiscounted total cost associated with initial response compliance activities for BWRs is $59.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $1.7 million, $3.4 million, and $5.2 million, respectively.

Exhibit B-12. BWR Implementation Cost: Initial Response

Initial Response Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Construct a seismic missile-protected emergency water storage tank (EWST).	$390,000	$770,000	$1,200,000	$13,000,000
Build clean water tank with availability to supply RCIC/ high-pressure coolant injection (HPCI) with water for RCIC/HPCI injection into reactor pressure vessel (RPV).	$390,000	$770,000	$1,200,000	$13,000,000
Install quick-disconnect connection point downstream of the CST isolation valve.	$94,000	$190,000	$280,000	$3,300,000
Install cross connect between the RCIC/HPCI suction supply lines.	$240,000	$470,000	$710,000	$8,200,000
Modify high-pressure core spray (HPCS) service water (SW), HPCS SW return line, and residual heat removal (RHR) C injection piping.	$590,000	$1,200,000	$1,800,000	$21,000,000
Subtotal	**$1,700,000**	**$3,400,000**	**$5,200,000**	**$59,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-13 reports on the upfront costs of onsite portable equipment compliance activities for BWRs. The onsite portable equipment compliance activities involve purchasing portable FLEX equipment and other supplies as well as installing and modifying equipment for coping strategies to maintain SFP cooling. The NRC staff estimates that the undiscounted total cost associated with the onsite portable equipment compliance activities is approximately $290.0

million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $8.2 million, $16.0 million, and $24.0 million, respectively.

Exhibit B-13. BWR Implementation Cost: Onsite Portable Equipment

Onsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Procure portable FLEX equipment (N+1).	$1,300,000	$2,000,000	$2,600,000	$38,000,000
Install quick-disconnect connection point on Auxiliary Steam Supply and an Auxiliary Steam Supply line to RCIC piping interconnection.	$1,100,000	$2,200,000	$3,300,000	$39,000,000
Design and pre-stage modified flange adapter for connection of FLEX pump discharge hose.	$27,000	$53,000	$80,000	$930,000
Modify HPCS SW to install connection points.	$990,000	$2,000,000	$3,000,000	$35,000,000
Add connection points and cabling at control building wall to connect to Buses. Add connection points and transfer switches.	$3,000,000	$6,100,000	$9,100,000	$110,000,000
Procure and install electrical cabling.	$1,600	$3,200	$4,900	$57,000
Modify or refurbish spare breaker on Class 1 E LC 15BA6/16BB6 to make connections from 480 V FLEX DG.	$2,100	$4,100	$6,200	$72,000
Install power cables from outside connection point to alternate decay heat removal (ADHR) power supply.	$1,200	$2,500	$3,700	$43,000
Modify power supply to battery chargers to install welding type receptacles, termination box, disconnects, and cable for quick connection to battery chargers and battery exhaust fan.	$3,200	$6,400	$9,600	$110,000
Modify power supply to Division I SPMU valves by installing a connection point and new permanent cable or conduit to receive backup power from 480 V FLEX DG.	$750,000	$1,500,000	$2,300,000	$26,000,000
Provide cable and raceway (that is seismically supported) from 480 V FLEX DG to battery chargers and battery room exhaust fan.	$100,000	$200,000	$300,000	$3,500,000
Modify or refurbish spare breaker to motor control center (MCC) 16B31 to provide sufficient capacity to power train B RHR support loads from 480 V FLEX DG.	$2,100	$4,100	$6,200	$72,000
Modify connection of 4160 Vac RRC FLEX DG to the Class1E 16AB 4160 Vac.	$750,000	$1,500,000	$2,300,000	$26,000,000
Modify the SFP line by installing 2 connections for 2 separate lines leading to the SFP area for a SFP FLEX hose connection and a SFP FLEX spray connection.	$170,000	$340,000	$520,000	$6,000,000

Onsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Install hard pipe with dual isolation valve to new SFP FLEX connection.	$29,000	$57,000	$76,000	$990,000
Subtotal	**$8,200,000**	**$16,000,000**	**$24,000,000**	**$290,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-14 shows the upfront costs of offsite portable equipment compliance activities for BWRs. Offsite portable equipment compliance activities include procuring offsite equipment and installing equipment for coping strategies to maintain SFP cooling. Note, this cost estimate does not include the licensee's share of RRC costs, which is discussed separately and in greater detail in the RRC costs section. The NRC staff estimates that the undiscounted total cost associated with the offsite portable equipment compliance activities is $1.8 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $52,000, $100,000, and $150,000, respectively.

Exhibit B-14. BWR Implementation Cost: Offsite Portable Equipment

Offsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Procure offsite Phase 3 equipment.*	$48,000	$96,000	$140,000	$1,700,000
Install transfer panel (disconnect switch) in Turbine Building.	$3,600	$7,200	$11,000	$130,000
Subtotal	**$52,000**	**$100,000**	**$150,000**	**$1,800,000**

*This does not include procuring equipment stored at the RRCs.
**Results are rounded.
***All costs in this table are presented in 2013 dollars.
****There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-15 documents the costs of supporting function compliance activities to BWRs. The supporting function compliance activities involve changing the lighting to conserve battery life and conducting an analysis to determine site-specific fuel consumption rates and available supplies. The NRC staff estimates that the undiscounted total cost associated with the supporting function compliance activities is $460,000. The cost per an affected 1-unit, 2-unit, and 3-unit site is $13,000, $27,000, and $40,000, respectively.

Exhibit B-15. BWR Implementation Cost: Supporting Function

Onsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Change emergency control room lighting to LED bulbs to reduce load on batteries.	$3,300	$6,500	$9,800	$110,000
An analysis will be performed to determine site-specific fuel consumption rates and available supplies.	$10,000	$20,000	$30,000	$350,000

Subtotal	**$13,000**	**$27,000**	**$40,000**	**$460,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-16 presents the costs of external event considerations compliance activities to BWRs. The external event considerations compliance activities involve establishing a flood staging area and building onsite FLEX storage buildings to protect equipment. The NRC staff estimates that the undiscounted total cost associated with the external event considerations compliance activities is approximately $200.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $5.3 million, $8.3 million, and $11.0 million, respectively.

Exhibit B-16. BWR Implementation Cost: External Event Considerations

External Event Considerations Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Establish a flood staging area for portable equipment.	$600,000	$1,200,000	$1,800,000	$21,000,000
Design or build onsite FLEX storage buildings (protect from storms and high winds).	$4,700,000	$7,100,000	$9,400,000	$140,000,000
Subtotal	**$5,300,000**	**$8,300,000**	**$11,000,000**	**$200,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-17 summarizes the initial costs of programmatic controls compliance activities to BWRs. The programmatic controls compliance activities include procedural and administrative activities such as developing an OIP as well as procedures for site configuration control, maintenance and testing, and setpoint calculations. Sites ensured that their FSGs were integrated with their EOPs, EDMGs, and SAMGs and established a strategies playbook with the respective RRC. Additionally, sites developed training modules and programs. Furthermore, sites conducted analyses to determine if staffing and commodities were adequate. The NRC staff estimates that the undiscounted total cost associated with the programmatic controls activities is $46.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $1.8 million, $2.2 million, and $2.6 million, respectively.

Exhibit B-17. BWR Implementation Cost: Programmatic Controls

Programmatic Controls Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Develop the OIP.	$340,000	$420,000	$500,000	$9,000,000
Develop strategies (playbook) with RRC.	$27,000	$34,000	$40,000	$720,000
Develop and conduct staffing analysis.	$40,000	$40,000	$40,000	$970,000
Issue FSGs.	$340,000	$500,000	$670,000	$9,900,000

Programmatic Controls Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Modify plant procedures to take into account FSGs. Procedures to be considered include EOP, EDMG, and SAMGs strategies.	$67,000	$100,000	$130,000	$2,000,000
Modify existing plant configuration control procedures to ensure that changes to the plant design physical layout, roads, buildings, and miscellaneous structures will not adversely affect the approved FLEX strategies.	$34,000	$34,000	$34,000	$800,000
Create maintenance and testing procedures.	$84,000	$100,000	$120,000	$2,200,000
Develop training programs for operation of FLEX equipment.	$250,000	$250,000	$250,000	$6,000,000
Develop training modules for personnel that will be responsible for implementing the FLEX strategies.	$250,000	$300,000	$350,000	$6,600,000
Develop design requirements and supporting analysis for portable FLEX equipment.	$170,000	$200,000	$230,000	$4,400,000
An analysis will be performed to determine commodity requirements.	$6,700	$6,700	$6,700	$160,000
Involvement with industry group activities.	$63,000	$66,000	$69,000	$1,500,000
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.	$84,000	$100,000	$130,000	$2,200,000
Subtotal	**$1,800,000**	**$2,200,000**	**$2,600,000**	**$46,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

The NRC staff provides more detail on the costs presented for these BWR compliance activities (i.e., equipment and labor costs, quantities needed, wage rates) in Appendices E, F, and G.

