Regulatory Analysis

Final Rule 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's (NRC's) Mitigation of Beyond-Design-Basis Events Rule amends Title 10 of the *Code of Federal Regulations* (10 CFR), "Energy," to accomplish three objectives: (1) make the requirements in NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (Ref. 1), and Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012 (Ref. 2), generically applicable; (2) establish requirements for an integrated response capability; and (3) address a number of petitions for rulemaking (PRMs) submitted to the NRC following the March 2011 Fukushima Dai-ichi event. To achieve these objectives, the rule amends 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," to require additional mitigation strategies for responding to beyond-design-basis events (Ref. 3). In conjunction with this rule, the NRC is issuing three regulatory guides to identify methods and procedures the NRC staff considers acceptable for demonstrating compliance with the new requirements.

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

The key findings are as follows:

- **Final Rule Analysis—Results.** The final rule encompasses provisions that either have been implemented at this time (December 2016) or, in some cases, are currently being implemented in accordance with Order EA-12-049 and Order EA-12-051 and related industry initiatives. Because the NRC uses a "no-action" baseline to estimate incremental costs, the total cost of the final rule, with a notable exception discussed below, largely results from licensee's review of the rule to confirm compliance with the requirements (i.e., comparing the rule requirements with the orders and related industry initiatives, then updating procedures, programs, or plans as needed) because plant modifications and programmatic changes that comply with the final requirements are expected to be implemented before the effective date of the rule.

  The notable exception referred to above concerns the possible impacts of licensees being required to mitigate the effects of seismic and flooding reevaluated hazards under 10 CFR 50.155(b)(2) by amending mitigation strategies, including potential plant modifications. The NRC requested and received external stakeholder feedback about these impacts to enable them to be included in this regulatory analysis of the final rule.

- **Total Cost to Industry.** The final rule is expected to result in a total one-time cost to industry of approximately ($93.8 million), followed by total annual costs of approximately ($1.2 million). The net present value of these costs is approximately ($107 million) using a 7-percent discount rate and approximately ($114 million) using a 3-percent discount rate.

- **Average Cost per Site.** The industry would incur a one-time average cost per site of ($1.7 million), followed by an average annual cost of ($23,000). The net present value of these costs per site is approximately ($2.0 million) using a 7-percent discount rate and approximately ($2.2 million) using a 3-percent discount rate.

- **Total Cost to the NRC.** The final rule is expected to result in a total one-time cost to the NRC of ($34 million) to review licensing submittals and draft and issue safety evaluations.

- **Total Cost.** The final rule is expected to result in a total one-time cost of approximately ($128 million), followed by total annual costs of approximately ($1.2 million). The net present value of these costs is approximately ($141 million) using a 7-percent discount rate and approximately ($148 million) using a 3-percent discount rate.

  According to Executive Order 12866, "Regulatory Planning and Review" (Volume 58 of the *Federal Register* (FR), page 51735; October 4, 1993), an economically significant regulatory action is one that would have an annual effect on the economy of $100 million or more (Ref. 4). This final rule is interpreted to exceed this threshold because the net present value of the total cost of the final rule would be ($141 million) using a 7-percent discount rate and ($148 million) using a 3-percent discount rate. As such, this is a major rule.

- **Benefits.** The final rule requirements (i.e., making the order requirements and industry initiatives generically applicable) are based on 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 that implementation. These regulatory requirements would (1) result in enhanced regulatory efficiency by giving a predictable and stable set of regulations for future designs and applications, (2) avoid the need for issuance of orders or license conditions, and (3) preserve regulatory stability.

- **Historical Cost Analysis—Results.** For informational purposes, the NRC 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 estimates that these actions result in a total present-value cost of $1.9 billion (using a 7-percent discount rate) and $2.3 billion (using a 3-percent discount rate).

  The average site incurred an upfront cost of approximately $29 million, followed by annual costs of approximately $170,000.

Decision Rationale. The staff selected Option 2, which is to undertake rulemaking to make generically applicable Order EA-12-049, Order EA-12-051, and the associated regulatory actions implemented in conjunction with the orders. The staff rejected Option 1, the no-action alternative, because it would not achieve the NRC's three objectives to (1) make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable, (2) establish new requirements for an integrated response, and (3) address a number of PRMs submitted to the NRC.

The scope to make the orders generically applicable and to address a number of PRMs results in limited implementation costs for industry to review the regulatory requirements in order to

confirm ongoing compliance. These activities included comparing the rule requirements with the orders and related industry initiatives and updates to procedures, programs, or plans.

This analysis shows that establishing new requirements for an integrated response, which includes the reevaluated hazards provisions of Option 2, would result in considerable additional cost above the $1.9 billion already spent by industry to comply with the orders. These provisions introduce a more stringent standard for some sites than currently specified in the orders, to consider the gap between a plant's licensing basis and the reevaluated hazards, which are low-frequency but potentially high-consequence events. The analysis identified three significant cost drivers: (1) industry activities necessary to perform the Path 4 seismic mitigating strategies assessments, (2) NRC review activities of the Path 4 seismic submittals, and (3) industry activities to maintain the diverse and flexible coping strategies (FLEX) program for the duration of the reactor operating licenses.

The analysis includes estimates associated with the impacts incurred as a result of licensees being required to address the reevaluated hazard information, which may result in the need to revise mitigation strategies or implement plant modifications. The analysis assumes that such changes would provide a reasonable level of protection against these beyond-design-basis events; higher levels of protection could result in licensees incurring substantially higher costs. The staff will be mindful of this consideration as further information is developed under Near-Term Task Force Recommendation 2.1 activities.

The staff concludes that Option 2 is preferable to Option 1.

Abbreviations and Acronyms

ABWR	Advanced Boiling-Water Reactor
ac	alternating current
ADAMS	Agencywide Documents Access and Management System
AMS	alternate mitigating strategy
AP1000	Advanced Passive 1000 reactor
ASI	alternate seal injection
BDBE	beyond-design-basis event
BDBEE	beyond-design-basis external event
BLS	Bureau of Labor Statistics
BWR	boiling-water reactor
BWROG	BWR Owners Group
CFR	*Code of Federal Regulations*
COL	combined license
COLA	combined license application
CRGR	Committee to Review Generic Requirements
CST	condensate storage tank
CVCS	chemical and volume control system
dc	direct current
DG	diesel generator
EDG	emergency diesel generator
EDMG	extensive damage mitigation guideline
ELAP	extended loss of ac power
EOP	emergency operating procedure
EPRI	Electric Power Research Institute
ERDS	emergency response data system
ERO	emergency response organization
ESBWR	Economic Simplified Boiling-Water Reactor
FENOC	FirstEnergy Nuclear Operating Company
FLEX	diverse and flexible coping strategies
FR	*Federal Register*
FRN	*Federal Register* notice
FSG	FLEX support guideline
ft	foot/feet
FTE	full-time equivalent
GMRS	ground motion response spectrum/spectra
HCLPF	high-confidence-of-low-probability-of-failure
HPCI	high-pressure coolant injection
HPCS	high-pressure core spray
hr	hour
Hz	hertz
IHS	IPEEE HCLPF spectrum

IPEEE	individual plant examination of external events
ISG	interim staff guidance
ITAAC	inspections, tests, analyses, and acceptance criteria
JLD	Japan Lessons-Learned Project Directorate
KHNP	Korea Hydro & Nuclear Power
kV	kilovolt(s)
kW	kilowatt(s)
LED	light-emitting diode
LOE	level of effort
LUHS	loss of normal access to the ultimate heat sink
MBDBE	mitigation of beyond-design-basis events
MCC	motor control center
MSA	mitigating strategies assessment
MSFHI	mitigating strategies flood hazard information
MSSHI	mitigating strategies seismic hazard information
NEI	Nuclear Energy Institute
NPV	net present value
NRC	U.S. Nuclear Regulatory Commission
NSRC	National SAFER Response Center
NSSS	nuclear steam supply system
NTTF	Near-Term Task Force
O&M	operation and maintenance
OIP	overall integrated plan
PERT	program evaluation and review technique
PORV	power-operated relief valves
PRM	petition for rulemaking
PRA	probabilistic risk assessment
PWR	pressurized-water-reactor
PWROG	PWR Owners Group
RAI	request for additional information
RCIC	reactor core isolation cooling
RCP	reactor coolant pump
RCS	reactor coolant system
RG	regulatory guide
RHR	residual heat removal
RMWST	reactor makeup water storage tank
ROP	reactor oversight process
RPV	reactor pressure vessel
RRC	regional response center
SAFER	Strategic Alliance for FLEX Emergency Response
SAG	severe accident guidelines
SAMG	severe accident management guideline

SAT	systematic approach to training
SBO	station blackout
SBOMS	station blackout mitigation strategies
SFP	spent fuel pool
SG	steam generator
SOC	standard occupational classification
SPID	screening, prioritization, and implementation details
SPMU	suppression pool makeup
SPRA	seismic probabilistic risk assessment
SRM	staff requirements memorandum
SSC	structure, system, and component
SSE	safe-shutdown earthquake
SSW	standby service water
SW	service water
TBR	technical basis report
THMS	targeted hazard mitigating strategy
UHS	ultimate heat sink
US-APWR	U.S. Advanced Pressurized-Water Reactor
U.S. EPR	U.S. Evolutionary Power Reactor
V	volt(s)
Vac	volts of alternating current
yr	year(s)

1. Introduction

This document presents the regulatory analysis of the final Mitigation of Beyond-Design-Basis Events Rulemaking. This introduction is divided into two sections—Section 1.1 gives background information on the rulemaking, and Section 1.2 states the problem and the objectives for the final rule.

1.1 Background

The events of March 11, 2011, at the Fukushima Dai-ichi nuclear power plant 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 U.S. Nuclear Regulatory Commission's (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 NRC Chairman at the time, Gregory Jaczko, directed the NRC, through tasking memorandum SRM-COMGBJ-11-0002, "Tasking Memorandum—COMGBJ-11-0002—NRC Actions Following the Events in Japan," dated March 23, 2011 (Ref. 5), to conduct a review of the NRC's processes and regulations to determine if any changes needed to be made and to make recommendations based on the findings. 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, dated July 12, 2011 (Ref. 6)) 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 multiunit events, (5) pursue additional emergency protection topics related to multiunit events and prolonged SBO, and (6) pursue emergency management topics related to decisionmaking, radiation monitoring, and public education.

Following the issuance of the NTTF report, the NRC developed recommendations for the Commission's consideration. In response, in Staff Requirements Memorandum (SRM)-SECY-11-0124, "Staff Requirements—SECY-11-0124—Recommended Actions To Be Taken without Delay from the Near-Term Task Force Report," dated October 18, 2011 (Ref. 7), and SRM-SECY-11-0137, "Staff Requirements—SECY-11-0137—Prioritization of Recommended Actions To Be Taken in Response to Fukushima Lessons Learned," dated December 15, 2011 (Ref. 8), the Commission directed the staff to initiate a high-priority rulemaking for SBO regulatory actions and onsite emergency response capabilities regulatory actions.

On February 17, 2012, the NRC staff sent 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. This paper included the proposed order to implement enhanced mitigation strategies. As directed by SRM-SECY-12-0025, dated

March 9, 2012 (Ref. 9), on March 12, 2012, the NRC issued Order EA-12-049, "Issuance of Order To Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Ref. 1), and Order EA-12-051, "Issuance of Order To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (Ref. 2). Order EA-12-049 imposed new requirements for licensees to implement mitigation strategies to provide additional capability to respond to beyond-design-basis external events (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 gave 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 began work on two rulemakings as directed by the Commission: the Station Blackout Mitigation Strategies (SBOMS) Rulemaking and the Onsite Emergency Response Capabilities rulemaking. During development of these rulemakings, the NRC found that the Onsite Emergency Response Capabilities Rulemaking could not be issued before the SBOMS rulemaking because it would need to reference the SBOMS requirements. The NRC also identified several areas of overlap between the two rules. The direct links between these post-Fukushima rulemakings caused the NRC to conclude that they should be combined into a single rule package.

In response to a request from the NRC staff in SECY-14-0046, "Fifth 6-Month Status Update on Response to Lessons Learned from Japan's March 11, 2011, Great Tōhoku Earthquake and Subsequent Tsunami," Enclosure 6, "Proposal to Consolidate Post-Fukushima Rulemaking Activities," dated April 17, 2014 (Ref. 10), the Commission agreed in SRM-SECY-14-0046, dated July 9, 2014 (Ref. 20), to consolidate the SBOMS and Onsite Emergency Response Capabilities rulemakings into one rulemaking for a new Mitigation of Beyond-Design-Basis Events (MBDBE) Rule. The combined scope of this final rule, described in terms of the relationship to various NTTF recommendations that gave the regulatory impetus for the final rule, includes the following:

- This final rule incorporates all the requirements that were within the scope of the SBOMS rulemaking, as directed by SRM-COMSECY-13-0002, "Staff Requirements—COMSECY-13-0002—Consolidation of Japan Lessons Learned Near-Term Task Force Recommendations 4 and 7 Regulatory Activities," dated March 4, 2013 (Ref. 11). This portion of the final rule stems from NTTF Recommendations 4 and 7 and is intended, in part, to make the requirements of Order EA-12-049 and Order EA-12-051 (and equivalent license conditions) generically applicable.

- This final rule incorporates all the requirements that were within the scope of the Onsite Emergency Response Capabilities Rulemaking. This portion of the final rule stems from NTTF Recommendation 8 and was directed by the Commission in SRM-SECY-11-0137 (Ref. 8). This includes command and control issues and, as such, addresses NTTF Recommendation 10.2 on command and control and the qualifications of decisionmakers. The regulatory guidance for the command and control provisions of this final rule is being addressed in supporting Regulatory Guide (RG) 1.228, "Integrated

Response Capabilities for Beyond-Design-Basis Events" (Ref. 41), which endorses Nuclear Energy Institute (NEI) 14-01, "Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents," Revision 1 (Ref. 12).

- Actions to enhance onsite emergency response capabilities are incorporated in this final rule. These enhanced emergency response capabilities have been implemented, or are currently being implemented (as of December 2016), in conjunction with the implementation of Order EA-12-049 and through the development of guidance supporting this final rule. Specifically, the regulatory actions and associated NTTF Recommendations from which they stem are as follows:

  – Staffing and communications requirements in this final rule stem from NTTF Recommendation 9.3 and are also discussed in NTTF Recommendations 9.1 and 9.2. These regulatory issues have been implemented or are currently (as of December 2016) being implemented through Order EA-12-049. Specifically, NEI 12-01 (Ref. 42) is referenced in NEI 12-06, Revision 0, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," issued August 2012 (Ref. 13), which is 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," dated August 29, 2012 (Ref. 14). The supporting guidance for this final rule, RG 1.226, "Flexible Mitigation Strategies for Beyond-Design-Basis Events" (Ref. 43), includes this guidance through endorsement of NEI 12-06 and NEI 12-01.

  – Facilities and equipment requirements that are addressed in this final rule 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 RG 1.228, which endorses NEI 13-06, "Enhancements to Emergency Response Capabilities for Beyond Design Basis Accidents and Events," Revision 1 (Ref. 15).

  – Multiple source term dose assessment capability addressed in the guidance for this final rule stems from NTTF Recommendation 9.3 and is also discussed in NTTF Recommendation 9.1. The nuclear industry is voluntarily addressing this regulatory issue and is establishing this capability by following the guidance in NEI 13-06, Revision 1.

  – Training and drills or exercise requirements addressed in this final rule 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 guidance for this final rule, which includes NEI 13-06, Revision 1.

- Onsite emergency resources to support a BDBEE that affects the entire site (referred to in the NTTF report as multiunit 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 requirement either implemented (or currently being implement as of December 2016) under Order EA-12-049. This requirement is addressed in RG 1.226 and is included in this final rule.

Accordingly, this final rule addresses, either in requirements, through implementation guidance, or through voluntary industry initiatives, 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]

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

The NRC has developed this final rule, in large measure, to make generically applicable the regulatory actions taken after the Fukushima event. With regard to FLEX support guidelines (FSGs), current NRC regulations do not include requirements to implement mitigation strategies that give additional capability to respond to events exceeding the external design basis of the facility (e.g., events arising from severe natural phenomena).[2] A final rule would make generically applicable requirements similar to those imposed by Order EA-12-049, Order EA-12-051, and other post-Fukushima industry initiatives. The final rule has the following regulatory objectives:

- Make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable. The rulemaking is intended to place the requirements of Order EA-12-049 and Order EA-12-051 in the NRC's regulations to give regulatory clarity to operating reactors and to ensure that they apply to all future power reactor applicants. All operating power reactor licensees and 11 combined license (COL) holders[3] currently are subject to these orders' requirements via order or license condition. In the absence of a rule, these requirements would need to be implemented for future licensees through additional orders or license conditions.

  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

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[1] The final rule also addresses NTTF Recommendation 9.4 to modernize the ERDS. This action differs from the above list of regulatory actions because the ERDS is not an essential component of a licensee's capability to mitigate a BDBE. However, the ERDS is important for communication between the licensee and the NRC and, in some situations, with other external stakeholders. The modernization has been voluntarily completed by industry, and the NRC has concluded it could readily be incorporated into this final rule to amend the technology-specific references in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 3), Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," Section VI, "Emergency Response Data System."