PWRs

The following sections detail the initial compliance activities required of a PWR site (i.e., initial response, onsite equipment, offsite equipment, supporting functions, external event considerations, and programmatic controls). These exhibits also provide the compliance activity cost estimates for affected 1-unit, 2-unit, and 3--unit PWR sites.

Exhibit B-18 presents the upfront costs of initial response compliance activities to PWRs. The initial response compliance activities include constructing, installing, upgrading, and modifying equipment for coping strategies to maintain SFP cooling. The NRC staff estimates that the undiscounted total cost associated with initial response compliance activities for PWRs is approximately $210.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $3.1 million, $6.4 million, and $9.6 million, respectively.

Exhibit B-18. PWR Implementation Cost: Initial Response

Initial Response Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Harden and protect the dedicated shutdown diesel generator (DG).	$87,000	$170,000	$260,000	$5,700,000
Install a robust, shielded connection on each reactor makeup water storage tank (RMWST).	$1,500,000	$3,100,000	$4,600,000	$100,000,000
Upgrade non-seismic condensate transfer pump suction nozzle to seismic qualification.	$24,000	$47,000	$71,000	$1,600,000
Construct a seismic, missile-protected EWST.	$390,000	$770,000	$1,200,000	$25,000,000
Construct a seismic, missile-protected tank to provide a protected water source for core cooling and heat removal strategies.	$420,000	$850,000	$1,300,000	$28,000,000
Install clean water receiver tank (CWRT) (high wind/missile protected and contains borated water).	$390,000	$770,000	$1,200,000	$25,000,000
Modify power controls for SG PORVs from a direct current-powered (dc) instrument bus.	$6,200	$12,000	$19,000	$410,000
Install permanent nitrogen bottle racks near each SG PORV operating station with hose and regulators.	$28,000	$56,000	$84,000	$1,800,000
Install Westinghouse low-leakage RCP seals.	$270,000	$540,000	$810,000	$18,000,000
Seismically upgrade the Alternate Seal Injection (ASI) system and add an ASI pump discharge path to the chemical and volume control system (CVCS) charging header.	$31,000	$61,000	$92,000	$2,000,000
Subtotal	**$3,100,000**	**$6,400,000**	**$9,600,000**	**$210,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-19 summarizes the initial costs of onsite portable equipment compliance activities to PWRs. The onsite portable equipment activities involve purchasing portable FLEX equipment and other supplies as well as installing and modifying equipment for coping strategies to maintain SFP cooling. The NRC staff estimates that the undiscounted total cost associated with onsite portable equipment compliance activities is approximately $170.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $2.7 million, $5.1 million, and $7.6 million, respectively.

Exhibit B-19. PWR Implementation Cost: Onsite Portable Equipment

Onsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Procure portable FLEX equipment (N+1).	$590,000	$940,000	$1,300,000	$32,000,000

Onsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Install diverse suction connections and fill connections on each CST. Install seismically-rugged new pipes.	$690,000	$1,400,000	$2,100,000	$46,000,000
Install connection points downstream of the charging pump discharge header.	$240,000	$470,000	$710,000	$16,000,000
Add branch connections with quick disconnect fittings to the boric acid transfer pump suction header. Install permanent piping to CVCS crosstie. Provide a branch from the CVCS drain line. Modify vent connection. Resize the CVCS crosstie drain line.	$330,000	$660,000	$980,000	$22,000,000
Add FLEX pump discharge connection points to both trains of the essential service water (ESW) system.	$190,000	$370,000	$560,000	$12,000,000
Install a connection point downstream of the EFW Pump.	$110,000	$220,000	$330,000	$7,300,000
Modify spare breaker for 480V FLEX DG connection. Install new vertical section on switchgear for 4160V FLEX DG connection.	$2,100	$4,100	$6,200	$140,000
Route a cable via a new penetration through the north wall of the Auxiliary Building.	$210,000	$420,000	$630,000	$14,000,000
Install supply and return connections outside containment to supply supplemental cooling to the containment fan coolers.	$190,000	$380,000	$560,000	$12,000,000
Route a new header directly to the SFP just above the normal water level.	$32,000	$63,000	$95,000	$2,100,000
Install spray nozzles in the Fuel Handling Building.	$96,000	$190,000	$290,000	$6,400,000
Subtotal	**$2,700,000**	**$5,100,000**	**$7,600,000**	**$170,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-20 documents the upfront costs of offsite portable equipment activities to PWRs. Offsite portable equipment compliance activities included procuring offsite equipment and installing equipment for coping strategies to maintain SFP cooling. Note, this cost estimate does not include the licensee's share of RRC costs, which is discussed separately and in greater detail in RRC costs section. The NRC staff estimates that the undiscounted total cost associated with offsite portable equipment compliance activities is approximately $53.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $810,000, $1.6 million, and $2.4 million, respectively.

Exhibit B-20. PWR Implementation Cost: Offsite Portable Equipment

Offsite Portable Equipment Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Procure offsite Phase 3 equipment.	$48,000	$96,000	$140,000	$3,200,000
Modify bus to allow connection of portable DG.	$760,000	$1,500,000	$2,300,000	$50,000,000
Subtotal	**$810,000**	**$1,600,000**	**$2,400,000**	**$53,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-21 presents the costs of supporting function compliance activities to PWRs. The supporting function compliance activities involved upgrading the lighting to conserve battery life and installing connection points. The NRC staff estimates that the undiscounted total cost associated with supporting function compliance activities is approximately $150.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $2.3 million, $4.5 million, and $6.8 million, respectively.

Exhibit B-21. PWR Implementation Cost: Supporting Function

Supporting Functions Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Upgrade dc emergency lighting units with LED lamps.	$3,300	$6,500	$9,800	$220,000
Install a connection to drain line located on the supply line to the emergency diesel generator (EDG).	$750,000	$1,500,000	$2,300,000	$50,000,000
Add connection points at Diesel fuel Oil Storage Tanks.	$1,500,000	$3,000,000	$4,500,000	$99,000,000
Subtotal	**$2,300,000**	**$4,500,000**	**$6,800,000**	**$150,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-22 reports the costs of external event considerations compliance activities to PWRs. The external event considerations compliance activities involved establishing a flood staging area and building onsite FLEX storage buildings to protect equipment. The NRC staff estimates that the undiscounted total cost associated with external event considerations compliance activities is approximately $280.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $5.3 million, $8.3 million, and $11.0 million, respectively.

Exhibit B-22. PWR Implementation Cost: External Event Considerations

External Event Considerations Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Develop a staging area for FLEX equipment.	$600,000	$1,200,000	$1,800,000	$40,000,000

External Event Considerations Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Build two FLEX storage locations.	$4,700,000	$7,100,000	$9,400,000	$240,000,000
Subtotal	**$5,300,000**	**$8,300,000**	**$11,000,000**	**$280,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-23 presents the costs of programmatic controls compliance activities to PWRs. The programmatic controls compliance activities included procedural and administrative activities such as developing an OIP as well as procedures for site configuration control, maintenance and testing, and setpoint calculations. Sites ensured that their FSGs were integrated with their EOPs, EDMGs, and SAMGs and established a strategies playbook with the respective RRC. Additionally, sites developed training modules and programs. Furthermore, sites conducted analyses to determine if staffing and commodities were adequate. The NRC staff estimates that the undiscounted total cost associated with programmatic controls compliance activities is $77.0 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $1.8 million, $2.1 million, and $2.6 million, respectively.