[2] In the context of the Mitigation of Beyond-Design-Basis Events Rulemaking, the term "FSGs" has replaced the term "SBOMS."

[3] The 11 COL holders are Fermi Unit 3, Lee Nuclear Station Units 3 and 4, Levy County Units 1 and 2, South Texas Project Units 3 and 4, Virgil C. Summer Nuclear Station Units 2 and 3, and Vogtle Electric Generating Plant Units 3 and 4.

not extend beyond the existing scope of the existing orders. The final rule contains provisions to rescind the orders and administratively remove the license conditions.

- Establish new requirements for an integrated response. An objective of the final rule is to establish requirements for an integrated response capability for BDBEs that would integrate strategies and guidelines (implemented through guideline sets) with the existing EOPs and enhance onsite emergency response capabilities. This would include guideline sets that implement the requirements of current 10 CFR 50.54(hh)(2) and Order EA-12-049. This also would include mitigation strategies, or alternative approaches, used to address reevaluated hazards, as applicable. This rule requires sufficient staffing, command and control, training, drills, communications capability, and documentation of changes to support the integrated response capability. These new requirements would address emergency-response-related actions such as the following:

  – 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 decisionmaking qualifications (NTTF Recommendation 10.2)

  The multiple source term dose assessment that addresses NTTF Recommendation 9.3 and was also addressed in NTTF Recommendation 9.1 is not a requirement within the MBDBE Rule because this issue has been implemented voluntarily by industry. The ERDS that addresses NTTF Recommendation 9.4 is not a requirement within the MBDBE Rule because (1) an ERDS is not an essential component of a licensee's capability to mitigate a BDBEE even though it is an important form of communication between the licensee and the NRC and (2) modernization of the ERDS was completed voluntarily by industry.

- Address a number of PRMs submitted to the NRC. An objective of the final rule is to address and complete the regulatory actions planned for the five PRMs[4] filed by the National Resources Defense Council, Inc., that raise issues pertaining to the technical aspects of this rulemaking. The petitions rely solely on the NTTF report and ask the NRC to undertake rulemaking in several areas that are addressed by this rule. This rule also addresses, in part, PRM-50-96 submitted by Mr. Thomas Popik; however, the issues raised in that petition remain under consideration by the NRC.

[4] The five PRMs are (1) PRM 50-97, "NRDC's Petition for Rulemaking To Require Emergency Preparedness Enhancements for Prolonged Station Blackouts," (2) PRM-50-98, "NRDC's Petition for Rulemaking To Require Emergency Preparedness Enhancements for Multiunit Events," (3) PRM-50-100, "NRDC's Petition for Rulemaking To Require Licensees To Improve Spent Nuclear Fuel Pool Safety," (4) PRM-50-101, "NRDC's Petition for Rulemaking To Revise 10 CFR § 50.63," and (5) PRM 50-102, "NRDC's Petition for Rulemaking To Require More Realistic Training on Severe Accident Mitigation Guidelines."

To achieve these objectives, the rule amends 10 CFR Part 50 and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," to require additional mitigation strategies for responding to BDBEs and an integrated response capability that includes FSGs, EDMGs, and EOPs.

2. Identification and Preliminary Analysis of Alternative Approaches

The NRC has identified three alternatives for consideration:

(1) Option 1: Take no action.

(2) Option 2: Undertake rulemaking to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable.

(3) Option 3: Undertake rulemaking to require SAMGs and make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. This option was considered by the staff and was proposed to the Commission in SECY-15-0065, "Proposed Rule: Mitigation of Beyond-Design-Basis Events," dated April 30, 2015 (Ref. 30). The Commission rejected this option in SRM-SECY-15-0065, dated August 27, 2015 (Ref. 31).

The following sections offer a preliminary analysis of these options.

2.1 Option 1: Take No Action

This alternative entails continuing the implementation of the mitigation strategy requirements in Order EA-12-049, Order EA-12-051, and other related industry initiatives. No further regulatory 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 includes that industry will continue to implement and maintain SAMGs through a voluntary industry initiative and EDMGs as required by 10 CFR 50.54(hh)(2). This alternative is equivalent to the status quo and serves as a baseline to measure against the other identified alternatives.

Consistent with the process described in COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," dated June 30, 2015 (Ref. 38), licensees have been acting to ensure their mitigating strategies are capable of addressing the reevaluated seismic and flooding hazards through the performance of mitigating strategies assessments (MSAs). Licensees are conducting MSAs using NRC-approved industry guidance in NEI 12-06, Revision 2 (Ref. 25). Activities being completed as part of NTTF Recommendation 2.1, some of which relate to Order EA-12-049 through the MSAs, are included as part of the regulatory baseline for Option 1. For example, one approach for conducting the seismic portion of the MSA involves leveraging risk insights from the seismic probabilistic risk assessments (SPRAs), which are being completed by some licensees as part of NTTF Recommendation 2.1, to assess the existing mitigating strategies against the reevaluated seismic hazard. Costs associated with developing the SPRA are included in Option 1 because they are being incurred as part of NTTF Recommendation 2.1.

This option would avoid certain costs that the final rule would impose, while the benefits associated with voluntary initiatives would remain. However, under this option, the NRC would

need to address mitigation strategy requirements for new reactor sites on a case-by-case basis, through either additional orders or license conditions. In addition, under this option, the NRC would need to undertake separate licensing actions to remove requirements of Order EA-12-049 and Order EA-12-051 that are no longer necessary during various stages of decommissioning. As a result, this option would not achieve the NRC's objectives discussed in Section 1.2 of this document.

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

The staff proposed this option to the Commission in SECY-15-0065 as Option 3. This option (i.e., the final 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. The final rule would ensure that future nuclear power plant license applications are subject to the same requirements as current operating sites and COL holders without the need for additional orders or license conditions. This rulemaking option also would allow the NRC to consider stakeholder feedback and lessons learned from the implementation of these orders and would give regulatory clarity to operating reactors. As discussed in Option 1, activities associated with NTTF Recommendation 2.1 (such as the completion of SPRAs by some licensees to inform the MSA for the reevaluated seismic hazard) are considered part of the regulatory baseline, and are not included as a cost for Option 2.

Section 3 presents the results of the NRC's detailed cost-benefit analysis of this option compared to the "take no action" option.

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

The staff proposed this option to the Commission in SECY-15-0065 as Option 2. In SECY-15-0065, the staff relied on an argument that related the requirement for SAMGs to defense in depth in order to satisfy the requirements of 10 CFR 50.109, "Backfitting." The Commission concluded that the imposition of SAMG requirements was not warranted because it did not meet the substantial additional protection criteria under 10 CFR 50.109(a)(3). Consequently, this regulatory analysis does not further evaluate SAMGs as proposed requirements in the final MBDBE Rule. Instead, SAMGs will continue to be implemented and maintained through a voluntary industry initiative as discussed in SRM-SECY-0065 and in Option 1. For more information on this option, refer to the proposed MBDBE Rule published on November 13, 2015 (80 FR 70609) (Ref. 40).

For the above reasons, the staff rejected Option 3 and did not consider this option any further in this analysis.

2.4 Nonrulemaking Alternatives

The NRC staff considered nonrulemaking approaches, such as voluntary initiatives, NRC guidance, and generic communications (e.g., information notices, regulatory information summaries, generic letters) but rejected these alternatives 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." Second, a nonrulemaking approach would not achieve the NRC'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. Because nonrulemaking approaches would not achieve the broad applicability of a rulemaking, the staff concluded that these nonrulemaking approaches would not be appropriate to address the NRC's objectives.

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

This section describes the NRC'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 Option 2 (the final rule).
- Section 3.4 discusses the benefits of Option 2 (the final rule).
- Section 3.5 discusses the uncertainty analysis.
- Section 3.6 discusses the disaggregated results.

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 in NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," Revision 4, issued September 2004 (Ref. 16). 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 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, Order EA-12-051, and industry initiatives. The NRC estimates all of the incremental costs and benefits resulting from the final rule requirements that would be incurred beginning in 2017, the year the final rule is assumed to become effective.

In addition, the NRC estimated the historical costs associated with Order EA-12-049, Order EA-12-051, and industry initiatives. Appendix B discusses the methodology and results of the historical cost analysis.

3.1.1 Affected Universe

The regulatory options under consideration would affect all nuclear power plant 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)). Section 3.3 describes the differences in cost in more detail.

The NRC estimates the costs incurred by 55 operating sites and 10 decommissioning sites (i.e., Clinton, Crystal River, FitzPatrick, Fort Calhoun, Kewaunee, Oyster Creek, Pilgrim, Quad Cities, San Onofre, and Vermont Yankee).[5] Paragraph 50.155(a)(2) enables decommissioning licensees to discontinue compliance with portions of the final rule, with the exception of the 10 CFR 50.155(b)(3), EDMGs, which would not impose incremental costs because EDMGs are existing requirements under the no-action baseline. To satisfy 10 CFR 50.155(a)(2), the licensee would be required to prepare and retain 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 that the boil-off period gives sufficient time for the licensee to obtain offsite resources; this is referred to as an "exemption analysis" in the regulatory analysis. The NRC assumes that the 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 have been incurred by current decommissioning sites before the effective date of the final rule.

Of the 55 operating sites included in the analysis, 18 are boiling-water-reactor (BWR) sites and 37 are pressurized-water-reactor (PWR) sites. Exhibit 3-1 lists BWR and PWR operating and new reactor sites that are included in the universe of affected entities under this analysis. The Advanced Passive 1000 (AP1000) reactor units are under construction at two of the operating sites (i.e., Virgil C. Summer Nuclear Station and Vogtle Electric Generating Plant). 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 Summer and Vogtle sites does affect the costs incurred by the sites and the timeline over which costs are incurred. Section 3.3 gives additional details about the cost analysis for each type of site.

Exhibit 3-1 List of Operating PWR and BWR Sites

PWR Sites	BWR Sites
Arkansas Nuclear One	Browns Ferry Nuclear Plant
Beaver Valley Power Station	Brunswick Steam Electric Plant
Braidwood Station	Columbia Generating Station
Byron Station	Cooper Nuclear Station
Callaway Plant	Dresden Nuclear Power Station
Calvert Cliffs Nuclear Power Plant	Duane Arnold Energy Center
Catawba Nuclear Station	Edwin I. Hatch Nuclear Plant
Comanche Peak Nuclear Power Plant	Fermi

[5] This set of sites reflects the NRC's understanding of regarding licensees' plans to decommission at the time this regulatory analysis was prepared. The licensees for Clinton, FitzPatrick, Fort Calhoun, Oyster Creek, Pilgrim, and Quad Cities had announced intentions to begin decommissioning before the end of the rule implementation period (estimated to occur in 2019). Crystal River, Kewaunee, San Onofre, and Vermont Yankee had already begun decommissioning. The NRC observes that licensee decisions regarding decommissioning consider multiple factors and may change before the end of this period. For example, recent licensee announcements relate to potential changes to future plans for Clinton, FitzPatrick, Quad Cities, and Palisades compared to what was assumed in the regulatory analysis. In addition, Fort Calhoun permanently shut down in October 2016. The final costs of the rule would be affected somewhat by the number of facilities that decommission during the timeframe considered by this analysis.

PWR Sites	BWR Sites
Davis-Besse Nuclear Power Station	Grand Gulf Nuclear Station
Diablo Canyon Power Plant	Hope Creek Generating Station
Donald C. Cook Nuclear Plant	LaSalle County Station
H.B. Robinson Steam Electric Plant	Limerick Generating Station
Indian Point Nuclear Generating	Monticello Nuclear Generating Plant
Joseph M. Farley Nuclear Plant	Nine Mile Point Nuclear Station
McGuire Nuclear Station	Peach Bottom Atomic Power Station
Millstone Power Station	Perry Nuclear Power Plant
North Anna Power Station	River Bend Station
Oconee Nuclear Station	Susquehanna Steam Electric Station
Palisades Nuclear Plant	
Palo Verde Nuclear Generating Station	
Point Beach Nuclear Plant	
Prairie Island Nuclear Generating Plant	
R.E. Ginna Nuclear Power Plant	
Salem Nuclear Generating Station	
Seabrook Station	
Sequoyah Nuclear Plant	
Shearon Harris Nuclear Power Plant	
South Texas Project	
St. Lucie Plant	
Surry Power Station	
Three Mile Island Nuclear Station	
Turkey Point Nuclear Generating	
Virgil C. Summer Nuclear Station	
Vogtle Electric Generating Plant	
Waterford Steam Electric Station	
Watts Bar Nuclear Plant	
Wolf Creek Generating Station	
37 Sites	**18 Sites**

Exhibit 3-2 gives information on the COL applications that the NRC has received to date. Other than the new AP1000 units at Virgil C. Summer Nuclear Station and Vogtle Electric Generating Plant, which are accounted for as part of the operating site on which they are located, as noted above, these COL applications are not included in the affected universe. Neither the licensees for the other issued COLs nor the applicants currently under review have announced an intention to construct and operate a new reactor. Therefore, costs for these applicants to develop and maintain the integrated response capability, additional equipment, training requirements, drills and exercises, and emergency preparedness requirements are not quantified in this analysis. Further, the NRC does not account for any incremental costs for other COL applications that may be submitted and affected by the alternatives (e.g., a potential application associated with the NuScale design). The staff considered forecasts of the timing of these applications and the future implementation of the MBDBE rule requirements as too speculative for this analysis.

Exhibit 3-2 COL Applications that Reference New Reactor Designs

Proposed New Reactors	Design	COL Applicant	Status
Bell Bend Nuclear Power Plant	U.S. EPR	PPL Bell Bend, LLC	Withdrawn
Bellefonte Nuclear Station, Units 3 and 4	AP1000	Tennessee Valley Authority	Suspended
Callaway Plant, Unit 2	U.S. EPR	AmerenUE	Withdrawn
Calvert Cliffs, Unit 3	U.S. EPR	Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC	Withdrawn
Comanche Peak, Units 3 and 4	US-APWR	Luminant Generation Company, LLC	Suspended
Fermi, Unit 3	ESBWR	Detroit Edison Company	Issued
Grand Gulf, Unit 3	ESBWR	Entergy Operations, Inc.	Withdrawn
Levy County, Units 1 and 2	AP1000	Progress Energy Florida, Inc.	Issued
Nine Mile Point, Unit 3	U.S. EPR	Nine Mile Point 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC	Withdrawn
North Anna, Unit 3	ESBWR	Dominion Virginia Power	Under Review
River Bend Station, Unit 3	ESBWR	Entergy Operations, Inc.	Withdrawn
Shearon Harris, Units 2 and 3	AP1000	Progress Energy Carolinas, Inc.	Suspended
South Texas Project, Units 3 and 4	ABWR	South Texas Project Nuclear Operating Company	Issued
Turkey Point, Units 6 and 7	AP1000	Florida Power and Light Company	Under Review
Victoria County Station, Units 1 and 2	ESBWR	Exelon Nuclear Texas Holdings, LLC	Withdrawn
Virgil C. Summer, Units 2 and 3	AP1000	South Carolina Electric & Gas	Issued
Vogtle, Units 3 and 4	AP1000	Southern Nuclear Operating Company	Issued
William States Lee III, Units 1 and 2	AP1000	Duke Energy	Under Review

* Values from NRC Web page, "Combined License Applications for New Reactors," accessed November 2, 2016, at http://www.nrc.gov/reactors/new-reactors/col.html.

3.1.2 Cost Estimation

All rule-related costs are presented in this analysis in 2017 dollars. The historical costs of the orders and industry initiatives were calculated in 2013 dollars.

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

The NRC 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 the 2015 occupational employment and wages data for rule-related costs. Per NUREG/CR-4627, Revision 2, "Generic Cost Estimates," issued February 1992 (Ref. 17), direct

wage rates are loaded using a 2.0 multiplier to account for licensee and contractor labor and incremental overhead (i.e., fringe, benefits, general administration, and profit). 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
2017 Wage Rates			
Industry Executives	$83.35	2	$166.69
Industry Managers	$55.18		$110.37
Industry Staff	$39.30		$78.60
Industry Clerical Staff	$28.32		$56.64
Industry Licensing Staff	$75.90		$151.80
NRC			$128.00**

* The mean wage rates for industry labor categories are calculated as the average of the mean hourly wage (in the Electric Power Generation, Transmission, and Distribution Industry) for applicable standard occupational classification (SOC) codes from the Bureau of Labor Statistics. The SOC codes used are Top Executives (SOC 11-1011), Chief Executives (SOC 11-0000); 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).

** The 2016 NRC staff labor rate is $128 per hour. NRC labor rates are calculated based on actual labor and benefit costs from the prior fiscal year.

3.1.2.1 Cost Estimation Methods

The NRC applied several cost estimation methods in this analysis. Many costs were estimated using expert opinion, which relies on the NRC's professional knowledge and judgment. The NRC consulted industry experts within and outside of the agency to develop most of the LOE estimates used in the analysis. For example, the NRC referred to industry comments in response to the reevaluated hazards to inform the LOE estimates used for performing site-specific reevaluated hazards evaluations.

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 extrapolated LOE estimates from existing NRC documentation and licensee submittals to estimate the LOE of the final rule's required activities. For example, the NRC reviewed exemption analyses already submitted by licensees to extrapolate the cost of this activity under the final rule.