Exhibit B-23. PWR Implementation Cost: Programmatic Controls

Programmatic Controls Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Develop the OIP.	$340,000	$420,000	$500,000	$15,000,000
Develop strategies (playbook) with RRC.	$27,000	$34,000	$40,000	$1,200,000
Develop and conduct staffing analysis.	$40,000	$40,000	$40,000	$1,500,000
Issue FSGs.	$340,000	$500,000	$670,000	$17,000,000
Modify plant procedures to take into account FSGs. Procedures to be considered include EOP, EDMG, and SAMGs strategies.	$67,000	$100,000	$130,000	$3,500,000
Modify plant configuration control procedures to ensure that changes to the physical layout, roads, buildings, and miscellaneous structures will not adversely affect the FLEX strategies.	$34,000	$34,000	$34,000	$1,300,000
Create maintenance and testing procedures.	$84,000	$100,000	$120,000	$3,700,000
Develop training programs for operation of FLEX equipment.	$250,000	$250,000	$250,000	$9,500,000
Develop training modules for personnel that will be responsible for implementing the FLEX strategies.	$250,000	$310,000	$380,000	$11,000,000
Develop design requirements and supporting analysis for portable FLEX equipment.	$170,000	$200,000	$230,000	$7,300,000
An analysis will be performed to determine commodity requirements.	$6,700	$6,700	$6,700	$250,000
Involvement with industry group activities.	$63,000	$66,000	$69,000	$2,500,000

Programmatic Controls Compliance Activity	Cost per Affected 1-Unit Site	Cost per Affected 2-Unit Site	Cost per Affected 3-Unit Site	Total Cost
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.	$84,000	$84,000	$84,000	$3,200,000
Subtotal	**$1,800,000**	**$2,100,000**	**$2,600,000**	**$77,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

The NRC staff provides more detail on the costs presented for these PWR compliance activities (i.e., equipment and labor costs, quantities needed, wage rates) in Appendices H, I, and J.

AP1000s

This section details the initial compliance activities required of an AP1000 site (i.e., programmatic controls) and the cost estimates associated with these activities. Although the AP1000 units are currently being constructed on sites with operating units (i.e., Virgil C. Summer and Vogtle), the historical cost analysis accounts for the costs for the AP1000 units on these sites separately.

Exhibit B-24 presents the costs of programmatic controls compliance activities to AP1000s. The programmatic controls compliance activities included procedural and administrative activities such as developing an OIP as well as procedures for site configuration control, maintenance and testing, and setpoint calculations. Sites ensured that their FSGs were integrated with their EOPs, EDMGs, and SAMGs and established a strategies playbook with the respective RRC. Additionally, sites developed training modules and programs. Furthermore, sites conducted analyses to determine if staffing and commodities are adequate. The NRC staff estimates that the undiscounted total cost associated with programmatic controls compliance activities is $6.1 million. The cost per an affected 2-unit site is $2.2 million.

Exhibit B-24. AP1000 Implementation Cost: Programmatic Controls

Programmatic Controls Compliance Activity	Cost per Affected 2-Unit Site	Total Cost
Develop the OIP.	$400,000	$800,000
Develop strategies (playbook) with RRC.	$34,000	$67,000
Develop and conduct staffing analysis.	$40,000	$80,000
Issue FSGs.	$500,000	$1,000,000
Modify plant procedures to take into account FSGs. Procedures to be considered include EOP, EDMG, and SAMGs strategies.	$100,000	$200,000
Modify plant configuration control procedures to ensure that changes to the physical layout, roads, buildings, and miscellaneous structures will not adversely affect the FLEX strategies.	$67,000	$130,000
Create maintenance and testing procedures.	$100,000	$200,000
Develop training programs for operation of FLEX equipment.	$250,000	$500,000

Programmatic Controls Compliance Activity	Cost per Affected 2-Unit Site	Total Cost
Develop training modules for personnel that will be responsible for implementing the FLEX strategies.	$300,000	$600,000
Develop design requirements and supporting analysis for portable FLEX equipment.	$200,000	$400,000
An analysis will be performed to determine commodity requirements.	$6,700	$13,000
Involvement with industry group activities.	$66,000	$790,000
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.	$100,000	$1,300,000
Subtotal	**$2,200,000**	**$6,100,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***There are two 2-unit AP1000 sites.

The NRC staff provides more detail on the costs presented for these AP1000 compliance activities (i.e., equipment and labor costs, quantities needed, wage rates) in Appendix K.

RRC Costs

To comply with the Order EA-12-049 requirements, industry decided to pre-stage equipment and resources at an offsite location. These resources will be available to sites within 24 hours after an event, and must provide the capability to sustain core cooling, containment, and SFP cooling indefinitely following a BDBEE. Industry established two RRCs: one in Phoenix, Arizona and another near Memphis, Tennessee. Exhibit B-25 presents the types of equipment that are expected to be available through the RRCs, the quantities of equipment available, and the estimated unit costs. This list of equipment was compiled based on the information provided in the sampled OIPs (See Exhibit B-7 for the list of sites sampled). The undiscounted total cost for both RRCs is estimated to be $54.0 million. The costs for equipping the RRCs will be shared equally by all 62 sites. The estimated cost per site is, therefore, $870,000.

Exhibit B-25. Cost of Offsite Equipment at RRCs

Equipment	Quantity in a "Set"	Unit Cost	Total Cost per RRC (5 Sets)	Total Costs for 2 RRCs (10 Sets)
	a	**b**	**c =a x b x 5**	**d =a x b x 10**
4 kV and 6.9 kV DG	3	$900,000	$14,000,000	$27,000,000
4 kV and 6.9 kV DG switchgear & transformer	3	$66,000	$990,000	$2,000,000
600 V generator	1	$100,000	$500,000	$1,000,000
Boron mixing system	2	$20,000	$200,000	$400,000
Cables for connecting portable generators	6	$4,000	$120,000	$240,000
Communication Gear: Antenna cable	2	$600	$6,000	$12,000

Equipment	Quantity in a "Set"	Unit Cost	Total Cost per RRC (5 Sets)	Total Costs for 2 RRCs (10 Sets)
	a	b	c =a x b x 5	d =a x b x 10
Communication Gear: Dc automobile outlet charger cord to charge single- and four-bay battery chargers	8	$20	$800	$2,000
Communication Gear: Docking station	1	$2,000	$10,000	$20,000
Communication Gear: Emergency kit	5	$2,000	$50,000	$100,000
Communication Gear: Fixed mast antenna	2	$200	$2,000	$4,000
Communication Gear: Four-bay satellite phone battery charger	8	$600	$24,000	$48,000
Communication Gear: Mobile phone	1	$1,000	$5,000	$10,000
Communication Gear: Rechargeable batteries	15	$100	$8,000	$16,000
Communication Gear: Single-bay satellite phone battery charger	8	$200	$8,000	$16,000
Communication Gear: Solar panel charger	4	$200	$4,000	$8,000
DG fuel transfer pump	3	$6,000	$90,000	$180,000
Female NPT SS hydraulic coupling	8	$50	$2,000	$4,000
Fuel air-lift container	1	$2,000	$10,000	$20,000
Heavy equipment for transportation and debris clearing	1	$290,000	$1,400,000	$2,900,000
High-capacity pump (diesel driven)	3	$20,000	$300,000	$600,000
High-pressure hose (50 ft)	4	$2,000	$40,000	$80,000
High-pressure hose (100 ft)	4	$6,000	$120,000	$240,000
High-pressure pump (diesel driven)	2	$20,000	$200,000	$400,000
High-pressure suction hose	2	$5,000	$50,000	$100,000
Holder, hydrant wrench, & spanner wrench	1	$200	$1,000	$2,000
Low-pressure, high-flow dewatering pump/ Suction booster lift pump	2	$55,000	$550,000	$1,100,000
Low-pressure, high-flow suction hose	12	$500	$30,000	$60,000
Low-pressure, medium-flow and low-pressure, high-flow discharge hose	48	$3,000	$720,000	$1,400,000

Equipment	Quantity in a "Set"	Unit Cost	Total Cost per RRC (5 Sets)	Total Costs for 2 RRCs (10 Sets)
	a	b	c =a x b x 5	d =a x b x 10
Low-pressure, medium-flow pump	1	$93,000	$470,000	$930,000
Low-pressure, medium-flow suction hose	8	$500	$20,000	$40,000
Low-voltage distribution transformer	4	$80,000	$1,600,000	$3,200,000
Low-voltage generator (1,100 kW)	1	$720,000	$3,600,000	$7,200,000
Low-voltage generator (250 kW)	2	$85,000	$850,000	$1,700,000
Portable air compressor	2	$13,000	$130,000	$260,000
Portable diesel fuel tank	1	$5,000	$25,000	$50,000
Portable lighting	6	$4,000	$120,000	$240,000
Portable submersible pump hose	1	$400	$2,000	$4,000
Portable toilet	10	$800	$40,000	$80,000
Portable ventilation fan	3	$2,000	$30,000	$60,000
SG/RPV hose	9	$800	$36,000	$72,000
SG/RPV suction hose	4	$500	$10,000	$20,000
Single phase generator	2	$7,000	$70,000	$140,000
Storz adapter	3	$200	$3,000	$6,000
Storz spanner wrench with holder	1	$100	$500	$1,000
Storz, storz outlet, storz inlet	1	$1,000	$5,000	$10,000
Storz to NH swivel rocker lug female thread	2	$200	$2,000	$4,000
Strainer	12	$1,000	$60,000	$120,000
Temporary housing	1	$100,000	$500,000	$1,000,000
Water purification skid	2	$40,000	$400,000	$800,000
Water storage	3	$9,000	$140,000	$270,000
Total			**$28,000,000**	**$54,000,000**
Total Cost Per Site				**$870,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The NRC staff also estimates the upfront costs to staff the RRCs and train the workers operating the RRCs, as well as to move the equipment into the RRCs. Exhibit B-26 lists the estimated unit costs for these activities. The undiscounted total cost for both RRCs is $16.0 million. The costs for the RRCs will be shared equally by all 62 sites. The estimated cost per site is approximately $280,000.

Exhibit B-26. Cost of Staffing, Training, Outfitting, and Moving at RRCs

	Cost per RRC	Total Cost (2 RRCs)

Staffing and Training Cost	$8,000,000	$16,000,000
Outfitting Costs (e.g., warehousing, transport, positioning equipment)	$750,000	$1,500,000
Moving Cost	$8,000	$16,000
Total	**$8,800,000**	**$18,000,000**
Total Cost Per Site		**$280,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

B.2.1.2 Industry Operation

Exhibit B-27 reports the industry's annual costs. The NRC staff estimates that industry will incur an annual cost of approximately $34.0 million. The present value of these costs is approximately $270.0 million (using a 7-percent discount rate) and $420.0 million (using a 3-percent discount rate). With 65 sites, the estimated annual cost per site is $520,000.[45]

Exhibit B-27. Present Value of Industry's Operations Cost

Section	Cost Per Site	Total Cost		
	Annual Cost	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
Programmatic Controls (Annual)	$520,000	$34,000,000	$270,000,000	$420,000,000
Total	**$520,000**	**$34,000,000**	**$270,000,000**	**$420,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The costs in Exhibit 3-56 are derived from the combined costs of the compliance activities from each reactor type (i.e., BWR, PWR, AP1000s). Because the compliance activities differ between reactor types, the following sections provide the costs for BWR, PWR, and AP1000 sites individually.

BWRs

Exhibit B-28 presents the costs of annual programmatic controls compliance activities to BWRs. The annual programmatic controls compliance activities include preparing and submitting 6-month status updates on the implementation of the mitigation strategies, performing maintenance and testing, conducting training, implementing change control, and maintaining the FSGs. Note, this cost estimate does not include the licensee's share of RRC costs, which is discussed separately and in greater detail in the RRC costs section. The NRC staff estimates that BWRs will incur annual costs associated with programmatic controls compliance activities of $4.7 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $160,000, $240,000, and $310,000, respectively.

[45] Although Order EA-12-049 only imposed costs on 62 sites under the historical cost analysis, the NRC staff used 65 sites as a metric to calculate the one-time costs per site in order to have a cost that is comparable to the one-time costs per sites in the remainder of the historical analysis.

Exhibit B-28. BWR Operations Cost: Programmatic Controls

Programmatic Controls	Annual Cost per Affected 1-Unit Site	Annual Cost per Affected 2-Unit Site	Annual Cost per Affected 3-Unit Site	Annual Cost
6-month status reports on implementation of mitigation strategies.*	$8,400	$13,000	$17,000	$250,000
Maintenance and testing.	$34,000	$34,000	$34,000	$800,000
Conduct training.	$84,000	$150,000	$210,000	$2,700,000
Change control. FLEX equipment will be documented and controlled by the existing plant modification process.	$13,000	$20,000	$27,000	$400,000
Maintenance of the FSGs.	$20,000	$26,000	$21,000	$540,000
Total	**$160,000**	**$240,000**	**$310,000**	**$4,700,000**

*This does not include ongoing costs for RRCs.
**Results are rounded.
***All costs in this table are presented in 2013 dollars.
****There are 14 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

The NRC staff provides more detail on the costs presented for these BWR compliance activities (i.e., equipment and labor costs, quantities needed, wage rates) in Appendices E, F, and G.

PWRs

Exhibit B-29 contains the costs of annual programmatic controls compliance activities to PWRs. The annual programmatic controls compliance activities include preparing and submitting 6-month status updates on the implementation of the mitigation strategies, performing maintenance and testing, conducting training, implementing change control, and maintaining the FSGs. Note, this cost estimate does not include the licensee's share of RRC costs, which is discussed separately and in greater detail in the RRC costs section. The NRC staff estimates that PWRs will incur annual costs associated with programmatic controls compliance activities of $8.3 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $160,000, $240,000, and $320,000, respectively.

Exhibit B-29. PWR Operations Cost: Programmatic Controls

Programmatic Controls	Annual Cost per Affected 1-Unit Site	Annual Cost per Affected 2-Unit Site	Annual Cost per Affected 3-Unit Site	Annual Cost
6-month status reports on implementation of mitigation strategies.*	$8,400	$13,000	$17,000	$440,000
Maintenance and testing.	$34,000	$34,000	$34,000	$1,300,000
Conduct training.	$84,000	$150,000	$210,000	$4,900,000
Change control. FLEX equipment will be documented and controlled by the existing plant modification process.	$13,000	$20,000	$27,000	$700,000
Maintenance of the FSGs.	$20,000	$26,000	$32,000	$930,000

Programmatic Controls	Annual Cost per Affected 1-Unit Site	Annual Cost per Affected 2-Unit Site	Annual Cost per Affected 3-Unit Site	Annual Cost
Subtotal	**$160,000**	**$240,000**	**$320,000**	**$8,300,000**

*This does not include ongoing costs for RRCs.
**Results are rounded.
***All costs in this table are presented in 2013 dollars.
****There are 12 1-unit PWR sites, 24 2-unit PWR sites, and two 3-unit PWR site.

The NRC staff provides more detail on the costs presented for these PWR compliance activities (i.e., equipment and labor costs, quantities needed, wage rates) in Appendices H, I, and J.

AP1000s

Exhibit B-30 presents the costs of annual programmatic controls compliance activities to AP1000s. The annual programmatic controls compliance activities include preparing and submitting 6-month status updates on the implementation of the mitigation strategies, performing maintenance and testing, conducting training, implementing change control, and maintaining the FSGs. Note, this cost estimate does not include the licensee's share of RRC costs, which is discussed separately and in greater detail in the RRC costs section. The NRC staff estimates that AP1000s will incur annual costs associated with programmatic controls compliance activities of $480,000. The cost per an affected 2-unit site is $250,000.

Exhibit B-30. AP1000 Operations Cost: Programmatic Controls

Programmatic Controls	Annual Cost per Affected 2-Unit Site	Annual Cost
6-month status reports on implementation of mitigation strategies.*	$13,000	$25,000
Maintenance and testing.	$34,000	$67,000
Conduct training.	$150,000	$290,000
Change control. FLEX equipment will be documented and controlled by the existing plant modification process.	$25,000	$50,000
Maintenance of the FSGs.	$26,000	$52,000
Subtotal	**$250,000**	**$480,000**

*This does not include ongoing costs for RRCs.
**Results are rounded.
***All costs in this table are presented in 2013 dollars.
****There are two 2-unit AP1000 sites.