Some activities were estimated using the engineering buildup method of cost estimation, which combines the incremental costs of an activity from the bottom up to estimate a total cost. For example, the NRC built up the BWR two-unit site costs based on the costs associated with the BWR one-unit site costs. In these cases, the NRC estimated the equipment and site labor to procure, modify the plant, and stage this equipment to comply with activities related to Order EA-12-049.

Finally, the NRC developed other costs using the analogy method, which compares similar activities to estimate costs. Examples of cost activities that were estimated using the analogy method include the effort required to develop and maintain the reevaluated hazard change control program. The NRC considered the costs associated with change management programs to estimate the costs imposed by the rule requirements.

3.1.3 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 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, Volume 28, "NRC Information Digest 2016–2017," issued September 2016 (Ref. 18). In total, the regulatory analysis covers a 63-year period.

To estimate the average remaining license term for operating reactors, the NRC 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 estimated that the average remaining license term is 24 years, as of the effective date of the final rule. At the end of this 24-year period, the NRC assumes that these sites would enter the decommissioning phase and would, in turn, incur decommissioning site costs associated with the final rule for the first 2 years of decommissioning. According to 10 CFR 50.155(a)(2)(ii), if the licensee performs and retains an analysis (hereafter referred to as the "exemption analysis") demonstrating that (1) the decay heat of the fuel in the SFP is removed solely by heating and boiling of water within the SFP and (2) the boil-off period provides sufficient time for the licensee to obtain offsite resources to sustain the SFP cooling function indefinitely, the licensee must only comply with 10 CFR 50.155(b)(3) of the final rule, which has no associated incremental costs. Therefore, the period of analysis for operating reactors begins in 2017, the year the final 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.[6]

The analysis includes two new reactor sites (i.e., Summer Units 2 and 3 and Vogtle Units 3 and 4). The NRC 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 final rule from 2017 through 2077. In 2078, costs associated with the new reactor sites would shift to those for decommissioning sites for 2 years (from 2078 through 2079), based on the NRC'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)(3) of the final rule requirements.[7]

The analysis includes four current COL applicants (i.e., Lee, Levy, North Anna, and Turkey Point). Because these applicants have not announced an intention to construct and operate a new reactor, costs for these applicants only include incremental licensing costs for their applications and the NRC review of that information.

3.1.4 Present-Value Calculations

The NRC calculated the present value of the costs sites would incur over the average remaining license term. The NRC assumes that the final 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 3-percent and 7-percent discount

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[6] 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 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.

[7] Ibid.

rates to calculate present values. Costs that would be incurred before the effective date of the final rule are expressed in present-value terms using the 3-percent and 7-percent discount rates, which increase the costs because of the time value of money.

3.1.5 Reevaluated Hazard Mitigating Strategy Assessment

The NRC is estimating the costs to implement mitigating strategies changes necessary to address the reevaluated seismic and flooding hazards that would be necessary under the new rule. The costs are associated with implementing the existing orders or associated with responding to the NRC letter on 10 CFR 50.54(f) to power reactor licensees dated May 9, 2014 (Ref. 23).

The final rule requires licensees to address the effects of the reevaluated hazard information using one or both of the two approaches:

(1) the mitigation strategies and guidelines required by 10 CFR 50.155(b)(1) as implemented or as modified

(2) event-specific approaches

The basis for requiring these provisions within the rule is in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," dated November 21, 2014 (Ref. 26), and its associated SRM, dated March 30, 2015 (Ref. 27). As discussed in COMSECY-14-0037, the requirements of Order EA-12-049 were imposed in parallel with the agency's March 12, 2012 (Ref. 44), requests for information on the reevaluation of external hazards. As a result, Order EA-12-049 included a requirement for licensees to give reasonable protection to equipment associated with the required mitigating strategies from external events without specific reference to the necessary level of protection. The appropriate level of protection from external hazards, particularly flooding, was the subject of discussion in the course of NRC-held public meetings leading up to the issuance of 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 1, on January 22, 2016 (Ref. 24), and its endorsement of the industry guidance for Order EA-12-049 in NEI 12-06, Revision 2 (Ref. 25).

In COMSECY-14-0037, the NRC staff asked the Commission to affirm the following three points:

(1) Licensees for operating nuclear power plants need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs.

(2) Licensees for operating nuclear power plants may need to address some specific flooding scenarios that could significantly damage the power plant site by developing targeted or scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs.

(3) The NRC staff should revise the flooding assessments and integrate the decisionmaking into the development and implementation of mitigating strategies in accordance with Order EA-12-049 and this rulemaking.

These principles reflect Revision 3 to NEI 12-06 (Ref. 29) and the key assumptions submitted by multiple licensees in their overall integrated plans for mitigating strategies, using the following language:

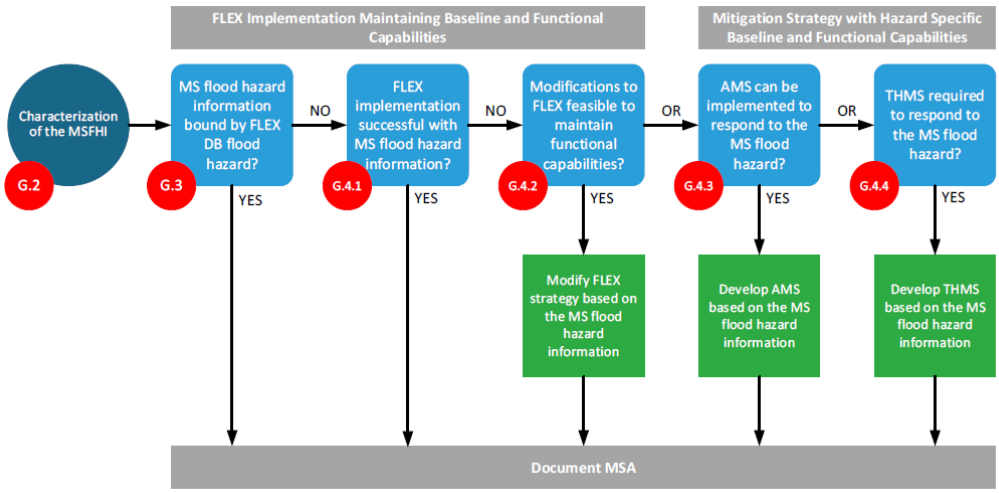
> Flood and seismic reevaluations pursuant to the § 50.54(f) letter of March 12, 2012, are not completed and therefore not assumed in this submittal. As the reevaluations are completed, appropriate issues would be entered into the corrective action system and addressed on a schedule commensurate with other licensing bases changes.

In SRM-COMSECY-14-0037, the Commission approved the first two items recommended by the NRC staff: (1) the need for operating nuclear power plant licensees to address the reevaluated flood hazards within the mitigating strategies and (2) the potential for using targeted or scenario-specific mitigating strategies.

3.1.5.1 Reevaluated Flooding Hazard

Appendix G to NEI 12-06, Revision 3 (Ref. 29), describes the methodology each licensee would use to evaluate the impact of the reevaluated flood hazard information using the process illustrated in Exhibit 3-4.

Exhibit 3-4 Mitigating Strategies Assessment Flow Chart—Flooding Reevaluation



Source: Ref. 29, Appendix E, Figure 1

The MSA determines whether FLEX strategies can be implemented given the impact of the mitigating strategies flood hazard information (MSFHI). If it is determined that FLEX strategies cannot be implemented, the MSA considers other options, such as modifications to FLEX strategies or different mitigation strategies that address the specific parameters of the MSFHI. If a strategy other than FLEX is chosen, the basis for choosing the selected strategy as the most effective option would be documented in the MSA. In addition, the targeted hazard mitigating strategy (THMS) method is an approach that deviates from the FLEX guidance in that it will not maintain or restore the containment capability. In this approach, the opening of containment is used as an element of the strategy. The THMS approach is used only if other strategies are not reasonable.

The following describes each path shown in Exhibit 3-4:

- Path G.3: Flood hazard information bound by FLEX design-basis flood hazard

  Path G.3 illustrates the comparison of the flood hazard used to develop the FLEX strategies with the MSFHI to determine if the MSFHI is bounded. If the flood hazard is bounded, no changes to the FLEX strategies are required.

  For Path G.3, licensees would document the reevaluated flooding hazard evaluation, which supports the conclusion that the flood hazard is bounded and that existing FLEX strategies are acceptable without modification for the MSFHI.

- Path G.4.1. FLEX implementation successful with mitigating strategies flood hazard information

  Path G.4.1 illustrates the situation if the MSFHI is not bounded in all aspects (i.e., flood height, associated effects, and flood event duration). Section G.4.1 of NEI 12-06, Revision 3 (Ref. 29), has guidance for evaluating the existing FLEX strategies against the impacts of the MSFHI to determine if the FLEX strategies can still be implemented without change.

  For Path G.4.1, licensees would document the reevaluated flooding hazard evaluation, which supports the conclusion that the existing FLEX strategies are acceptable without modification for the MSFHI.

- Path G.4.2. Modifications to FLEX feasible to maintain functional capabilities

  Path G.4.2 illustrates the situation if the FLEX strategies cannot be implemented without change. Section G.4.2 of NEI 12-06 has guidance for determining if the FLEX strategies can be modified to address the identified impacts from the MSFHI.

  For Path G.4.2, licensees would document the reevaluated flooding hazard evaluation, which supports the conclusion that modifications enable the FLEX strategies to be implemented based on the impacts of the MSFHI. The documentation would include the following:

  – identification of the impacts to the FLEX strategies

  – a revised sequence of events demonstrating the necessity of revised FLEX actions

  – description and justification of the modifications (e.g., equipment, procedures) necessary to address the revised FLEX actions

  – validation documents.

- Path G.4.3. An alternate mitigating strategy (AMS) can be implemented to respond to the mitigating strategies flood hazard

Path G.4.3 illustrates an alternative to modifying the FLEX strategies. Section G.4.3 of NEI 12-06 has guidance for developing an AMS. Unlike the FLEX strategies, which assume specific event consequences from an undefined external event, the AMS would be based specifically on the MSFHI as the defined external event. As such, the AMS would not assume an ELAP and loss of the ultimate heat sink unless the flood event caused such consequences. The AMS can use any configuration of equipment (e.g., protective features, plant equipment, FLEX equipment) to maintain or restore core cooling, containment, and SFP cooling capabilities.

For Path G.4.3, licensees would document the reevaluated flooding hazard evaluation that concludes that the selected strategy will mitigate the MSFHI. The documentation would include the following:

– the sequence of events for the flood hazards

– a detailed description of the mitigating strategies

– a detailed list of equipment necessary for the mitigating strategies

– a description of how the provisions for the baseline coping capability, the external flooding impact, and the programmatic controls have been addressed

– validation documentation

- Path G.4.4. THMS required to respond to the mitigating strategies flood hazard

Path G.4.4 illustrates an alternative to modifying the FLEX strategies or developing an AMS. Section G.4.4 of NEI 12-06 has guidance for developing a THMS that would consider other mitigative measures. The difference between an AMS and THMS is that for the THMS, there will be a need to open containment as an element of the strategy to perform the core cooling function and, as such, only the core cooling and SFP cooling capabilities would be maintained or restored. A THMS is used only if it is not reasonable to develop an AMS.

For Path G.4.4, licensees would document the reevaluated flooding hazard evaluation that concludes that the selected strategy will mitigate the MSFHI. The documentation would include the following:

– the sequence of events for the flood hazards

– a detailed description of the mitigating strategies

– a detailed list of equipment necessary for the mitigating strategies

– a description of how the provisions for the baseline coping capability, the external flooding impact, and the programmatic controls have been addressed

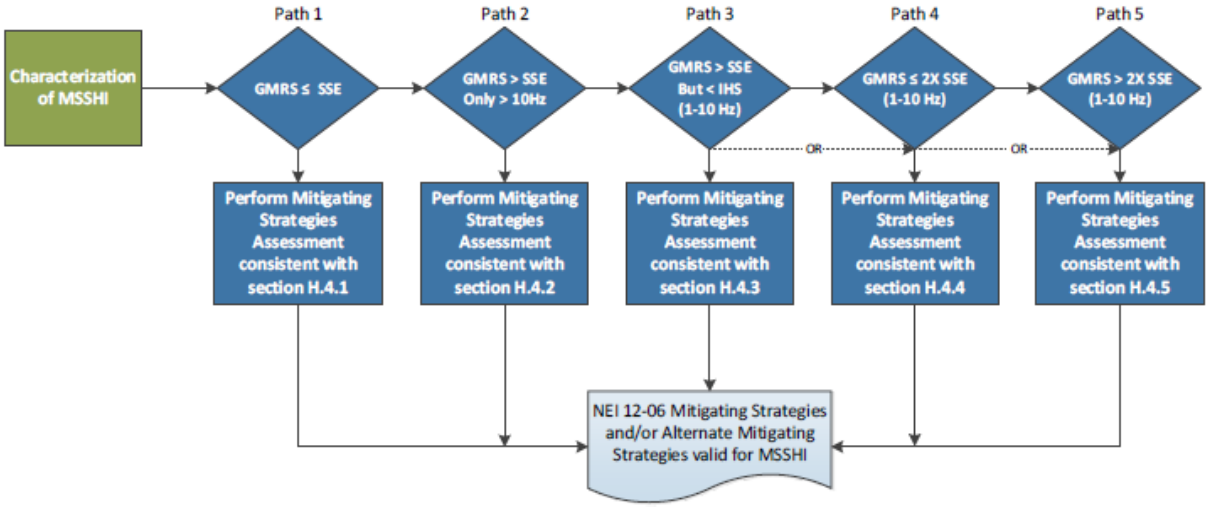
– validation documentation

– for a THMS, documentation of the justification for not maintaining the containment capability

3.1.5.2 Revaluated Seismic Hazard

Appendix H to NEI 12-06, Revision 3 (Ref. 29), describes the methodology each licensee would use to evaluate the effect of the reevaluated seismic hazard information using the appropriate MSA methodology, as illustrated in Exhibit 3-5 and described below.

Exhibit 3-5 Mitigating Strategies Assessment Process for the Mitigating Strategies Seismic Hazard Information



Source: Ref. 29, Appendix H, Figure H.2

- Path 1: GMRS ≤ SSE

  If the safe-shutdown earthquake (SSE) spectrum bounds the ground motion response spectrum (GMRS) at frequencies of 1 hertz (Hz) and greater, NEI 12-06 advises licensees that additional evaluation is unnecessary because the effects of the mitigating strategies seismic hazard information (MSSHI) are bounded by the hazard for which the mitigating strategies were designed.

  For Path 1, licensees would document the reevaluated seismic hazard evaluation that demonstrates existing FLEX strategies are acceptable without modification for the MSSHI Path 1. This documentation would include the following:

  – the FLEX strategies that can be implemented for the MSSHI
  – a comparison of the GMRS to the SSE

- Path 2: GMRS < SSE with high-frequency exceedances

  For plants where the GMRS spectrum above 10 Hz exceeds the SSE spectrum, licensees must demonstrate adequacy of the FLEX strategies with respect to the MSSHI by performing an MSA that consists of an evaluation of high-frequency-sensitive plant equipment required for strategy implementation.

For Path 2, licensees would document the reevaluated seismic hazard evaluation to demonstrate that FLEX strategies, or FLEX strategies with modifications, address the effects of the MSSHI on mitigation strategies. The documented evaluation would include the following:

– description of comparison of GMRS to SSE

– identification of any MSSHI impacts to the FLEX strategies

– revised sequence of events demonstrating the necessity of revised FLEX actions, as appropriate

– description of and justification for any resulting modifications (e.g., equipment, procedures) to address the revised FLEX actions, as appropriate

– validation documents

- Path 3: SSE < GMRS < IHS

For Path 3, the GMRS is compared to a plant capacity spectrum derived from the individual plant examination of external events (IPEEE) program using the plant's high-confidence-of-low-probability-of-failure (HCLPF) capacity. The IPEEE HCLPF spectrum (IHS) is described in Section 3.3 of EPRI Report No. 1025287 (Ref. 28). If the IHS envelops the GMRS between 1 and 10 Hz or was previously accepted by the NRC, licensees could use an MSA to demonstrate robustness to the MSSHI of structures, systems, and components (SSCs) relied on for the AMS. These MSAs rely on the IPEEE seismic evaluation of plant equipment to demonstrate the robustness of SSCs to the MSSHI. Licensees would also supplement the IPEEE evaluation with reviews of SFP cooling functions and high-frequency exceedances (as applicable).

For Path 3, licensees would document the reevaluated seismic hazard evaluation that concludes that the selected strategy will address the effects of the MSSHI. The documented evaluation would include the following:

– description of comparison of GMRS to IHS

– description of plant-specific IPEEE and adequacy from March 2014 submittal

– description of and need for the AMS and how it provides evaluation of paths to plant safety

– description of approach, implementation, and results to address items (including any modifications) outside the scope of IPEEE (e.g., SFP cooling)

– description of any limitations and how they were accommodated

– description of evaluation of IPEEE to full scope

– description of availability of FLEX equipment

– validation documents

- Path 4: GMRS ≤ 2X SSE

  Licensees who determine that a plant GMRS has spectral ordinates greater than the SSE but no more than two times the SSE anywhere in the 1 to 10 Hz frequency range may use Path 4 to perform an MSA of the impacts of the MSSHI on FLEX strategies. These licensees may also elect to follow Path 5. For this path, licensees need to evaluate SSCs and seismic iterations that were not included within the expedited seismic evaluation process review and use approved methods to demonstrate adequate seismic ruggedness. These methods include use of qualitative criteria based on previous experience to show adequate seismic ruggedness as well as a more quantitative approach to demonstrate SSCs are seismically robust up to the GMRS earthquake level.