The NRC staff provides more detail on the costs presented for these AP1000 compliance activities (i.e., equipment and labor costs, quantities needed, wage rates) in Appendix K.

RRCs

Industry has chosen to comply with the Order EA-12-049 requirements by pre-staging Phase 3 equipment and resources at an offsite location. These resources must be available to sites

within 24 hours after an event, and must provide the capability to sustain core cooling, containment, and SFP cooling indefinitely following a BDBEE. As discussed earlier in this analysis, industry established two RRCs (one in Phoenix, Arizona and another near Memphis, Tennessee). Exhibit B-31 presents the types of activities that are expected to be performed by the RRCs (such as maintenance and transportation). The NRC staff estimates that transportation costs will be approximately $5.7 million per year for the first three years and will decrease to $450,000 per year for all subsequent years. The NRC staff assumes that costs related to the RRCs are variable in the sense that after a site submits its exemption analysis, it will no longer contribute to the RRC costs. The undiscounted total cost for both RRCs is $9.0 million. The costs for the RRCs will be shared equally by all 62 sites. Therefore, the estimated cost per site is $150,000.

Exhibit B-31. Quantity and Cost of Ongoing RRC Activities

COMPONENT	Annual Cost per RRC	Total Annual Costs (2 RRCs)
Maintenance activities	$4,000,000	$8,000,000
Transportation capability (For After 3 Years)	$450,000	$900,000
Total	**$4,500,000**	**$9,000,000**
Total Cost Per Site		**$150,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***The annual transportation capability cost data represent the per year costs incurred by sites after the first three years in which operating costs are incurred.

B.2.1.3 NRC Implementation

Exhibit B-32 presents the NRC's total upfront costs of licensing activities related to Order EA-12-049. The NRC staff estimates the total undiscounted cost of licensing activities amounted to approximately $530,000. The total present value of these costs is approximately $490,000 (using a 7 percent discount rate) and $510,000 (using a 3 percent discount rate).

Exhibit B-32. Present Value of NRC Implementation Cost

Section	Total Cost		
	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
Implementation Costs (Licensing Activities)	$530,000	$490,000	$510,000
Total	**$530,000**	**$490,000**	**$510,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

B.2.1.4 NRC Operation

The NRC also will incur ongoing, operations costs (specifically, inspection activities). These annual costs are assumed to begin in 2014 and accrue over two years.

Exhibit B-33 provides the NRC's total operations costs (i.e., inspection activities) which amount to an annual cost of approximately $530,000. The total present value of these costs is

approximately $1.3 million (using a 7 percent discount rate) and $1.5 million (using a 3 percent discount rate).

Exhibit B-33. Present Value of NRC Operations Cost

Section	Total Costs		
	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
Operations Costs (Inspections)	$530,000	$1,300,000	$1,500,000
Total	**$530,000**	**$1,300,000**	**$1,500,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

B.2.2 Costs of Order EA-12-051

Exhibit B-34 summarizes the estimated costs of Order EA-12-051. Under the historical cost analysis, the requirements contained in Order EA-12-051 impose costs between $210.0 million and $230.0 million (using a 7-percent and 3-percent discount rate, respectively). These costs are described in more detail in the following sections.

Exhibit B-34. Summary of Costs for Order EA-12-051

	Average Cost Per Site		Total Cost				
	One-Time Cost	Annual Cost	One-Time Cost	Annual Cost	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
SFP Instrumentation							
Industry	$3,800,000	$15,000	$250,000,000	$1,000,000	$250,000,000	$210,000,000	$230,000,000
NRC	N/A	N/A	$390,000	$150,000	$840,000	$730,000	$790,000
Total	**$3,800,000**	**$15,000**	**$250,000,000**	**$1,200,000**	**$250,000,000**	**$210,000,000**	**$230,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***The annual cost data represents the per year costs incurred by sites during their operating license term.

B.2.2.1 Industry Implementation

According to information on Order EA-12-051, 60 sites incurred implementation costs resulting from the Order. These costs included procedural and administrative activities (such as purchasing and installing SFP instrumentation, purchasing spare SFP instruments, developing industry guidance, and preparing and submitting 6-month updates to their integrated plans). These upfront costs are assumed to be incurred between 2012 and 2016.

Exhibit B-35 lists the industry's implementation costs, which amount to a total upfront cost of approximately $250.0 million. The total present value of these costs is approximately $200 million (using a 7 percent discount rate) and $230.0 million (using a 3 percent discount rate). The average cost per site is estimated at $3.8 million.

Exhibit B-35. Present Value of Industry's Implementation Cost

Section	Average Cost per Site	Total Cost		
	One-Time Cost	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
SFP Instrumentation	$3,800,000	$250,000,000	$200,000,000	$230,000,000
Total	**$3,800,000**	**$250,000,000**	**$200,000,000**	**$230,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

Exhibit B-36 contains the SFP instrumentation compliance activities. The NRC staff assumes that after the Order was issued, 60 operating sites purchased and installed SFP instrumentation on a rolling basis from 2014 to 2016. The NRC staff estimated the number of instruments purchased per site as follows:

- Forty sites purchased two instruments,
- One site purchased three instruments,
- Seventeen sites purchased four instruments, and
- Two sites purchased six instruments.

The NRC staff assumes that installation costs decreased by 20 percent for each of the first four instruments installed. For example, installation of one instrument cost $1.8 million based on NRC staff's unit cost estimates. Installation of two instruments cost $3.2 million (i.e., the first installation cost $1.8 million and the second cost $1.4 million, 80 percent of $1.8 million). Installation of three instruments cost $4.3 million (i.e., the third installation cost $1.1 million, 60 percent of $1.8 million).

In addition, each affected site purchased one spare instrument, and each RRC purchased six spare instruments for a total of 72 spare instruments. The NRC staff estimates that the cost of a spare instrument is 10 percent of the cost to install one instrument ($1.8 million). The NRC staff assumes that industry purchased spares on a rolling basis from 2014 to 2016.

Industry developed implementation guidance (i.e., NEI 12-02). Additionally, each site incurred costs to prepare and submit its first and second 6-month update to its integrated plans. The undiscounted total implementation cost is estimated to be $250 million.

Exhibit B-36. Industry Implementation Cost: SFP Instrumentation

Activity	Average Cost per Affected Site	Total Cost
Purchase and install SFP instrumentation	$3,200,000	$130,000,000
	$4,300,000	$4,300,000
	$5,000,000	$86,000,000
	$6,500,000	$13,000,000
Purchase spare instruments	N/A	$13,000,000
Develop industry guidance (NEI 12-02)	N/A	$240,000

Activity	Average Cost per Affected Site	Total Cost
Prepare and submit first and second 6-month update to integrated plan	$31,000	$1,900,000
Subtotal		**$250,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.5 for additional detail on these cost estimates.

B.2.2.2 Industry Operation

Order EA-12-051 also resulted in operations costs. These costs include routine and recurring activities (such as preparing and submitting 6-month status updates to integrated plans and testing SFP instrumentation). These annual costs are assumed to begin in 2014 and accrue over the remaining license term.

Exhibit B-37 presents the industry's operations costs. The NRC staff estimates that industry will incur an annual cost of approximately $1.0 million. The present value of these costs is approximately $2.8 million (using a 7 percent discount rate) and $3.5 million (using a 3 percent discount rate). The average annual cost per site is $15,000 (based on 65 sites).

Exhibit B-37. Present Value of Industry's Operations Cost

Section	Average Cost per Site	Total Cost		
	Annual Cost	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
SFP Instrumentation	$15,000	$1,000,000	$2,800,000	$3,500,000
Total	**$15,000**	**$1,000,000**	**$2,800,000**	**$3,500,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

Exhibits B-38 and B-39 present the costs of annual SFP instrumentation compliance activities that will be incurred during sites' operating license terms and during the first two years of decommissioning, respectively.