  For Path 4, licensees would document the reevaluated seismic hazard evaluation to demonstrate that FLEX strategies, or FLEX strategies with modifications, address the effects of the MSSHI on mitigation strategies. The documented evaluation would include the following:

  – description of comparison of GMRS to SSE

  – identification of any MSSHI impacts to the FLEX strategies

  – revised sequence of events demonstrating the necessity of revised FLEX actions, as appropriate

  – description of and justification for any resulting modifications (e.g., equipment, procedures) to address the revised FLEX actions, as appropriate

  – description of approach, implementation, and results to address additional considerations (e.g., high frequency, spent fuel cooling)

  – validation documents

- Path 5: GMRS > 2X SSE

  Licensees who determine that a plant GMRS has spectral ordinates greater than two times the SSE anywhere in the 1 to 10 Hz frequency range may use the plant's SPRA results or elements based on the SPRA to demonstrate the capability to maintain or restore core cooling and containment capabilities. The deterministic assessment performed for Path 5 is consistent with that used for Path 4 to determine if the FLEX strategies can be implemented as designed in view of the impacts of the MSSHI, or if the FLEX strategies can be modified to address the impacts of the MSSHI. As part of this assessment, the results and insights from the plant SPRA may also be used to inform the evaluation of the mitigating strategies SSCs to determine which FLEX equipment or other plant modifications (such as an AMS), if any, will improve the plant's seismic safety.

  Plants using the SPRA need to demonstrate the technical adequacy of the SPRA. Licensees would establish the SPRA's technical adequacy through the conduct of SPRA peer reviews, in accordance with the screening, prioritization, and implementation detail

(Ref. 28) expectations, including resolution of peer review findings pertinent to the ELAP/LUHS modeling and results.

For Path 5 using the deterministic approach, the licensee would document the reevaluated seismic hazard evaluation that demonstrates that FLEX strategies or FLEX strategies with modifications address the effects of the MSSHI on mitigation strategies. The documented evaluation would include the following:

– description of comparison of GMRS to SSE

– identification of the MSSHI impacts to the FLEX strategies, as appropriate

– revised sequence of events demonstrating the necessity of revised FLEX actions, as appropriate

– description of and justification for any resulting modifications (e.g., equipment, procedures) to address the revised FLEX actions, as appropriate

– discussion of the bases for accepting the seismic capacities of mitigating strategy SSCs, including those SSCs that may have lower than $C_{10\%}$ capacities.[8]

– description of approach, implementation, and results to address additional considerations (e.g. high frequency, spent fuel cooling)

– validation documents

For Path 5 using the risk-informed approach, the licensee would document the reevaluated seismic hazard evaluation to demonstrate that the selected strategy will address the effects of the MSSHI on mitigation strategies. The documented evaluation would include the following:

– description of comparison of GMRS to SSE

– description of the mitigating strategy approach selected and how it demonstrates reasonable protection for the MSSHI

– discussion of the bases for accepting the seismic capacities of mitigating strategy SSCs, including those SSCs that may have lower than $C_{10\%}$ capacities

– description of approach, implementation, and results to address SFP cooling

– description of any limitations and how they were accommodated

– validation documents

[8] The variable, $C_{10\%}$, is the seismic capacity corresponding to 10 percent conditional probability of failure. An SSC with a capacity lower than this value would have a higher conditional probability of failure for the same event.

There are significant uncertainties in estimating the costs and benefits of this rule because of the site-specific nature of the external phenomena that are postulated to challenge the plant's safety-feature capabilities. There are also challenges in estimating the costs and extent of the analyses and mitigation features necessary to consider reevaluated external hazards actions. This is caused, in part, by the sensitivity of the analysis to the following key assumptions and observations:

- The MSA guidance was not final at the time the NRC staff performed this analysis or during the collection of cost data.
- The NRC and industry have limited experience in performing and approving an MSA, with the following results:
  - The effort required to complete an MSA is a best estimate with significant uncertainty.
  - The effort required to implement any changes to plant programs and procedures and to complete necessary training depends on the MSA results. Because these results are not known at the time of this analysis, estimates to perform this task have a large uncertainty.
  - The extent of any plant modifications depends on both the mitigating strategy used and the results of the MSA as compared to the existing plant design. Both of these factors have a very large effect on estimated uncertainty.
  - The costs of maintaining configuration control for the resulting programs, procedures, and modifications depend on the extent and complexity of the documentation and modifications. These factors have a large effect on estimated uncertainty.
- One available seismic strategy uses a risk-informed approach with an SPRA. The cost of developing the underlying SPRA has a large effect on the cost and the estimated uncertainty.

Additional assumptions used for this analysis are discussed in the section or appendix where they are used. The costs presented in this analysis are based on estimates by the analyst or cited documents. This is a generic cost estimate and should be used accordingly. Site-specific features may result in higher or lower costs than those estimated.

3.2 Summary of Costs and Benefits of the Regulatory Options

This section presents the costs and benefits of the final rule with respect to three options: (1) take no action, (2) undertake a rulemaking to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable, and (3) undertake a rulemaking to require SAMGs and make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. Where possible, the NRC monetizes effects. Those effects that cannot be monetized are instead described, to the extent possible, quantitatively or qualitatively. This section summarizes 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 requirements under Option 2 (the final rule). Appendix B presents the historical costs of the orders and industry initiatives. Note that all costs presented

in this analysis are rounded to two significant figures. Appendices C and D give a more detailed presentation of the cost data.

Option 1: Take No Action

Under Option 1, the NRC assumes that the final rule would not be implemented; however, existing programs and regulatory efforts would still be in effect. Therefore, the NRC assumes that industry would continue with the implementation of all orders (including Order EA-12-049 and Order EA-12-051) as well as industry initiatives undertaken following the Fukushima accident (Ref. 19). Activities being completed as part of NTTF Recommendation 2.1, some of which relate to Order EA-12-049 through the MSAs, are included as part of the regulatory baseline for Option 1. This includes conducting the seismic portion of the MSA, which may involve leveraging risk insights from the SPRAs. As previously discussed, some licensees are completing SPRAs as part of NTTF Recommendation 2.1, to assess the existing mitigating strategies against the reevaluated seismic hazard. There are no incremental costs associated with this option, as shown in Exhibit 3-6.

Exhibit 3-6 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	**Regulatory Efficiency—**The quantitative benefit of this alternative related to regulatory efficiency is reflected in no additional costs to the NRC and the industry.
NRC: $0 using a 3% discount rate $0 using a 7% discount rate	

Option 2: Undertake Rulemaking To Make the Orders and Industry Initiatives Generically Applicable (NRC-Selected)

Under this option, the NRC would undertake the final rule to make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. This option imposes requirements for evaluating the impact of flood and seismic hazard information developed in response to the NRC's 10 CFR 50.54(f) letter (Ref. 44) and the modification of existing or the development of new mitigating strategies, if necessary, to mitigate the effects of the reevaluated hazard information. The NRC estimates the costs and benefits of this option relative to the no-action baseline. This option would result in incremental costs of ($141 million) using a 7-percent discount rate or ($148 million) using a 3-percent discount rate. These costs result from the industry's review of the rule requirements; the industry's performing, documenting, and maintaining the reevaluated hazards evaluations; and the NRC's review and approval of industry submittals. Exhibit 3-7 presents the total costs associated with this option.

Exhibit 3-7 Summary of Total Costs for Undertaking Rulemaking To Make the Orders and Industry Initiatives Generically Applicable

Activity	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)
Review Rule Requirements							
Industry	($110,000)	N/A	($7,200,000)	N/A	($7,200,000)	($7,200,000)	($7,200,000)
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*($110,000)*	*$0*	*($7,200,000)*	*$0*	*($7,200,000)*	*($7,200,000)*	*($7,200,000)*
Staffing Capabilities							
Industry	N/A	($3,600)	N/A	($112,000)	($2,850,000)	($980,000)	($1,710,000)
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$0*	*($3,600)*	*$0*	*($112,000)*	*($2,850,000)*	*($980,000)*	*($1,710,000)*
Communication Capabilities							
Industry	N/A	($900)	N/A	($83,000)	($2,060,000)	($730,000)	($1,260,000)
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$0*	*($900)*	*$0*	*($83,000)*	($2,060,000)	($730,000)	($1,260,000)
Command and Control Procedures							
Industry	N/A	($800)	N/A	*($47,000)*	($1,090,000)	($520,000)	($760,000)
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$0*	*($800)*	*$0*	*($47,000)*	($1,090,000)	($520,000)	($760,000)
Reevaluated Hazard Evaluation							
Industry	($1,620,000)	N/A	($86,600,000)	N/A	($86,600,000)	($86,600,000)	($86,600,000)
NRC	($620,000)	N/A	($33,900,000)	N/A	($33,900,000)	($33,900,000)	($33,900,000)
Subtotal	*($2,240,000)*	*$0*	*($120,500,000)*	*$0*	*($120,500,000)*	*($120,500,000)*	*($120,500,000)*
Reevaluated Hazards Change Management							
Industry	N/A	($18,100)	N/A	($990,000)	($23,200,000)	($11,100,000)	($16,200,000)
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subtotal	*$0*	*($18,100)*	*$0*	*($990,000)*	*($23,200,000)*	*($11,100,000)*	*($16,200,000)*
Total							
Industry	*($1,730,000)*	*($23,400)*	*($93,800,000)*	*($1,232,000)*	*($123,000,000)*	*($107,130,000)*	*($113,730,000)*
NRC	*($620,000)*	*$0*	*($33,900,000)*	*$0*	*($33,900,000)*	*($33,900,000)*	*($33,900,000)*
Total	**($2,350,000)**	**($23,400)**	**($127,700,000)**	**($1,232,000)**	**($156,900,000)**	**($141,030,000)**	**($147,630,000)**

* Results are rounded.

Exhibit 3-8 summarizes the incremental costs and benefits of Option 2.

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

Incremental Costs	Incremental Benefits
Industry: ($114 million) using a 3% discount rate ($107 million) using a 7% discount rate **NRC:** ($34 million) using a 3% discount rate ($34 million) using a 7% discount rate Total: ($148 million) using a 3% discount rate ($141 million) using a 7% discount rate	Increases regulatory efficiency. Ensures strategies and guidelines are useable and cohesive to address scenarios identified in the NTTF Recommendation 2.1 assessments and that mitigation strategies equipment is considered. Addresses lessons learned from the Fukushima accident and orders implementation. Ensures adequate staffing, command and control, and communication capabilities for severe external and multiunit events. Meets the intent of the Consolidated Appropriations Act. Provides defense in depth by giving increased confidence in the availability of mitigating strategies equipment following severe external flooding and seismic events.

3.3 Costs of the Final Rule

This section details the estimated costs of the final rule (Option 2). Under the final rule option, these costs include reviewing the rule requirements in the following portions of 10 CFR 50.155, "Mitigation of Beyond-Design-Basis Events":

- Paragraph 50.155(b)(2) requires each licensee that received the March 12, 2012, NRC letter issued under 10 CFR 50.54(f) (Ref. 44) to consider in the development of the mitigation strategies the effects of the reevaluated hazards information developed in response to that request.

- Paragraph 50.155(b)(4) requires each licensee and applicant to integrate the FSGs and EDMGs with the EOPs.

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

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

- Paragraph 50.155(c)(2) requires each licensee and applicant to give reasonable protection from the effects of the natural phenomena that are equivalent in magnitude to the phenomena assumed for developing the design basis of the facility

- Paragraph 50.155(c)(3) requires each licensee and applicant to give reasonable protection from the effects of the reevaluated flooding and seismic hazards determined in response to the March 12, 2012, NRC letter issued under 10 CFR 50.54(f) (Ref. 44) in the development of mitigation strategies.

- Paragraphs 50.155(c)(2) and 50.155(c)(3) require licensees to provide reasonable protection of the equipment relied on for mitigation strategies, as previously required by

Order EA-12-049. The costs for the final rule option include the additional costs associated with the industry confirmation that equipment relied on for mitigation strategies are reasonably protected for the reevaluated protection levels as clarified by the Commission in SRM-COMSECY-14-0037. All of the remaining requirements are limited to FSGs and EDMGs and, as such, would be implemented by ongoing activities before the effective date of the rule and are not expected to result in any incremental costs.

- Paragraph 50.155(c)(4) requires each licensee to provide sufficient communications capability, both on site and off site, to support implementation of the mitigation strategies and guidelines.

- Paragraph 50.155(d) requires each licensee to train and qualify personnel who perform activities in accordance with the FSGs and EDMGs.

- Paragraphs 50.155(e) requires each licensee and applicant to conduct drills or exercises demonstrating implementation of FSGs and EDMGs.

- Paragraph 50.155(g) allows a licensee to make changes in the implementation of the requirements of 10 CFR 50.155 without prior NRC approval, provided that before implementing each such change, the licensee performs an evaluation demonstrating that regulatory requirements continue to be met. Licensees need to maintain documentation of these changes.

Additionally, under this option, the final rule includes the following requirements as a result of the requirements of Order EA-12-049, which are not analyzed in this regulatory analysis:

- Paragraph 50.155(a)(2) allows licensees to prepare and retain an analysis to enable decommissioning licensees to discontinue compliance with portions of the final rule, with the exception of 10 CFR 50.155(b)(3). The costs associated with this rule provision are treated as historical costs because currently decommissioning sites are preparing these analyses in the baseline to be exempted from Order EA-12-049 and Order EA-12-051; these costs are estimated and discussed in Appendix B. The NRC modelled these costs as averted costs because the final rule saves decommissioning licensees the expense of sending in an exemption request and the NRC the expense of reviewing and acting on the request (versus the current process).

- Paragraph 50.155(b)(1) requires strategies and guidelines to mitigate BDBEE from natural phenomena that result in a loss of all ac power concurrent with either an 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 being incurred as a result of the requirements of Order EA-12-049 and are treated as historical costs. These costs are estimated and discussed in Appendix B.

- Paragraph 50.155(b)(2) requires each licensees that received the March 12, 2012, NRC letter issued under 10 CFR 50.54(f) to consider in the development of the mitigation strategies the effects of the reevaluated hazards information developed in response to that request. The costs associated with this rule provision are being incurred as a result of the requirements of Order EA-12-049 and are treated as historical costs. Appendix B estimates and discusses these costs. However, the NRC has estimated the additional

incremental costs associated with maintaining documentation (i.e., updates to procedures, programs, or plans), training, and plant configuration control to remain in compliance with the final rule. The staff analyzes these costs in Section 3.3 of this analysis.

- Paragraph 50.155(b)(5) requires each licensee and applicant to develop, implement, and maintain sufficient staffing to support implementation of FSGs and EDMGs in conjunction with the EOPs during an event. The costs associated with this rule provision are being incurred as a result of existing industry initiatives and are discussed in Appendix B. The costs associated with this rule provision are being incurred as a result of the requirements of Order EA-12-049 and are estimated and discussed in Appendix B.

- Paragraphs 50.155(c)(2) and 50.155(c)(3) require licensees to provide reasonable protection of the equipment relied on for mitigation strategies, as previously required by Order EA-12-049. However, the NRC has estimated the additional incremental costs associated with the industry confirmation and reevaluated hazards assessment that equipment relied on for mitigation strategies are reasonably protected for the reevaluated protection levels, as clarified by the Commission in SRM-COMSECY-14-0037. The staff analyzes these costs in Section 3.3 of this analysis.

- Paragraph 50.155(c)(4) requires each licensee to provide sufficient communications capability, both on site and off site, to support implementation of the mitigation strategies and guidelines. The costs associated with this rule provision are being incurred as a result of existing industry initiatives and are discussed in Appendix B. This final provision also requires licensees to make and describe adequate provisions for onsite and offsite communication. The equipment procurement costs associated with this rule provision are being incurred as a result of the requirements of Order EA-12-049 and are estimated and discussed in Appendix B. The operation and maintenance costs for maintaining and testing this equipment are incurred as a result of the proposed MBDBE Rule and are estimated and discussed in Section 3.3 of this analysis.

- Paragraph 50.155(f) requires licensees to install SFP level instrumentation, as required by Order EA-12-051. The costs associated with this rule provision are being incurred as a result of the requirements of Order EA-12-051 and are estimated and discussed in Appendix B.

Under this option, the final rule requires each applicant or licensee to be capable of executing strategies and guidelines in the context of the reevaluated flooding and seismic hazards in a manner sufficient to demonstrate reasonable protection for mitigation of BDBEEs. The final rule requires plant equipment relied on for the mitigation strategies to meet the current design basis for a hazard level as severe as that originally determined for the facility, unless the magnitude of the reevaluated hazards stemming from the March 12, 2012, NRC letter issued under 10 CFR 50.54(f) (Ref. 44) exceeds the external design basis of the facility.

This option results in incremental costs of ($141 million) using a 7-percent discount rate or ($148 million) using a 3-percent discount rate, as shown in Exhibit 3-7. The sections below describe these monetized costs in more detail.

3.3.1 Industry Implementation

This section presents the industry implementation costs resulting from Option 2.