Costs associated with testing SFP instrumentation will be incurred during the operating term and during the first two years of the decommissioning period. The NRC staff assumes that the 58 BWR and PWR sites will incur operating costs beginning in 2017 and ending in 2040 (the average remaining industry-wide operating license term for currently licensed BWR and PWR sites). The two AP1000 sites will incur operating costs associated with testing SFP instrumentation from 2017 to 2077 (the average remaining industry-wide operating license term for current AP1000 sites). See Section 3.1 of the regulatory analysis for more detail on how these average license terms were derived.

Each site also will incur costs once the licensee has prepared and submitted the appropriate decommissioning certifications to the NRC. The NRC staff assumes that for two years following the end of the operating license term (2041 and 2042), the 58 BWR and PWR sites will incur

costs to test their SFP instrumentation, while the two AP1000 sites will incur these costs in 2078 and 2079.

Assumptions Related to Costs Incurred During the Operating Period

Costs associated with preparing and submitting the third through eighth update to a site's integrated plan will be incurred beginning in 2014 through 2017. The NRC staff assumes that each of the 60 operating sites prepared and submitted eight 6-month updates to their integrated plans. The costs associated with the first and second updates to the integrated plan are discussed in Appendix B.2.1. The NRC staff assumes that the third through eighth 6-month updates will require half the effort of the first two.

Each of the 60 operating sites will also incur costs to test SFP instrumentation on a biennial basis. The cost to test the SFP instrumentation does not vary by the number of instruments onsite. The NRC staff estimates that during the sites' operating periods, industry will incur a cost of $1.0 million.

Exhibit B-38. Industry Operations Cost: SFP Instrumentation (During the Operating Period)

Activity	Average Annual Cost per Affected Site	Annual Cost
Prepare and submit third through eighth 6-month updates to integrated plan	$16,000	$940,000
Test SFP instrumentation (operating sites)	$2,000	$59,000
Subtotal		**$1,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.5 for additional detail on these cost estimates.

Assumptions Related to Costs Incurred During the First Two Years of Decommissioning

The NRC staff assumes that each of the 60 sites will continue to incur costs relating to testing SFP instrumentation on a biennial basis during the first two years of decommissioning. The LOE required will not vary based on the number of SFP instruments.

Exhibit B-39. Industry Operations Cost: SFP Instrumentation (During the First Two Years of Decommissioning)

Activity	Average Annual Cost per Affected Site	Annual Cost
Test SFP instrumentation (BWR and PWR decommissioning sites)	$2,000	$57,000
Test SFP instrumentation (AP1000 sites)	$2,000	$2,000
Subtotal		**$59,000**

*Results are rounded.
**See Appendix D.2 for additional detail on these cost estimates.

B.2.2.3 NRC Implementation

Order EA-12-051 also imposed implementation costs on the NRC. These costs include procedural and administrative activities (such as inspecting SFP instrumentation, as well as reviewing and approving industry guidance and 6-month updates to integrated plans). These initial costs are assumed to be incurred over the period from 2012 to 2016.

Exhibit B-40 presents the NRC's total implementation costs which amount to a one-time cost of approximately $390,000. The total present value of these costs is approximately $360,000 (using a 7 percent discount rate) and $380,000 (using a 3 percent discount rate).

Exhibit B-40. Present Value of NRC's Implementation Cost

Section	Total Cost		
	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
SFP Instrumentation	$390,000	$360,000	$380,000
Total	**$390,000**	**$360,000**	**$380,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

Exhibit B-41 presents the costs of annual SFP Instrumentation compliance activities. The NRC reviewed the industry guidance (i.e., NEI 12-02) as well as the sites' integrated plans. In addition, the NRC inspected the SFP instrumentation over a 3-year period beginning in 2014. The NRC staff estimates that the NRC incurred $390,000 in implementation costs.

Exhibit B-41. NRC Implementation Cost: SFP Instrumentation

Activity	Total Cost
Inspect SFP instrumentation	$60,000
Review industry guidance (NEI 12-02)	$35,000
Review first and second 6-month updates to integrated plans	$300,000
Subtotal	**$390,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.5 for additional detail on these cost estimates.

B.2.2.4 NRC Operation

The NRC also will incur ongoing, operations costs (specifically, reviewing 6-month updates to integrated plans). These annual costs are assumed to begin in 2014 and accrue over the following two years.

Exhibit B-42 provides the NRC's total operations costs which amount to an annual cost of approximately $150,000. The total present value of these costs is approximately $360,000 (using a 7 percent discount rate) and $410,000 (using a 3 percent discount rate).

Exhibit B-42. Present Value of NRC Operations Cost

Section	Total Cost

	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
SFP Instrumentation	$150,000	$360,000	$410,000
Total	**$150,000**	**$360,000**	**$410,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The NRC will review updates to the sites' integrated plans. The NRC staff assumes that reviewing the third through eighth 6-month updates will take the NRC half the LOE needed to review the first and second 6-month updates. Exhibit B-43 presents the costs associated with this compliance activity.

The NRC will inspect the SFP instruments within the existing Reactor Oversight Program. Therefore, the NRC staff does not include annual NRC inspection costs as the costs for inspecting the new equipment would be negligible. The NRC's operations costs are estimated to be $150,000.

Exhibit B-43. NRC Operations Cost: SFP Instrumentation

Activity	Annual Cost
Review the third through eighth 6-month updates to integrated plans	$150,000
Subtotal	**$150,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.5 for additional detail on these cost estimates.

B.2.3 Costs of Industry Initiatives

Exhibit B-44 summarizes the costs associated with selected industry initiatives implemented following the Fukushima accident. In the historical cost analysis, these activities would result in total costs between $27.0 million and $42.0 million (using a 7-percent and 3-percent discount rate, respectively). These monetized costs, as well as the non-monetary benefits and costs, are described in more detail in the following sections.

Exhibit B-44. Summary of Costs for Industry Initiatives

	Average Cost Per Site		Total Cost				
	One-Time Cost	Annual Cost	One-Time Cost	Annual Cost	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Exemption Analysis							
Industry	$510,000	N/A	$33,000,000	N/A	$33,000,000	$6,000,000	$14,000,000
NRC	N/A	N/A	$8,100,000	N/A	$8,100,000	$1,900,000	$4,100,000
Subtotal	*$510,000*	*N/A*	*$41,000,000*	*N/A*	*$41,000,000*	*$7,900,000*	*$18,000,000*
SAMGs Guidance							
Industry	$63,000	N/A	$4,100,000	N/A	$4,100,000	$4,000,000	$4,000,000
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	Average Cost Per Site		Total Cost				
	One-Time Cost	Annual Cost	One-Time Cost	Annual Cost	Undiscounted Value	Present Value (7 percent)	Present Value (3 percent)
Subtotal	*$63,000*	*N/A*	*$4,100,000*	*N/A*	*$4,100,000*	*$4,000,000*	*$4,000,000*
Phase 1 Staffing							
Industry	$23,000	N/A	$1,500,000	N/A	$1,500,000	$1,500,000	$1,500,000
NRC	N/A	N/A	$250,000	N/A	$250,000	$250,000	$250,000
Subtotal	*$23,000*	*N/A*	*$1,800,000*	*N/A*	*$1,800,000*	*$1,800,000*	*$1,800,000*
Multi-Source Dose Assessment							
Industry	$130,000	$8,500	$8,600,000	$550,000	$24,000,000	$13,000,000	$17,000,000
NRC	N/A	N/A	$150,000	$15,000	$1,100,000	$320,000	$540,000
Subtotal	*$130,000*	*$8,500*	*$8,800,000*	*$570,000*	*$25,000,000*	*$13,000,000*	*$18,000,000*
Total							
Industry	$730,000	$8,500	$47,000,000	$550,000	$63,000,000	$25,000,000	$37,000,000
NRC	N/A	N/A	$8,500,000	$15,000	$9,500,000	$2,500,000	$4,900,000
Total	**$730,000**	**$8,500**	**$56,000,000**	**$570,000**	**$70,000,000**	**$27,000,000**	**$42,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***The annual cost data represents the per year costs incurred during the operating license term.

B.2.3.1 Industry Implementation

The industry initiatives were implemented by 65 sites, including operating sites and decommissioning sites. The costs associated with industry initiatives include procedural and administrative activities (such as developing industry implementation guidance, the SAMGs Technical Basis Report (TBR), and generic SAMGs; conducting Phase 1 staffing assessments; reviewing and revising procedures; and developing and customizing multi-source dose assessment computer software). These upfront costs are assumed to be incurred over the period of 2012 to 2014.

Exhibit B-45 lists the industry's historical implementation costs, which amount to a total upfront cost of approximately $47.0 million. The total present value of these costs is approximately $28.0 million (using a 7 percent discount rate) and $19.0 million (using a 3 percent discount rate). The average cost per site is estimated at $730,000 (based on 65 sites).

Exhibit B-45. Present Value of Industry's Implementation Cost for Industry Initiatives

Section	Average Cost per Site	Total Cost		
	One-Time Cost	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
Exemption Analysis	$510,000	$33,000,000	$6,000,000	$14,000,000
SAMGs Guidance	$63,000	$4,100,000	$4,000,000	$4,000,000
Phase 1 Staffing	$23,000	$1,500,000	$1,500,000	$1,500,000
Multi-Source Dose Assessment	$130,000	$8,600,000	$7,500,000	$8,100,000
Total	**$730,000**	**$47,000,000**	**$19,000,000**	**$28,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

The following sections detail the compliance activities required of affected sites (i.e., related to the exemption analysis, SAMGs, Phase 1 staffing, and multi-source dose assessment).

Exemption Analysis

Exhibit B-46 details the historical implementation costs to industry associated with conducting and submitting the exemption analysis to the NRC. Sites that have announced plans to decommission have voluntarily submitted these analysis requesting that the NRC exempt them from Order EA-12-049 and Order EA-12-051. The NRC staff assumes that each of the five sites that are currently undergoing decommissioning (i.e., Crystal River, Kewaunee, Oyster Creek, San Onofre, and Vermont Yankee) prepared and submitted exemption analyses to the NRC in 2014. The NRC staff also assumes that currently operating sites will submit and receive approval of exemption analyses two years into the decommissioning phase (in 2042). Section 3.1 of the regulatory analysis provides additional detail on the exemption analysis and the NRC staff's assumptions. The total cost associated with the preparation and submission of the exemption analysis is $33.0 million.

Exhibit B-46. Industry Implementation Cost for Industry Initiatives: Exemption Analysis

Activity	Average Cost per Affected Site	Total Cost
Conduct and submit the exemption analysis (Current decommissioning sites)	$500,000	$2,500,000
Conduct and submit the exemption analysis (BWR and PWR decommissioning sites)	$500,000	$29,000,000
Conduct and submit the exemption analysis (AP1000 decommissioning sites)	$500,000	$1,000,000
Subtotal		**$33,000,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix D.1 for additional detail on these cost estimates.

SAMGs Guidance

Exhibit B-47 presents the upfront costs associated with industry initiatives focused on SAMGs. Industry developed implementation guidance (i.e., NEI 14-01, *Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents* (Ref. 11)), EPRI developed the SAMG TBR, the BWROG developed the generic BWR SAG, and the PWROG developed the generic PWR SAMG. The NRC staff assumes the PWROG required additional effort to develop one generic PWROG SAMG to replace the three existing SAMGs for the Westinghouse, Combustion Engineering, and Babcock and Wilcox reactor designs. The NRC staff estimates that the undiscounted total cost associated with these SAMGs industry initiatives is $4.1 million.

Exhibit B-47. Industry Implementation Cost for Industry Initiatives: SAMGs Guidance

Activity	Average Cost per Affected Site	Total Cost
Develop industry implementation guidance (NEI 14-01)	N/A	$120,000
Develop the SAMG TBR (EPRI)	N/A	$530,000
Develop generic BWROG SAG	N/A	$1,500,000
Develop generic PWROG SAMG	N/A	$2,000,000
Subtotal		**$4,100,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
**See Appendix C.1 for additional detail on these cost estimates.

Phase 1 Staffing Assessments

Exhibit B-48 shows the estimated costs associated with the industry's work on the Phase 1 Staffing Assessments. According to NRC staff estimates, 35 multi-unit operating sites and one multi-unit decommissioning site with fuel remaining in the SFP (i.e., San Onofre) performed a Phase 1 Staffing Assessment.[46,47] The NRC staff estimates that the undiscounted total cost associated with Phase 1 Staffing Assessments is $1.5 million.

Exhibit B-48. Industry Implementation Cost for Industry Initiatives: Phase 1 Staffing

Activity	Average Cost per Affected Site	Total Cost
Perform Phase 1 staffing assessment (multi-unit sites)	$42,000	$1,500,000
Subtotal		**$1,500,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.3 for additional detail on these cost estimates.

Multi-Source Dose Assessment

Exhibit B-49 presents the costs associated with Multi-Source Dose Assessment activities. A review of NRC data indicates that 56 operating sites and four decommissioning sites with fuel remaining in the SFP implemented multi-source dose assessment capabilities. The remaining decommissioning site with fuel in the SFP (i.e., San Onofre) did not implement multi-source dose assessment capabilities. Four sites had previously implemented multi-source dose assessment capabilities voluntarily (i.e., Duane Arnold, Fermi, Fort Calhoun, and Seabrook). Therefore, the NRC staff does not estimate the costs for these four sites.

[46] Based on NRC data, no site added ERO personnel to its minimum staffing in response to the Phase 1 Staffing Assessments. Therefore, the historical cost analysis does not include any operational costs on behalf of industry as a result of the staffing assessments.
[47] Historical costs associated with performing the Phase 2 Staffing Assessment are reflected in the analysis of Order EA-12-049. See Appendix B.2.1.

Each of the 60 affected sites reviewed and revised their procedures, developed training materials for its ERO team, and delivered the ERO training on how to conduct individual dose assessments for multiple release points. Each site chose to either customize the NRC-provided RASCAL URI software for its site-specific needs (28 sites, comprised of 26 operating sites and two decommissioning sites), or to develop its own software independently (32 sites, comprised of 30 operating sites and two decommissioning sites). As a result, the NRC staff estimates that the undiscounted total cost associated with multi-source dose assessment activities is $8.6 million.

Exhibit B-49. Industry Implementation Cost for Industry Initiatives: Multi-Source Dose Assessment

Activity	Average Cost per Affected Site	Total Cost
Review and revise procedures (operating sites)	$6,400	$360,000
Review and revise procedures (decommissioning sites)	$6,400	$26,000
Develop computer software	$150,000	$4,800,000
Customize computer software	$70,000	$2,000,000
Develop training materials for ERO team (operating sites)	$18,000	$1,000,000
Develop training materials for ERO team (decommissioning sites)	$18,000	$74,000
Deliver ERO training (operating sites)	$5,900	$330,000
Deliver ERO training (decommissioning sites)	$5,900	$23,000
Subtotal		**$8,600,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.9 for additional detail on these cost estimates.

B.2.3.2 Industry Operation

The 65 affected sites also will incur operations costs as a result of the industry initiatives. These costs include routine and recurring activities (such as updating multi-source dose assessment computer software). These annual costs are assumed to begin in 2015 and accrue up to 63 years (depending on activity, operating status, and reactor type).

Exhibit B-50 reports the industry's operations costs. The NRC staff estimates industry costs to be approximately $550,000. The present value of these costs is approximately $5.5 million (using a 7 percent discount rate) and $9.3 million (using a 3 percent discount rate). The average annual cost per site is $8,500 (based on 65 sites).

Exhibit B-50. Present Value of Industry's Operations Cost for Industry Initiatives

Section	Average Cost per Site	Total Cost		
	Annual Cost	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
Multi-Source Dose Assessment	$8,500	$550,000	$5,500,000	$9,300,000

Section	Average Cost per Site	Total Cost		
Total	**$8,500**	**$550,000**	**$5,500,000**	**$9,300,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

Multi-Source Dose Assessment

Exhibits B-51 and B-52 present the costs of annual multi-source dose assessment activities that will be incurred during sites' operating license terms and during the first two years of decommissioning, respectively. The NRC staff assumes that each of the 60 operating sites and the five currently decommissioning sites will incur costs to update computer software on an annual basis. The 58 BWR and PWR sites will incur operating costs from 2015 through 2040, and the two AP1000 sites will incur operating costs from 2015 through 2077. The five currently decommissioning sites will incur costs in 2015 and 2016. The NRC staff assumes that each site will prepare and submit an exemption analysis to the NRC in the second year of decommissioning, which will exempt them from multi-source dose assessment activities.