3.3.1.1 Review Rule Requirements

The final rule results in industry implementation costs associated with reviewing the rule requirements to (1) confirm compliance with the final rule (i.e., a comparison of the rule requirements with the orders and related industry initiatives and updates to procedures, programs, or plans) and (2) consider the reevaluated hazards. The NRC assumes that each of the 55 operating sites (including the two AP1000 COL sites) and the 10 decommissioning sites will review the final rule and make limited updates to procedures, programs, or plans to reflect the rule requirements. One-time industry implementation costs are assumed to begin in 2017 (the year the rule is expected to be effective).

3.3.1.2 Staffing and Communication Capabilities

As part of the no-action baseline, licensees and applicants are performing staffing analyses and communication system assessments and implementing changes based on these analyses as required by Order EA-12-049 and Order EA-12-051. Appendix B discusses the historical industry implementation costs for this activity.

3.3.1.3 Command and Control Capabilities

As part of the no-action baseline, licensees and applicants are performing command and control capabilities analyses and implementing changes based on these analyses as required by Order EA-12-049 and Order EA-12-051. Appendix B discusses the historical industry implementation costs for this activity.

3.3.1.4 Reevaluated Hazards Analyses

As part of the no-action baseline, licensees and applicants are (1) performing reevaluated hazard analyses and (2) considering the effects of the reevaluated seismic and flooding hazards, which may require licensees to amend mitigation strategies and also could require plant modifications. In response to the feedback questions in the proposed rule, NEI supplied industry estimates (Ref. 22) based on the guidance in NEI 12-06, Revision 3 (Ref. 29), and on information that NEI collected from 60 percent of the affected sites.

The licensing reevaluation hazard assessments are divided into three tasks: (1) the MSA for flooding and seismic hazards, (2) FLEX plan modification to incorporate MSA results, and (3) plant modifications to improve reevaluated hazard mitigation capability. The estimates for each task are discussed below.

Mitigating Strategies Assessment

Implementation costs depend on the combination of flooding and seismic strategies adopted plus how much the existing FLEX implementation plans would need to change. The information below is based on industry estimates in labor hour ranges per site for those that expect to perform these implementation tasks. Note that some sites expect zero costs for programs, procedures, or training efforts if no changes are expected.

a. Flooding MSAs

Exhibit 3-9 shows the NRC estimates for the number of sites using each flooding MSA path and the average level of effort necessary for each site to complete the flooding MSAs.

Exhibit 3-9 Flooding MSA Estimates

Flooding MSA Path ID	Path Description	Estimated Number of Sites	Industry Labor Hours*		
			Low Estimate	Best Estimate	High Estimate
Path G.3 or Path G.4.1	Existing FLEX strategy adequately considers reevaluated flooding hazard	33	100	690	1,000
Path G.4.2	FLEX strategy needs to be modified	17	1,200	2,450	5,000
Path G.4.3	AMS strategy is used	4	1,000	1,550	3,000
Path G.4.4	THMS strategy is used	1	1,500	2,500	5,000

* The industry effort required to conduct a flooding MSA depends on the controlling flooding parameters identified from the MSFHI, the number and diversity of flood hazards to which the site is exposed, and the existing plant flooding design mitigation features. Because of the possibility of large variations on a site-specific basis, the estimates in this table have large uncertainties.

b. Seismic MSAs

Exhibit 3-10 shows the NRC estimates for the number of sites using each seismic MSA path and the average level of effort necessary for each site to complete the seismic MSAs.

Exhibit 3-10 Seismic MSA Estimates

Seismic MSA Path ID	Path Description	Estimated Number of Sites	Industry Labor Hours*		
			Low Estimate	Best Estimate	High Estimate
Path 1	GMRS ≤ SSE	15	40	60	120
Path 2	GMRS > SSE, only > 10 Hz	11	250	450	900
Path 3	SSE < GMRS < IHS (1–10 Hz)	3	1,000	1,900	8,000
Path 4	GMRS ≤ 2X SSE (1–10 Hz)	24	2,000	3,800	15,000
Path 5a**	GMRS > 2X SSE (1–10 Hz), risk ≤ $5x10^{-5}$/reactor-year	6	250	450	900
Path 5b**	GMRS > 2X SSE (1–10 Hz), risk> $5x10^{-5}$/reactor-year	6	5,000	10,000	20,000

* The industry effort required to conduct a seismic MSA depends on the GMRS characteristics and the existing plant seismic design results. Because of the possibility of large variations on a site-specific basis, the estimates in this table have large uncertainties.

** One of the available seismic strategies (Path 5) uses a probabilistic approach, which some licensees are completing as part of NTTF Recommendation 2.1 to assess the existing mitigating strategies against the reevaluated seismic hazard. Because the performance of NTTF Recommendation 2.1 activities is included in Option 1, there are no incremental costs in Option 2 for developing the underlying SPRA.

As discussed in Section 2.1 of this analysis and consistent with the process described in COMSECY-15-0019 (Ref. 38), licensees have been acting to ensure their mitigating strategies are capable of addressing the reevaluated seismic and flooding hazards through the performance of MSAs. The MSAs are being conducted using NRC-approved industry guidance in NEI 12-06, Revision 2 (Ref. 25). One approach for conducting the seismic portion of the MSA involves leveraging risk insights from the SPRAs. Because the development of new SPRAs or

the modification to existing SPRAs is being performed as part of Option 1 and would be available for use if the rulemaking option is approved, there are no incremental costs. For information purposes, Exhibit 3-11 gives the estimated industry cost for developing or improving the site-specific SPRAs.

Exhibit 3-11 Seismic Probabilistic Risk Assessment Incurred Under Option 1

Description*	Estimated Number of Sites	Industry Implementation Cost		
		Low Estimate	Best Estimate	High Estimate
Prepare, review, and peer review a new SPRA	4	$5,000,000	$7,500,000	$20,000,000
Upgrade an existing SPRA for use in performing a seismic MSA	8	$600,000	$1,500,000	$3,000,000

* Because these costs are incurred as part of NTTF Recommendation 2.1 under Option1, there are no incremental SPRA development or upgrade costs for Option 2.

Licensees having an SPRA that demonstrates that the NTTF Recommendation 2.1 risk results, with or without credit for FLEX, are less than $5x10^{-5}$ per year seismic core damage frequency and $5x10^{-6}$ per year for seismic large early release frequency can submit an abbreviated evaluation, as allowed by NEI 12-06 (Ref. 29). This is modelled as Path 5a in Exhibit 3-10. Path 5a has a low industry burden because the SPRA results demonstrate a high likelihood that the mitigation strategies are reasonably protected for the mitigating strategies seismic hazard information, which eliminates further analysis.

c. FLEX Program Modifications To Incorporate MSA Results

Exhibit 3-12 summarizes the programmatic actions that are considered in the estimate to incorporate MSA results into the site's FLEX program and to respond to NRC requests for additional information (RAIs) and resolve comments on the MSA activities.

Exhibit 3-12 Industry Implementation of FLEX Program Revision

Industry Implementation Activity	Estimated Number of Sites	Industry Labor Hours*		
		Low Estimate	Best Estimate	High Estimate
Licensee prepares and submits MSA submittal to NRC	65	400 hrs	600 hrs	1,000 hrs
FLEX program revision	65	100 hrs	300 hrs	700 hrs
Procedure development and revision	65	50 hrs	500 hrs	1,500 hrs
Training	65	50 hrs	500 hrs	1,500 hrs
Respond to RAIs on submittal	65	60 hrs	380 hrs	1,400 hrs

* Industry effort required to implement any changes to plant procedures, complete any necessary training, and respond to questions on the submittal depends on the MSA documentation and results. Because this documentation and these results are not known, the estimates in this table have large uncertainties.

Plant Modifications To Improve Reevaluated Hazard Mitigation Capability

Plant modifications to improve the reevaluated hazards mitigation capability may vary significantly between sites. In fact, NEI gave a very broad range for the potential modification efforts that may be implemented at a given site. This is because licensees at the time this information was collected did not yet know what plant changes may be necessary. Industry estimates for individual sites ranged from zero increase, indicating that no modifications are expected, to tens of millions of dollars for sites that may need to enhance their flood protection

features. Exhibit 3-13 shows the NRC estimates of the number of sites that will voluntarily implement plant modifications to improve the site's reevaluated hazard mitigation capability and the costs that would be incurred for this additional capability.

As discussed in Enclosure 2, "Coordination and Clarification," to COMSECY-14-0037, the reevaluated hazards are not automatically incorporated into the licensing basis for operating reactors. As such, any staff-imposed requirements that go beyond the level of protection proposed by the licensee would need to follow established regulatory processes, including the Backfit Rule, to determine whether additional requirements are warranted on a plant-specific basis. Therefore, these plant-specific cases are outside the scope of this rule.

Exhibit 3-13 Plant Modification Estimates To Improve Reevaluated Hazard Mitigation Capability

Plant Modifications	Estimated Number of Sites	Modification Costs (2017 dollars)*		
		Low Estimate	Best Estimate	High Estimate
Group 1: Minor seismic or flooding modifications	30	$0	$50,000	$100,000
Group 2: Limited seismic or flooding modifications	20	$100,000	$250,000	$400,000
Group 3: Considerable seismic or flooding modifications	10	$500,000	$750,000	$1,000,000
Group 4: Significant seismic or flooding modifications	2	$1,250,000	$2,500,000	$3,750,000
Group 5: Substantial seismic or flooding modifications	2	$3,750,000	$5,000,000	$6,250,000
Group 6: Major seismic or flooding modifications	1	$7,500,000	$12,500,000	$17,500,000

* Industry effort required to implement any changes to plant procedures and complete any necessary training depends on the MSA results. Because these results are not known, the estimates in this table have large uncertainties.

Exhibit 3-14 presents the industry's implementation costs for industry consideration of the reevaluated hazard.

Exhibit 3-14 Present Value of Industry's Implementation Costs for the Reevaluated Hazards

Activity	Industry Average Cost Per Site	Total Industry Implementation Cost
Flooding MSAs	($170,000)	($9,600,000)
Seismic MSAs	($340,000)	($18,700,000)
FLEX Program Modifications	($310,000)	($16,800,000)
Plant Modifications	($800,000)	($41,500,000)
Total	**($1,620,000)**	**($86,600,000)**

* Results are rounded.
** All costs in this exhibit are in 2017 dollars.

Exhibit 3-15 lists the industry's implementation costs for the final rule, which amount to a total one-time cost of approximately ($86.6 million). The average one-time cost per site is estimated at ($1.62 million) based on 65 affected sites.

Exhibit 3-15 Industry Implementation Costs for the Rulemaking Option

Activity	Average Cost Per Site	Total Industry Implementation Cost
Review Rule Requirements	($110,000)	($7,200,000)
Ongoing Staffing Assessments	N/A	N/A
Communication Capabilities O&M	N/A	N/A
Reevaluated Hazards Analyses	($1,620,000)	($86,600,000)
Total	**($1,730,000)**	**($93,800,000)**

* Results are rounded.
** All costs in this exhibit are in 2017 dollars.

3.3.2 Industry Operation

This section presents the industry operation costs resulting from Option 2. Exhibit 3-16 shows the industry operation cost estimate inputs, and Exhibit 3-17 shows the estimated industry operation costs for the final rule. These total industry operation costs range from ($13.3 million) using a 7-percent discount rate to ($19.9 million) using a 3-percent discount rate. The average industry annual cost per site is ($23,400) for the remaining operating licensed term, based on 65 affected sites.

3.3.2.1 Review Rule Requirements

The NRC assumes that each of the 55 operating sites (including the two AP1000 COL sites) and the 10 decommissioning sites would complete this activity during implementation and there would be no residual industry operations costs for this activity.

3.3.2.2 Staffing and Communication Capabilities

Relative to the no-action baseline, the estimated costs for the rulemaking option largely represents the costs associated with the new regulatory requirements for licensees to maintain the staffing and communications system capabilities for the term of the license.

3.3.2.3 Reevaluated Hazard Analyses

Relative to the no-action baseline, licensees would be required to maintain configuration control for the programs, procedures, analyses, and modifications that were performed or installed to improve reevaluated hazard mitigation.

Industry annual FLEX program and procedure maintenance to incorporate new information could be fairly straightforward and has been modeled over a range to represent a low estimate, best estimate, and high estimate per year.

There is no requirement to maintain either the MSA documentation or the supporting SPRA, although licensees may choose to maintain this documentation for other reasons.

Licensee activities that are required under the orders, such as maintaining configuration control of installed hazard mitigation capability, performing periodic preventive maintenance on hazard mitigation capability components and equipment, and performing surveillance and testing on FLEX equipment, would continue under the rulemaking option and would not result in any incremental costs.

Exhibit 3-16 Industry Operation Cost Estimate Inputs

<table>
<tr><th rowspan="2">Activity</th><th colspan="3">Industry Annual Cost (per site)</th></tr>
<tr><th>Low Estimate</th><th>Best Estimate</th><th>High Estimate</th></tr>
<tr><td>Maintain staffing analyses</td><td>20 hours</td><td>42 hours</td><td>84 hours</td></tr>
<tr><td>Maintain communication system capability*</td><td>$303</td><td>$908</td><td>$1,513</td></tr>
<tr><td>Maintain flooding MSA</td><td colspan="3" rowspan="3">There is no requirement to maintain either the MSA documentation or the supporting SPRA, although the licensee may choose to maintain this documentation for other reasons.</td></tr>
<tr><td>Maintain seismic MSA</td></tr>
<tr><td>Perform annual SPRA review and update</td></tr>
<tr><td>Maintain FLEX program</td><td>80 hours</td><td>160 hours</td><td>320 hours</td></tr>
<tr><td>Maintain configuration control of installed hazard mitigation capability</td><td colspan="3" rowspan="3">Included in Option 1</td></tr>
<tr><td>Perform periodic preventive maintenance on hazard mitigation capability components and equipment</td></tr>
<tr><td>Perform surveillance and testing on hazard mitigation capability components and equipment</td></tr>
</table>

* Industry effort to maintain and test communication equipment include monthly tests, annual replacement of batteries, and replace or repair units out of service.

Exhibit 3-17 Industry Operation

Activity	Industry Average Annual Cost Per Site	Total Industry Cost		
		Undiscounted	Present Value (7 percent)	Present Value (3 percent)
Maintain staffing analysis	($3,600)	($2,900,000)	($1,000,000)	($1,700,000)
Maintain communication system capability	($900)	($2,100,000)	($700,000)	($1,300,000)
Maintain command and control procedures	($800)	($1,100,000)	($500,000)	($800,000)
Maintain flooding MSA	($9,000)	($11,600,000)	($5,500,000)	($8,100,000)
Maintain seismic MSA	($9,000)	($11,600,000)	($5,500,000)	($8,100,000)
Perform annual SPRA review and update	($22,600)	($15,100,000)	($7,100,000)	($10,500,000)
Maintain FLEX program	($18,100)	($23,200,000)	($11,100,000)	($16,200,000)
Perform SPRA model updates and peer reviews every 4 years	($105,800)**	($228,500,000)	($48,200,000)	($100,800,000)
Total	**($169,800)**	**($296,100,000)**	**($79,600,000)**	**($147,500,000)**

* Results are rounded.
** Recurring costs were equally divided over the period of recurrence to approximate the annual cost.

3.3.3 NRC Implementation

The NRC will incur costs to review licensing submittals and prepare and issue safety evaluations. Exhibit 3-18 presents the estimates to perform these activities, and Exhibit 3-19 presents the resultant costs.

Exhibit 3-18 NRC Implementation Inputs

NRC Activity	MSA Submittal ID and Path Description	Estimated Number of Submittals	NRC Labor Hours (per submittal)		
			Low Estimate	Best Estimate	High Estimate
Flooding MSA submittals					
Review flooding MSA submittals. Prepare and issue safety evaluations.	Path G.3 or Path G.4.1—Existing FLEX strategy adequately considers reevaluated flooding hazard	40	40 hrs	150 hrs	200 hrs
	Path G.4.2—FLEX strategy needs to be modified for flooding hazard	19	300 hrs	500 hrs	1,000 hrs
	Path G.4.3—AMS strategy is used for flooding hazard	5	200 hrs	320 hrs	600 hrs
	Path G.4.4—THMS strategy is used for flooding hazard	1	300 hrs	500 hrs	1,000 hrs
Seismic MSA submittals					
Review seismic MSA submittals. Prepare and issue safety evaluations.	Path 1—MRS ≤ SSE	15	20 hrs	30 hrs	60 hrs
	Path 2—GMRS > SSE, only > 10 Hz	11	80 hrs	150 hrs	300 hrs
	Path 3—SSE < GMRS < IHS (1–10 Hz)	3	600 hrs	1,200 hrs	2,400 hrs
	Path 4—GMRS ≤ 2X SSE (1–10 Hz)	24	1,000 hrs	2,200 hrs	5,000 hrs
	Path 5—GMRS > 2X SSE (1–10 Hz), risk ≤ $5x10^{-5}$/reactor-yr	6	80 hrs	150 hrs	300 hrs
	Path 5—GMRS > 2X SSE (1–10 Hz), risk > $5x10^{-5}$/reactor-yr	6	1,500 hrs	3,000 hrs	6,000 hrs

Exhibit 3-19 NRC Implementation Cost for Rulemaking Option

NRC Activity	NRC Implementation Cost
Review flooding MSA submittals. Prepare and issue safety evaluations	$6,200,000
Review seismic MSA submittals. Prepare and issue safety evaluations	$27,800,000
Total	**$34,000,000**

* Results are rounded.

3.3.4 NRC Operation

The NRC estimates that the final rule would not impose any incremental NRC operations costs because the NRC does not plan any special inspections for this rule. NRC oversight of the licensees' compliance with the final rule requirements will be performed under the Reactor Oversight Process (ROP). The ROP costs are included in the baseline of the analysis.

Furthermore, the NRC is including in the final rule specific terms that rescind orders and remove license conditions[9] that are substantively redundant with provisions in the final rule. A primary objective of this rulemaking is to make the requirements of NRC Order EA-12-049 and Order EA-12-051 generically applicable to power reactor licensees and applicants, taking into

[9] These orders and license conditions are discussed under "Order Rescission and Removal of License Conditions" in the "Mitigation of Beyond-Design-Basis Events" Final Rule *Federal Register* notice.

account lessons learned in the orders' implementation and stakeholder feedback received through the regulatory process. As such, the requirements of 10 CFR 50.155 fully replace the requirements of those orders. Although the orders provide for their relaxation or rescission on a licensee-specific basis, use of that process would be an inefficient and unnecessary administrative burden on licensees and the NRC—with no impact on public health and safety—because the final rule simultaneously replaces the orders in their entirety for all applicable licensees. Therefore, the NRC finds that good cause is shown to rescind, three years after the final rule goes into effect, Order EA-12-049 and Order EA-12-051 for all licensees that received those orders. Based on this approach, the NRC will not incur additional administrative burden following the promulgation of this rule to resolve inconsistencies with or rescind redundant orders or license conditions once the final rule goes into effect.

3.4 Benefits of the Final Rule

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

- 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 make Order EA-12-049, Order EA-12-051, and industry initiatives generically applicable. This option (i.e., the final rule) would result in regulatory efficiency improvements, which are discussed in Sections 3.4.1 and 3.4.2.

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

The NRC estimates that the MBDBE final rule (Option 2) would result in incremental benefits to public health (accident), occupational health (accident), offsite property, onsite property, and environmental considerations because the final rule requires protection for mitigation strategies equipment based on updated flooding and seismic hazards information and the use of present-day guidance and methods as the licensing criteria for siting new reactors. This represents a more stringent standard for some plants. However, given the low frequency of the events that would be included based on the reevaluated hazards, the costs associated with increasing plants' resistance to these events would be relatively high compared to the risk that would be reduced.

The MBDBE final rule requirement that supports the integrated response capability also supports the effective use of emergency procedures by ensuring that strategies and guidelines are useable and cohesive to address scenarios identified by assessments under NTTF Recommendation 2.1. The remaining benefits associated with the final rule requirements are accounted for in the baseline of the analysis via the orders.

3.4.2 Benefits Associated with Regulatory Efficiency

The NRC anticipates that the order-related requirements would result in regulatory efficiency benefits. Placing the requirements of Order EA-12-049 and Order EA-12-051 in the NRC's regulations would enhance regulatory efficiency by applying the requirements to all current and future power reactor applicants. In addition, the MBDBE final rule (1) clarifies the path for

operating reactors to complete activities underway to address lessons learned from the Fukushima accident and (2) describes how rulemaking and reevaluated hazards relate to each other now that sufficient information exists to describe a more integrated process.

Operating reactor licensees and three COL holder reactor sites currently are subject to Order EA-12-049 requirements. Any future licensees would not be covered by the order requirements unless license conditions or separate orders are issued that contain these requirements. In making the requirements of Order EA-12-049 generically applicable, this option would also consider the reevaluated hazard information from the March 12, 2012, NRC letter issued under 10 CFR 50.54(f) (Ref. 44) as part of providing reasonable protection for mitigation strategies equipment from external flooding or seismic hazards.

In the absence of the final rule, these requirements would need to be implemented for new reactor sites through additional orders or license conditions (as was done for the Fermi, Summer, and Vogtle COLs and is expected for the Lee and Levy COLs), which would impose additional costs on the NRC. In addition, in the absence of the final rule, the NRC would need to undertake separate licensing actions to remove requirements of Order EA-12-049 and Order EA-12-051 that are no longer necessary during various stages of decommissioning, which would impose additional costs on licensees and the NRC. The final rule 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 the implementation of Order EA-12-049 and Order EA-12-051.

3.5 Uncertainty Analysis

To determine the robustness of the costs and net benefits of the draft final rule, the NRC staff examined how the industry and the NRC costs change as a result of uncertainties associated with the NRC staff's analytical assumptions and input data. The NRC staff used Monte Carlo simulation to examine the impact of uncertainty on the estimated net benefits of the MBDBE final rule. These Monte Carlo simulations were performed using the @RISK® software program.[10]

Monte Carlo simulations involve introducing uncertainty into the analysis by replacing the point estimates of the variables used to estimate base case costs and benefits with probability distributions. By defining input variables as probability distributions instead of as point estimates, the analyst can effectively model the effect of uncertainty on the results of the analysis (i.e., the net benefits).

The probability distributions chosen to represent the different variables in the analysis were bounded by the range-referenced input, historical data, and the NRC staff's professional judgment. When defining the probability distributions for use in the Monte Carlo simulation, the analyst needs summary statistics to characterize the distributions. These summary statistics include the minimum, most likely, and maximum values of a program evaluation and review

[10] Information about this software is available online at www.palisade.com.

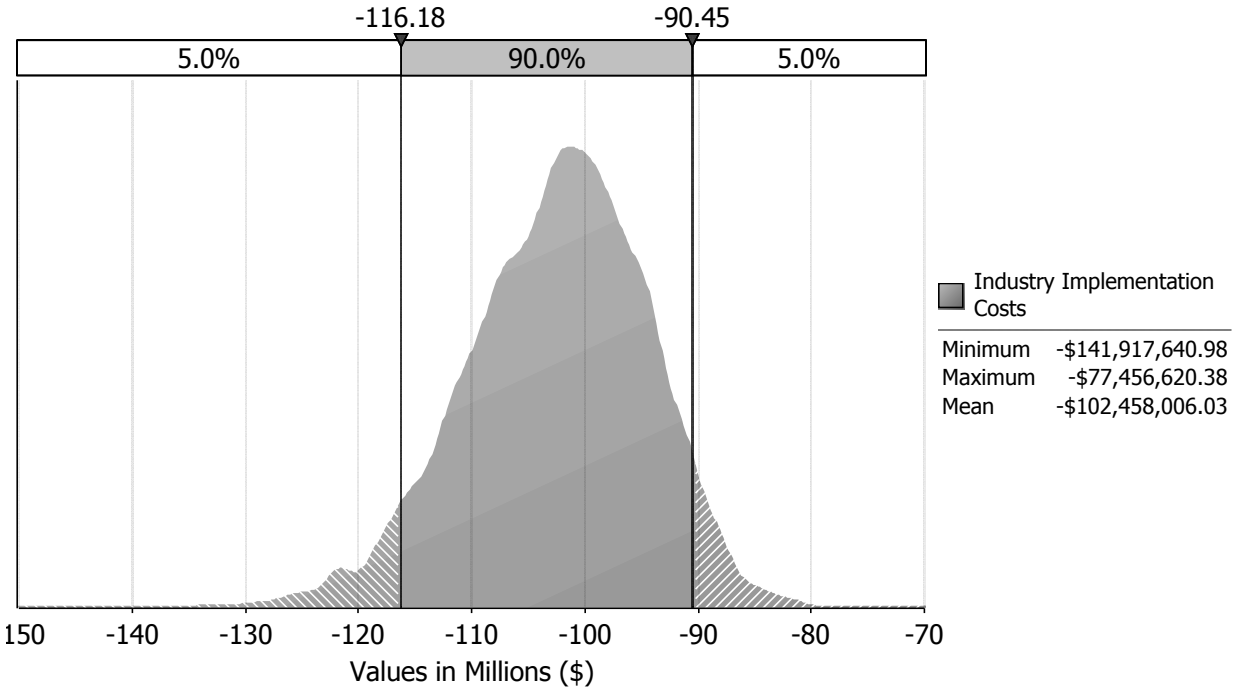
technique (PERT) distribution.[11] The PERT distribution is used to reflect the relative spread and skewness of the distribution defined by the three estimates.

Exhibit A-1 in Appendix A identifies the data elements and the distribution that the staff used in the uncertainty analysis.

3.5.1. Uncertainty Analysis Results

For each exhibit below, the NRC staff ran 10,000 Monte Carlo simulations in which the key variables were changed to assess the resulting effect on costs. The cost distributions illustrated in Exhibits 3-20 through 3-25 represent the incremental costs from the regulatory baseline of Option 1 (take no action). As can be seen from these exhibits, none of the curves are net beneficial because of the inability to monetize the benefits of this rule.

Exhibit 3-20 Industry Implementation Costs



[11] A PERT distribution is a special form of the beta distribution with a minimum and maximum value specified. The shape parameter is calculated from the defined most likely value. The PERT distribution is similar to a triangular distribution in that it has the same set of three parameters. Technically, it is a special case of a scaled beta (or beta general) distribution. It can generally be considered to be superior to the triangular distribution when the parameters result in a skewed distribution, as the smooth shape of the curve places less emphasis in the direction of skew. Similar to the triangular distribution, the PERT distribution is bounded on both sides and, therefore, may not be adequate for some modeling purposes, such as those intended to capture tail or extreme events.

Exhibit 3-21 NRC Implementation Costs

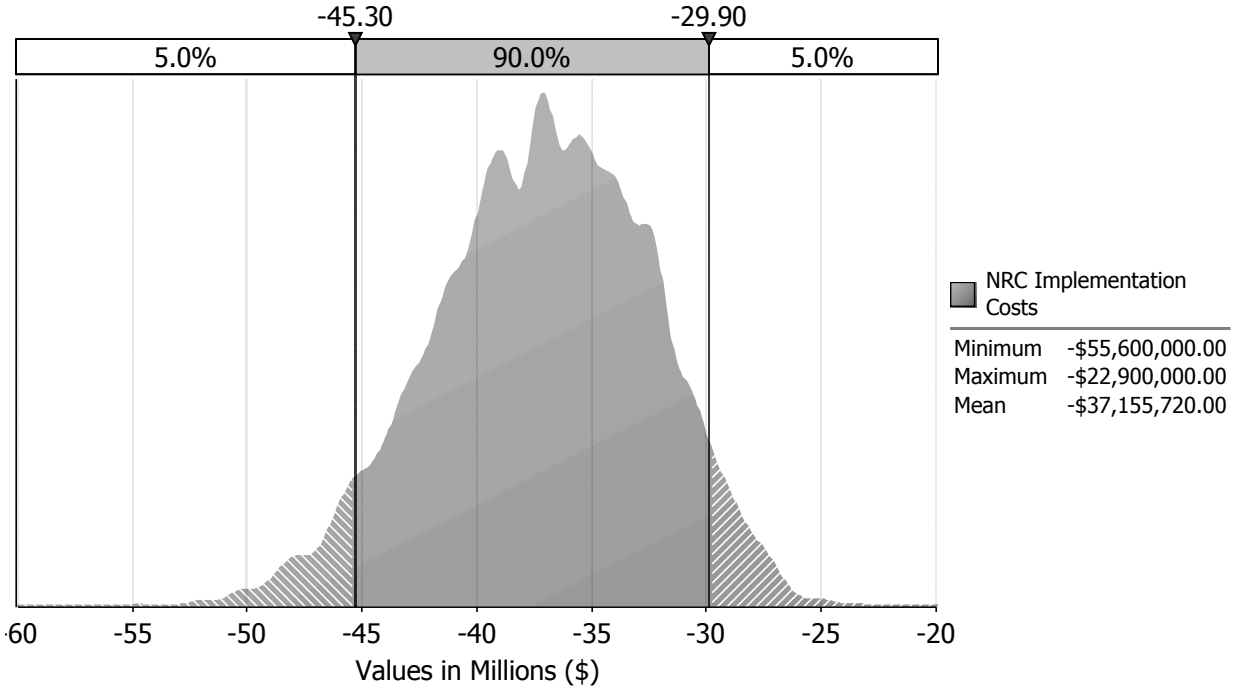


Exhibit 3-22 Industry Operation Costs (7-percent discount rate)

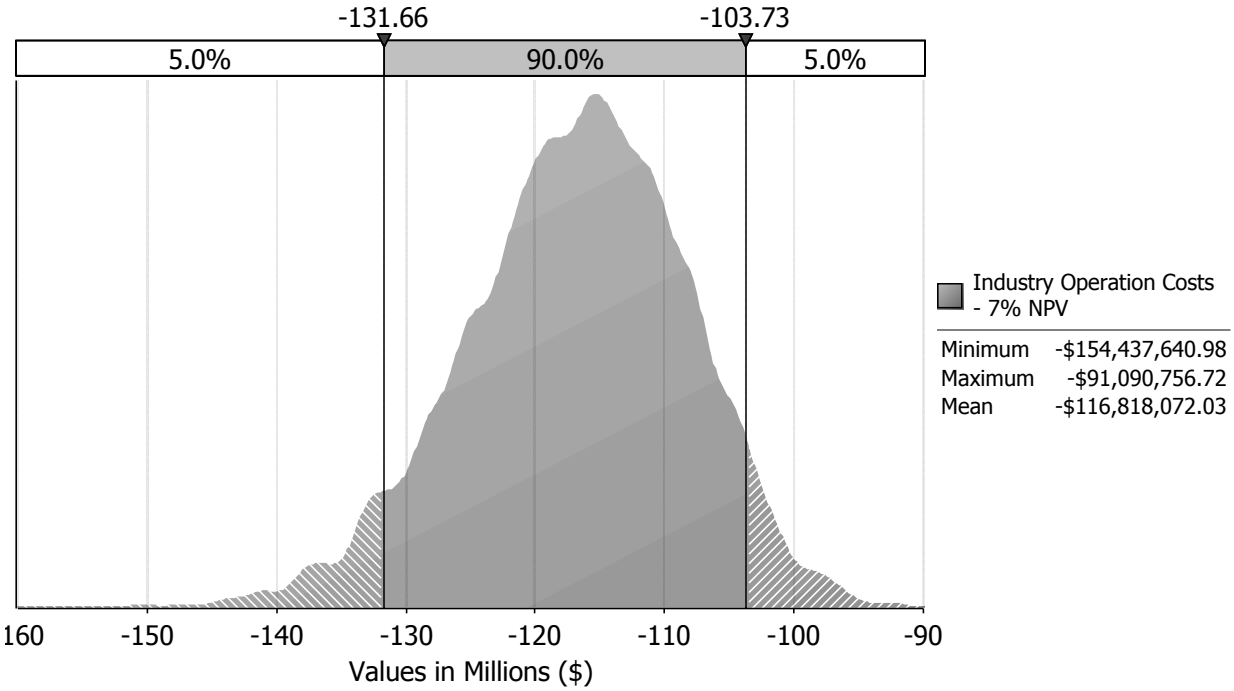


Exhibit 3-23 Industry Operation Costs (3-percent discount rate)

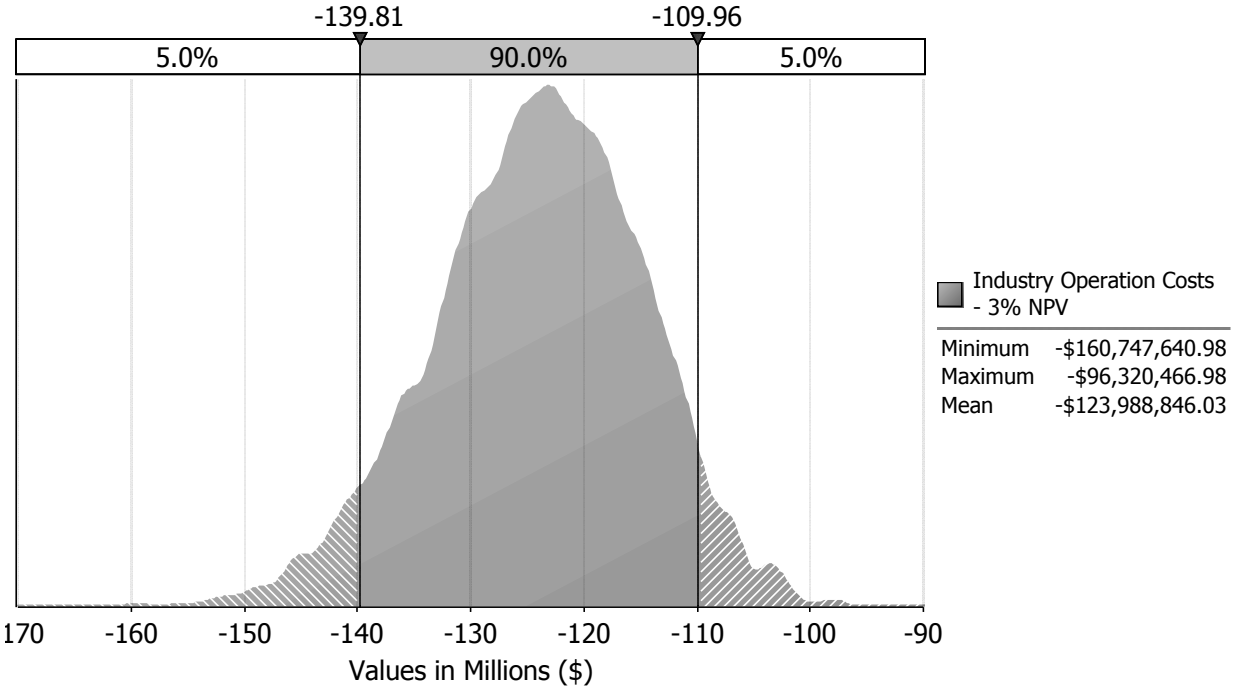


Exhibit 3-24 Total (7-percent discount rate)