Assumptions Related to Costs Incurred During the Operating Period

The NRC staff assumes that each of the 60 operating sites and the five currently decommissioning sites will incur an annual cost to update their computer software. The annual cost to industry of this activity is estimated to be $550,000.

Exhibit B-51. Industry Operations Cost for Industry Initiatives: Multi-Source Dose Assessment (During the Operating Period)

Activity	Average Annual Cost per Affected Site	Annual Cost
Update computer software (operating sites)	$9,100	$510,000
Update computer software (decommissioning sites)	$9,100	$37,000
Subtotal		**$550,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.9 for additional detail on these cost estimates.

Assumptions Related to Costs Incurred During the First Two Years of Decommissioning

The NRC staff assumes that each of the 60 operating sites will continue to incur annual costs associated with updating computer software for the first two years of decommissioning. The cost to update computer software will not vary by design type or operating status, and the NRC staff estimates that industry will incur $510,000 in annual costs during the first two years of decommissioning.

Exhibit B-52. Industry Operations Cost for Industry Initiatives: Multi-Source Dose Assessment (During the First Two Years of Decommissioning)

Activity	Average Annual Cost per Affected Site	Annual Cost
Update computer software (BWR and PWR decommissioning sites)	$9,100	$490,000
Update computer software (AP1000 decommissioning sites)	$9,100	$18,000
Subtotal		**$510,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix D.5 for additional detail on these cost estimates.

B.2.3.3 NRC Implementation

The requirements associated with the industry initiatives also will impose implementation costs on the NRC. These costs include procedural and administrative activities (such as reviewing sites' staffing plan evaluations, conducting inspection activities, as well as developing multi-source dose assessment computer software along with training and a user's guide). These initial costs were incurred between 2012 and 2014.

Exhibit B-53 presents the NRC's total implementation costs which amount to approximately $8.5 million. The total present value of these costs is approximately $2.3 million (using a 7 percent discount rate) and $4.5 million (using a 3 percent discount rate).

Exhibit B-53. Present Value of NRC Implementation Cost for Industry Initiatives

Section	Total Cost		
	One-Time Cost	Present Value (7 percent)	Present Value (3 percent)
Exemption Analysis	$8,100,000	$1,900,000	$4,100,000
Phase 1 Staffing	$250,000	$250,000	$250,000
Multi-Source Dose Assessment	$150,000	$140,000	$150,000
Total	**$8,500,000**	**$2,300,000**	**$4,500,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

Exemption Analysis

Exhibit B-54 presents the costs to the NRC associated with reviewing and approving the exemption analyses. The NRC staff assumes that the NRC reviewed the exemption analyses for the five currently decommissioning sites (i.e., Crystal River, Kewaunee, Oyster Creek, San Onofre, and Vermont Yankee) in 2014 and will review the exemption analysis for each of the 60 operating sites during the second year of decommissioning. The NRC staff estimates the total undiscounted cost to review and approve exemption analyses sites is $8.1 million.

Exhibit B-54. NRC Implementation Cost for Industry Initiatives: Exemption Analysis

Activity	Total Cost
Review and approve the exemption analyses for current decommissioning sites	$620,000
Review and approve the exemption analyses for BWR and PWR decommissioning sites	$7,200,000
Review and approve the exemption analyses for AP1000 decommissioning sites	$250,000
Subtotal	**$8,100,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix D.1 for additional detail on these cost estimates.

Phase 1 Staffing Assessments

Exhibit B-55 presents the implementation costs of Phase 1 Staffing Assessments. The NRC reviewed sites' staffing plan evaluations and conducted inspection activities.[48] The implementation cost incurred by the NRC as a result of the Phase 1 Staffing Assessments is estimated to be approximately $250,000.

Exhibit B-55. NRC Implementation Cost for Industry Initiatives: Phase 1 Staffing

Activity	Total Cost
Review sites' staffing plan evaluations	$220,000
Conduct inspection activities	$30,000
Subtotal	**$250,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.3 for additional detail on these cost estimates.

Multi-Source Dose Assessment

Exhibit B-56 presents the implementation costs incurred by the NRC as a result of the multi-source dose assessment requirements. The NRC developed computer software, as well as training and a user's guide. The upfront cost incurred by the NRC as a result of the multi-source dose assessment is estimated to be approximately $150,000.

[48] The NRC staff assumes the NRC will perform ongoing oversight; however, this incremental effort will be integrated into existing inspection activities. Therefore, the historical cost analysis does not estimate incremental costs for the NRC's oversight.

Exhibit B-56. NRC Implementation Cost for Industry Initiatives: Multi-Source Dose Assessment

Activity	Total Cost
Develop computer software, training, and user's guide	$150,000
Subtotal	**$150,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
*See Appendix C.9 for additional detail on these cost estimates.

B.2.3.4 NRC Operation

The NRC staff expects there will be annual costs to the NRC to update multi-source dose assessment computer software. Exhibit B-59 provides the NRC's total operations costs which amount to an annual cost of approximately $15,000. The total present value of these costs is approximately $180,000 (using a 7 percent discount rate) and $400,000 (using a 3 percent discount rate).

Exhibit B-57. Present Value of NRC's Operations Cost

Section	Total Cost		
	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
Multi-Source Dose Assessment	$15,000	$180,000	$400,000
Total	**$15,000**	**$180,000**	**$400,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.

Multi-Source Dose Assessment

Exhibit B-58 presents the NRC's annual costs as a result of the multi-source dose assessment requirements. The NRC expects that there will be annual updates to the NRC-provided computer software. As a result, the NRC staff estimates annual costs to NRC of approximately $15,000.

Exhibit B-58. NRC Implementation Cost for Industry Initiatives: Multi-Source Dose Assessment

Activity	Annual Cost
Update computer software	$15,000
Subtotal	**$15,000**

*Results are rounded.
**All costs in this table are presented in 2013 dollars.
***See Appendix C.9 for additional detail on these cost estimates.

References

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

2. U.S. Nuclear Regulatory Commission, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," Order EA-12-051, March 12, 2012, ADAMS Accession No. ML12054A682.

3. U.S. Nuclear Regulatory Commission, "Memorandum and Order CLI-12-09 – In the Matter of South Carolina Electric & Gas Co. and South Carolina Public Service Authority" (Also Referred to as Santee Cooper; Virgil C. Summer Nuclear Station, Units 2 and 3), March 30, 2012, ADAMS Accession No. ML12090A531.

4. Waier, P. R. *Building Construction Cost Data*, 63rd ed., RS Means Co., 2005.

5. Mossman, J. M., & Plotner, S. C. *Facilities Construction Cost Data*, 15th ed., RS Means Co., 2000.

6. Electric Power Research Institute, "Costs of Utility Distributed Generators, 1-10 MW: Twenty-Four Case Studies," Technical Update Report No. 1007760, 2003, Retrieved from: http://www.publicpower.org/files/Deed/FinalReportCostsofUtilityDistributedGenerators.pdf.

7. FENOC, "Response to NRC Letter, Request for Information Pursuant to Title 10 of *the Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," Dated March 12, 2012. Attachment L-12-193, 2012, Retrieved from: http://pbadupws.nrc.gov/docs/ML1216/ML12163A320.pdf.

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

9. Westinghouse, "PRA Model for the Generation III Westinghouse Shutdown Seal," PWROG-14001-NP, Rev. 1, July 2014, ADAMS Accession No. ML14190A332.

10. U.S. Nuclear Regulatory Commission, "Draft Interim Staff Guidance JLD-ISG-12-05, Guidance for Performing the Integrated Assessment for Flooding," Revision 0, September 20, 2012, ADAMS Accession No. ML12235A319.

11. Nuclear Energy Institute document 14-01, "Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents," Revision 0, March 2014, ADAMS Accession No. ML14049A005.