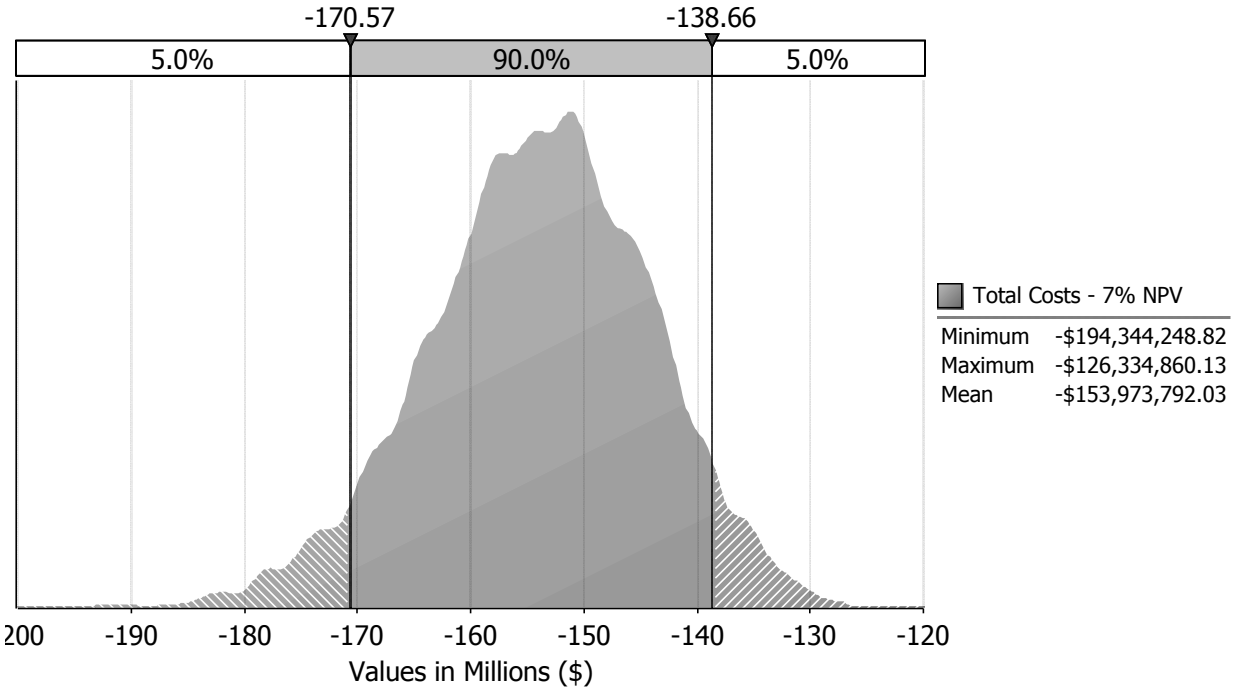
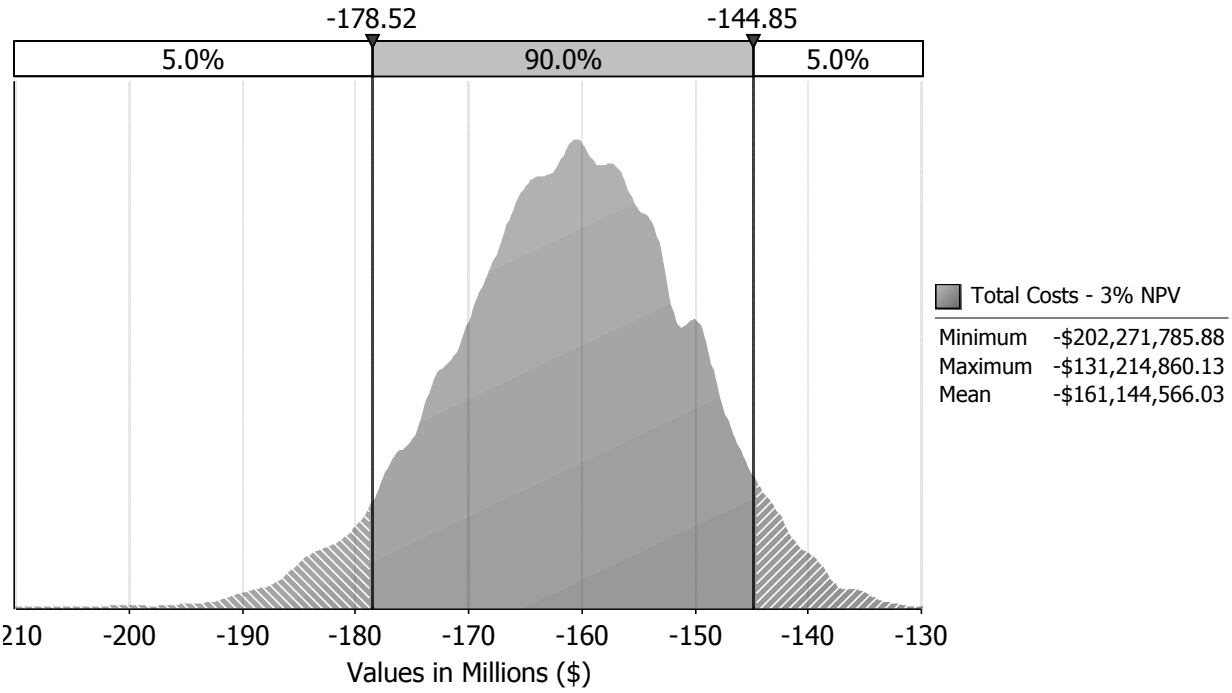


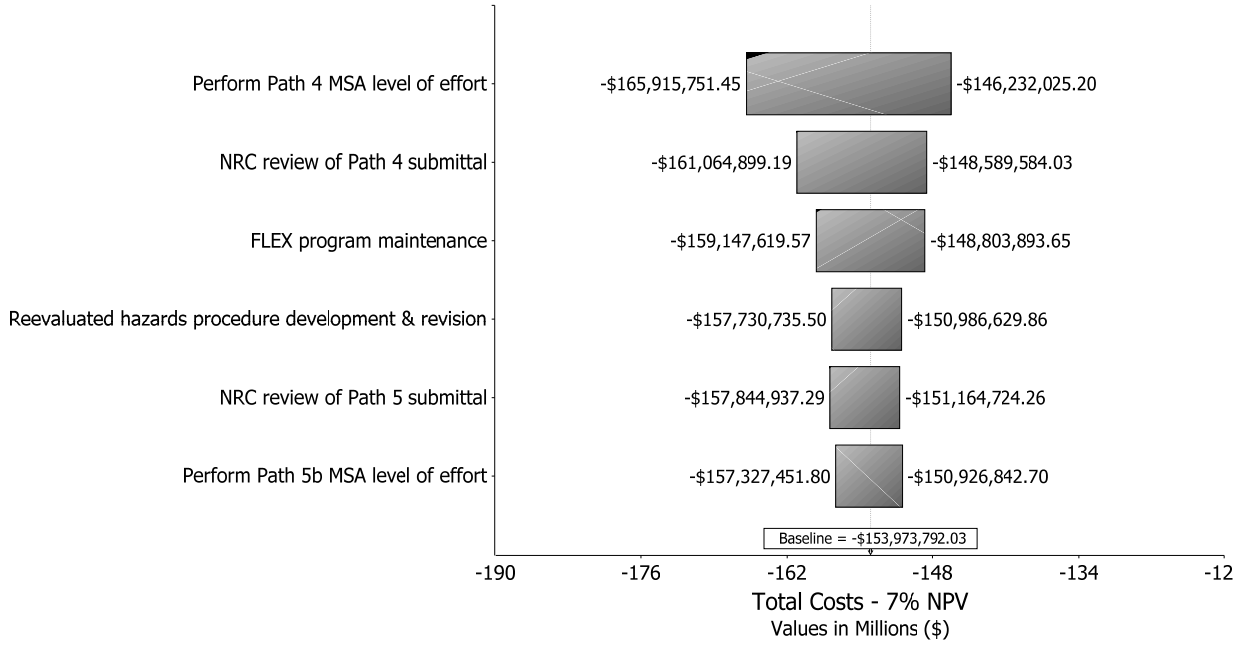
Exhibit 3-25 Total (3-percent discount rate)



In addition to estimating the probability distributions for the net benefits of this rule, the staff used the Monte Carlo simulation to determine the variables with the greatest impact on the resulting net benefits. Variables shown to have a large effect on the resulting net benefits may deserve more attention and scrutiny than variables shown to have a small or minimal effect.

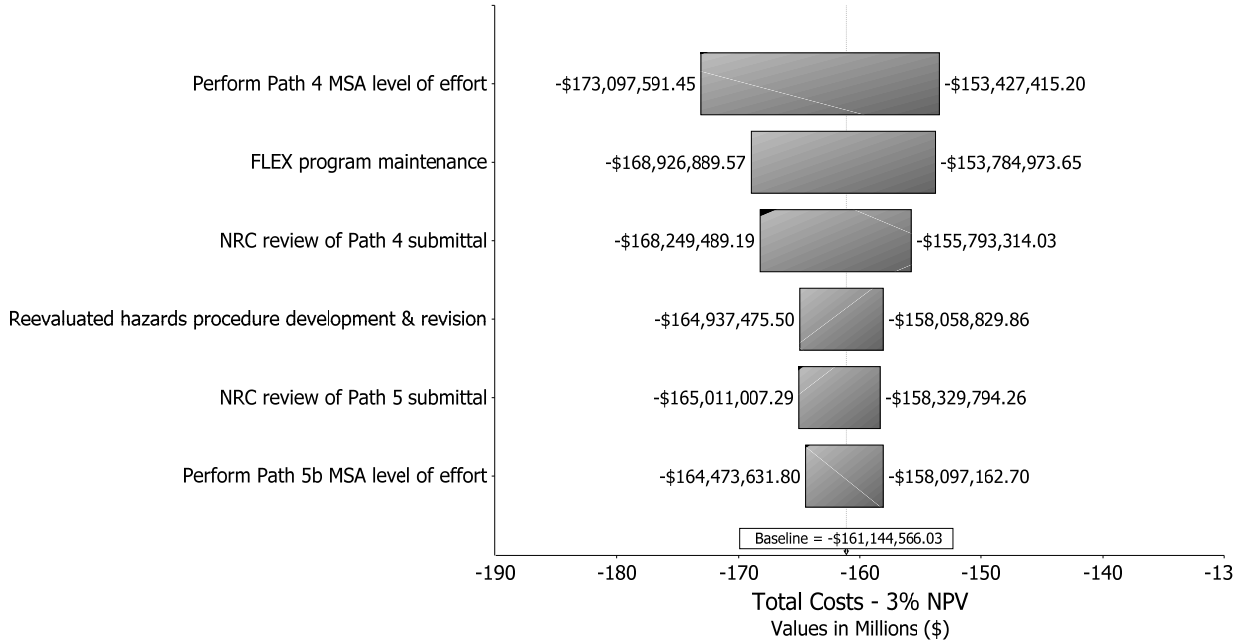
To estimate the effect of each variable on the net benefits, the staff performed a regression, with the net benefits modeled as the dependent variable and the inputs as the independent variables. The result of this regression, called a tornado diagram, represents in vertical order the variables with the greatest influence on the net benefits. The tornado diagram also displays the resulting effect on the calculated mean value for each of the input variables. Exhibit 3-26 presents the tornado diagram for the total cost of the final rule using a 7-percent discount factor. Exhibit 3-27 presents the tornado diagram for the total cost of the MBDBE final rule using a 3-percent discount factor.

Exhibit 3-26 Key Variables Whose Uncertainty Drives the Largest Impact on Costs (7-Percent Net Present Value)



Examining the tornado diagrams gives insight into which inputs have the largest effects on the output mean of this quantitative analysis. Exhibit 3-26 shows that the parameter that has the highest sensitivity ranking and is the most important is the industry costs in performing the Path 4 MSAs. The next two highest sensitivity rankings are the costs of the NRC's review of the Path 4 submittals and the industry costs for maintain the FLEX program for the duration of the reactor operating licenses. The remaining three variables have lesser impacts on the total mean cost. The influence of a variable on the mean output value is not only a function of that variable but also the spread of its distribution. In Exhibit 3-27, using a 3-percent discount factor, the first six parameters are the same but the second- and third-ranked variables are in reversed order when compared to the ranked parameters listed in Exhibit 3-26.

Exhibit 3-27 Key Variables Whose Uncertainty Drives the Largest Impact on Costs (3-Percent Net Present Value)



The three plots in Exhibit 3-28 summarize the distribution of the undiscounted net benefits, the net benefits discounted at 3 percent, and net benefits discounted at 7 percent. As illustrated by this exhibit, regardless of discount rate, the final rule has a negative monetized net benefit (i.e., 100 percent of the distributions informed by these data are less than zero).

Exhibit 3-28 Relative Frequency of the Net Benefits of the Final Rule

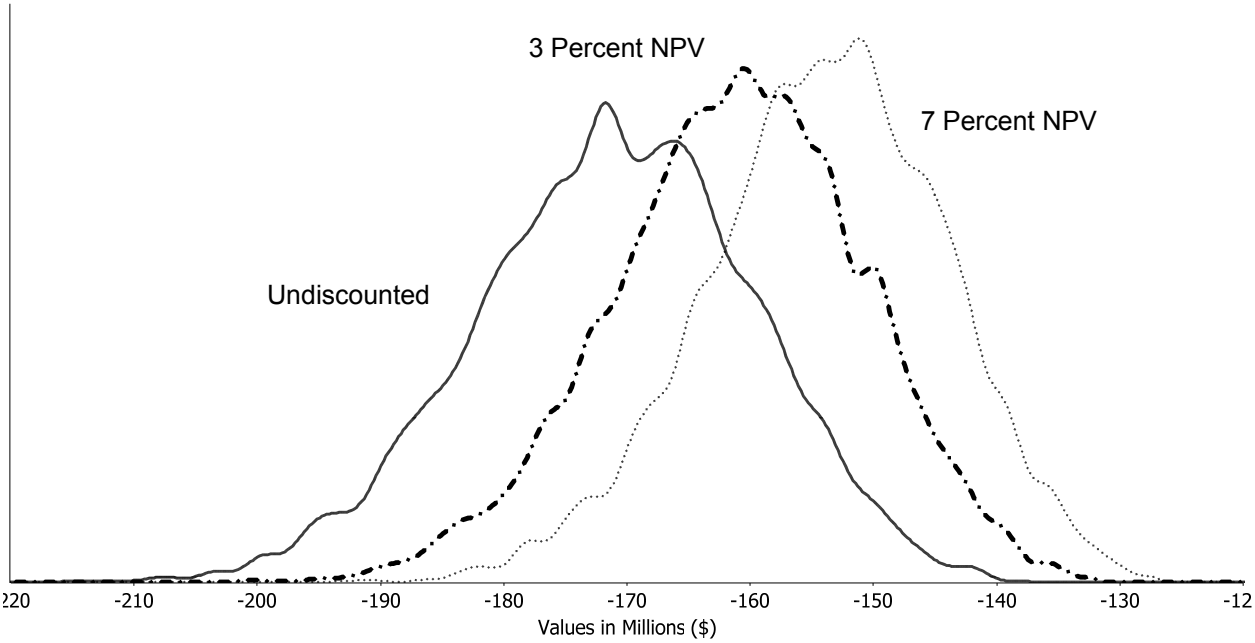


Exhibit 3-28 also displays the sensitivity of the uncertainty analysis to the discount rates used for the net benefits of the final rule, based on 10,000 simulations. Allowing uncertain assumptions and inputs to vary across a distribution gives results that are no longer static and instead are spread across a range with varying degrees of certainty. For this simulation, the analysis indicates that for the attributes that could be quantified, the MBDBE final rule is estimated to result in a net cost of between ($126 million) and ($217 million).

3.5.2. Summary of Uncertainty Analysis

The simulation analysis shows that the estimated mean cost for the MBDBE final rule is ($154 million), with 90-percent confidence that the cost is between ($139 million) and ($171 million) using a 7-percent discount rate.

The NRC staff assessed which variables have the largest impact on total costs (and averted costs) for this final rule. As shown in Exhibits 3-26 and 3-27, the three parameters that have the highest sensitivity ranking are the industry costs in performing the Path 4 flooding MSAs, the costs of the NRC's review of these Path 4 flooding MSA submittals, and the industry costs for maintain the FLEX program for the duration of the reactor operating licenses. The remaining variables have lesser and comparable effects on the total cost of implementing the final rule.

As illustrated in Exhibit 3-28, variation in the key variables results in cost distributions that range from ($126 million) and ($217 million) from the regulatory baseline of Option 1 (take no action) when accounting for different discount factors.

3.6. Disaggregation

The NRC staff performed a screening review to determine whether any of the individual requirements (or set of integrated requirements) of the rule would be unnecessary to achieve the objectives of the rulemaking. The NRC staff concludes that each of the MBDBE rule changes would be necessary to achieve one or more of the objectives of the rulemaking, as described in Section 1.2 and summarized in Exhibit 3-29.

Exhibit 3-29 Disaggregated Requirements

New or Revised 10 CFR Requirement	Generically Applicable Requirements	New Integrated Response Capability	Address Fukushima Dai-ichi-Related PRMs
Section 50.8, "Information Collection Requirements: OMB Approval"	X	X	X
Section 50.34, "Contents of Applications; Technical Information"	X	X	X
Section 50.54, "Conditions of Licenses"	X	X	X
Paragraph 50.155(a), "Applicability"	X	X	X
Paragraph 50.155(b), "Integrated Response Capability"	X	X	X
Paragraph 50.155(c), "Equipment Requirements"	X	X	X
Paragraph 50.155(d), "Training Requirements"	X	X	X
Paragraph 50.155(e), "Drills or Exercises"	X	X	X
Paragraph 50.155(f), "Spent Fuel Pool Monitoring"	X		
Paragraph 50.155(g), "Documentation of Changes"		X	
Paragraph 50.155(h), "Implementation"	X	X	X
Paragraph 50.155(i), "Rescission of orders and removal of license conditions"	X		
10 CFR Part 50, Appendix E, Section IV.F, "Training" (moved EDMG training requirement element to 10 CFR 50.155(e))		X	
10 CFR Part 50, Appendix E, Section VI, "Emergency Response Data System" (administratively removed the word "modem")		X	
Section 52.80, "Contents of Applications; Additional Technical Information"	X	X	X

Exhibit 3-30 summarizes the estimated total costs to implement each of the stated regulatory objectives.

Exhibit 3-30 Disaggregated Cost-Benefit of the Final Rule Regulatory Objectives

Regulatory Objective	7% Net Present Value			Estimated Benefit
	5%	Mean	95%	
1. Make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable	($10,200,000)	($7,800,000)	($5,800,000)	Regulatory efficiency
2. Establish new requirements, which requires the following sub-initiatives to support the integrated response capability	($176,170,000)	($146,100,000)	($118,900,000)	Regulatory efficiency Supports effective use of emergency procedures by ensuring that strategies and guidelines are useable and cohesive to address scenarios identified from the NTTF Recommendation 2.1 assessments. Clarifies the path to complete activities underway to address lessons learned from the Fukushima accident and describes how the mitigation strategies order, rulemaking, and reevaluated hazards relate to each other now that sufficient information exists to describe a more integrated process.
• Staffing, command and control, training, drills, communication capability, and documentation of changes	($2,970,000)	($2,300,000)	($1,700,000)	Ensures adequate staffing, command and control, and communication capabilities for severe external and multiunit events.
• Reevaluated flooding hazards**,***	($21,300,000)	($18,000,000)	($14,900,000)	Defense in depth Gives protection for mitigation strategies equipment from flooding hazards using updated flooding hazards information and present-day guidance and methods that are used as the licensing criteria for siting of new reactors***** Meets the intent of the Consolidated Appropriations Act (Ref. 36).
• Reevaluated seismic hazards**,***	($66,600,000)	($52,900,000)	($41,300,000)	Defense in depth Gives protection of mitigating strategies equipment from seismic hazards using updated seismic hazard information and present-day guidance and methods. Meets the intent of the Consolidated Appropriations Act (Ref. 36).

Regulatory Objective	7% Net Present Value			Estimated Benefit
	5%	Mean	95%	
• FLEX program modifications	($39,200,000)	($31,400,000)	($24,100,000)	Gives increased confidence in the availability of mitigating strategies equipment following severe external flooding and seismic events.
• Seismic or flooding modifications****	($46,100,000)	($41,500,000)	($36,900,000)	Defense in depth Gives protection of mitigating strategies equipment based on reevaluated flooding and seismic hazards
3. Address a number of petitions for rulemaking submitted to the NRC following the March 2011 Fukushima Dai-ichi event	Same as regulatory objective 1			Regulatory efficiency
Final Rule Statistics (7% NPV)*	($170,600,000)	($154,000,000)	($138,700,000)	

* The values are rounded and are not additive because the distributions are not normal distributions. The final rule statistics are the statistics from the simulation curve.

** As described in COMSECY-14-0037, the NRC staff will, on a case-specific basis, consider information about the reevaluated hazards, available response times for identified scenarios, plant-specific configurations and licensing histories, and other factors when defining an appropriate assessment of flooding and seismic scenarios to support evaluating potential plant-specific backfits.

*** The reevaluated flooding and seismic hazard cost estimates include maintaining MSA-related documentation during the term of the operating license.

**** Seismic or flooding modification cost estimates are based on industry estimates provided to the NRC before licensees completing their seismic and flooding MSAs.

***** Final rule statistics are from the calculated distribution and not the summation of the intermediate values in this table.

****** Present-day regulatory guidance is in RG 1.59, "Design Basis Floods for Nuclear Power Plants" (last updated in 1977, Ref. 32), and industry consensus standards (last issued in 1992, Ref. 33). The staff also issued two interim staff guidance documents related to hazard assessments for dam failure (Ref. 34) and storm surge, seiche, and tsunami (Ref. 35) to supplement existing guidance and assist licensees in responding to the NRC's 10 CFR 50.54(f) letter.

3.7 Backfitting and Issue Finality

As required by 10 CFR 50.109 and 10 CFR 52.98, "Finality of Combined Licenses; Information Requests," the Commission has completed a backfitting and issue finality assessment (Ref. 39). This document presents the reasons why Option 2, the rulemaking option, does not contain any backfits.

4. Decision Rationale for Selection of Final Action

The decision rationale is based on the quantitative (monetized) and qualitative (nonmonetized) benefits and costs. Option 1 is defined as the regulatory baseline, and the benefits and costs of Option 2, the rulemaking option, are evaluated relative to the Option 1 baseline to determine the recommended alternative.

4.1 Make the Order Requirements Generically Applicable

This analysis describes the cost-benefits of placing the requirements in Order EA-12-049 and Order EA-12-051 in the NRC's regulations to give regulatory clarity to operating reactors and to ensure that they apply to all future power reactor applicants. 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 2015 SRM (Ref. 31)). These are captured in the updated guidance for mitigation strategies. Option 2 is superior to the regulatory baseline because rulemaking allows the NRC to make the order requirements generically applicable with adjustments to account for any lessons learned. These adjustments would (1) result in more effective regulation, (2) not extend beyond the existing scope of the existing orders, and (3) provide a mechanism to rescind Order EA-12-049 and Order EA-12-051 and associated license conditions. The net cost to achieve this objective ranges between ($5.8 million) and ($10.2 million) with a mean value of ($7.8 million) using a 7-percent discount factor over a 63-year analysis horizon. These costs also achieve the objective described in Section 4.3.

Furthermore, the requirements in Option 2 that make Order EA-12-049 and Order EA-12-051 generically applicable do not qualify as backfitting as that term is defined in 10 CFR 50.109 or violate the pertinent issue finality provisions in 10 CFR Part 52, as discussed in the backfitting and issue finality assessment (Ref. 39).

4.2 Establish New Requirements for an Integrated Response Capability

Relative to the regulatory baseline, Option 2 would establish requirements for an integrated response capability for BDBEs that would integrate strategies and guidelines (implemented through guideline sets) with the existing EOPs and enhance onsite emergency response capabilities. This would include guideline sets that implement the requirements of current 10 CFR 50.54(hh)(2) and Order EA-12-049. This also includes mitigation strategies, or alternative approaches, used to address reevaluated hazards, as applicable. This rule requires sufficient staffing, command and control, training, drills, communications capability, and documentation of changes to support the integrated response capability. Accordingly, Option 2 is superior to the regulatory baseline because Option 2 ensures through requirements, implementation guidance, or voluntary industry initiatives that NTTF Recommendations 4, 7, 8, 9.1, 9.2, and 9.3 (with one exception) are addressed. Option 2 does not contain requirements for the maintenance of ERDS capability throughout the accident. This is because an ERDS is not an essential component of a licensee's capability to mitigate a BDBE. However, an ERDS is important for communication between the licensee and the NRC and, in some situations, with other external stakeholders. As a result, this modernization was voluntarily completed by industry without regulatory action, is treated as a sunk cost, and is part of the regulatory baseline.

These new requirements for an integrated response capability in Option 2 (1) require reactor licensees to address the effects of the reevaluated seismic and flooding external hazards at their sites against current applicable Commission requirements and guidance and (2) place these requirements within the NRC's regulatory framework. This objective meets the intent of the *Consolidated Appropriations Act*, Pub. L. No. 112-074, Sec. 402 (Ref. 36), and offers a superior solution than the regulatory baseline.

The net cost to achieve this objective ranges between ($119 million) and ($176 million) with a mean value of ($146 million) using a 7-percent discount factor over a 63-year analysis horizon. The average site net present value for achieving this objective based on 65 sites is approximately ($2.25 million) per site. These estimates are driven by the costs of performing the reevaluated seismic hazards (mean value of ($53 million)), the seismic and/or flooding modifications (mean value of ($41.5 million)), and the FLEX program modifications ($31.4 million). These costs account for 86 percent of the ($146 million) cost to achieve this objective.

The basis for requiring these provisions within the MBDBE Rule is in COMSECY-14-0037 (Ref. 26) and its associated SRM (Ref. 27). As discussed in COMSECY-14-0037, the NRC imposed the requirements of Order EA-12-049 in parallel with the agency's March 12, 2012, request for information on the reevaluation of external hazards. Order EA-12-049 included a requirement for licensees to give reasonable protection from external events for equipment associated with the required mitigating strategies without specific reference to the necessary level of protection.

In COMSECY-14-0037, the NRC staff asked the Commission to affirm that (1) licensees for operating nuclear power plants need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, (2) licensees for operating nuclear power plants may need to address some specific flooding scenarios that could significantly damage the power plant site by developing targeted or scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs, and (3) the NRC staff should revise the flooding assessments and integrate the decisionmaking into the development and implementation of mitigating strategies in accordance with Order EA-12-049 and this rulemaking. In SRM-COMSECY-14-0037, the Commission approved the first two items recommended by the NRC staff, on the need for operating nuclear power plant licensees to address the reevaluated flood hazards within the mitigating strategies and the potential for using targeted or scenario-specific mitigating strategies. The Commission did not approve the third recommendation. Option 2 reflects this direction.

Accordingly, the NRC concludes in the backfitting and issue finality assessment (Ref. 39) that the requirements for licensees to address the effects of the reevaluated hazards information, as incorporated within Option 2, are part of Order EA-12-049 and do not constitute a new instance of backfitting.

4.3 Addresses a Number of Petitions for Rulemaking

Relative to the regulatory baseline, Option 2 would address, and complete the regulatory actions planned for, the five PRMs[12] filed by the National Resources Defense Council, Inc. that raise issues pertaining to the technical aspects of this rulemaking. The petitions rely solely on the NTTF report and request that the NRC undertake rulemaking in several areas that are addressed by this rule. This rule also addresses, in part, PRM-50-96; however, the issues raised in that petition remain under consideration by the NRC. Therefore, Option 2 is the

[12] The five PRMs are (1) PRM 50-97, "NRDC's Petition for Rulemaking To Require Emergency Preparedness Enhancements for Prolonged Station Blackouts," (2) PRM-50-98, "NRDC's Petition for Rulemaking To Require Emergency Preparedness Enhancements for Multiunit Events," (3) PRM-50-100, "NRDC's Petition for Rulemaking To Require Licensees To Improve Spent Nuclear Fuel Pool Safety," (4) PRM-50-101, "NRDC's Petition for Rulemaking To Revise 10 CFR § 50.63," and (5) PRM 50-102, "NRDC's Petition for Rulemaking To Require More Realistic Training on Severe Accident Mitigation Guidelines."

preferred approach for achieving this objective. The net cost to achieve this objective is included in the costs discussed in Section 4.1.

4.4 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).

A safety goal evaluation is intended to eliminate regulatory requirements in cases where the residual risk is already acceptably low. Instead, the Commission limited the scope of the final rule to encompass provisions that are currently being implemented under Order EA-12-049, Order EA-12-051, and related industry initiatives. Therefore, a safety goal evaluation is not appropriate for the final rule (see Section 3.7).

4.5 Committee to Review Generic Requirements

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 final rule. As a reference aid, Exhibit 4-1 cross-references 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. 21)	Information Item To Be Included in a Regulatory Analysis Prepared for CRGR Review	Where Item Is Discussed
Appendix C, (i)	Generic requirement or staff position as it is to be sent out to licensees.	Final 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 final rule.
Appendix C, (iii)	The sponsoring office's position on each requirement or staff position as to whether it would modify requirements or staff positions, implement existing requirements or staff positions, or relax or reduce existing requirements or staff positions.	*Federal Register* notice for the final rule, Regulatory Analysis, Section 3.3, and Backfitting and Issue Finality Assessment (Ref. 39).
Appendix C, (iv)	The method of implementation.	*Federal Register* notice for the final rule and Regulatory Analysis, Section 5.
Appendix C, (vi)	Identification of the category of power reactors, new reactors, or nuclear materials facilities or activities to which the generic requirement or staff position is applicable.	Regulatory Analysis, Section 3.1.

CRGR Charter Citation (Ref. 21)	Information Item To Be Included in a Regulatory Analysis Prepared for CRGR Review	Where Item Is Discussed
Appendix C (vii)–(viii)	The final requirements do not contain any backfits.	Backfitting and Issue Finality Assessment (Ref. 39).
III.	The final requirements do not contain any relaxations or decreases in current requirements or staff positions. The final rule contains decommissioning provisions that in the future will relax requirements for licensees that enter decommissioning in the future.	*Federal Register* notice for the final rule.
Appendix C, (xi)	Preparation of an assessment of how the action relates to the Commission's Safety Goal Policy Statement.	Regulatory Analysis, Section 4.4.

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

4.6 Staff Recommendation

The staff selected Option 2, which is to undertake rulemaking to make generically applicable Order EA-12-049, Order EA-12-051, and the associated regulatory actions implemented in conjunction with the orders. The staff rejected Option 1, the no-action alternative, because it would not achieve the NRC's three objectives to (1) make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable, (2) establish new requirements for an integrated response, and (3) address a number of PRMs submitted to the NRC.

The scope to make the orders generically applicable and to address a number of PRMs results in limited implementation costs for industry to review the regulatory requirements in order to confirm ongoing compliance. These activities include comparing the rule requirements with the orders and related industry initiatives and updates to procedures, programs, or plans.

This analysis shows that establishing new requirements for an integrated response, which includes the reevaluated hazards provisions of Option 2, would result in considerable additional cost above the $1.9 billion already spent by industry to comply with the orders. This provision introduces a more stringent standard for some sites than that specified in the orders to consider the gap between a plant's licensing basis and the reevaluated hazards, which are low-frequency but potentially high-consequence events. The analysis identified three significant cost drivers: (1) industry activities necessary to perform the Path 4 seismic MSAs, (2) NRC review activities of the Path 4 seismic submittals, and (3) industry activities to maintain the FLEX program for the duration of the reactor operating licenses.

The analysis includes estimates associated with the impacts incurred as a result of licensees being required to address the reevaluated hazard information, which may result in the need to revise mitigation strategies or implement plant modifications. The analysis assumes that such changes would provide a reasonable level of protection against these beyond-design-basis events; higher levels of protection could result in licensees incurring substantially higher costs. The staff will be mindful of this consideration as further information is developed under Near-Term Task Force Recommendation 2.1 activities.

The staff concludes that Option 2 is preferable to Option 1.

5. Implementation

The NRC staff recommends a compliance date of 2 years following the effective date of the MBDBE Rule for most licensees. This would apply to each holder of a 10 CFR Part 50 operating license on the effective date of the final rule and each holder of a 10 CFR Part 52 COL for which the Commission has made the 10 CFR 52.103(g) finding as of the effective date of the rule, except for licensees that received NRC Order EA-13-109, who have a three year implementation period.

Paragraph 50.155(h)(2) has a flexible-schedule provision for currently operating power licensees. For 10 CFR Part 50 operating licensees that need additional time beyond the compliance schedule established in 10 CFR 50.155(h)(1) to address the requirements in 10 CFR 50.155(b)(2), the NRC will consider an alternative compliance date if the licensee submits under 10 CFR 50.4, "Written Communications," a schedule request to use 10 CFR 50.155(h)(2). The request to use 10 CFR 50.155(h)(2) must give good cause for exceeding the 2-year or 3-year (as applicable) compliance date of 10 CFR 50.155(h)(1).

Continued compliance with the strategies and guidelines now required under 10 CFR 50.155(b)(3) justifies removal of the mitigation strategies license conditions. The NRC does not intend to allow a gap in compliance with this requirement through use of the flexible scheduling provisions of 10 CFR 50.155(h)(2).

The NRC is aware that the current state of licensee implementation of post-Fukushima regulatory actions varies widely across the industry. The NRC also understands that addressing the reevaluated hazard information is the limiting activity in terms of implementation and may pose a challenge to licensees meeting the 2-year or 3-year (as applicable) compliance date for the MBDBE Rule. To address these cumulative effects of regulation, the final rule provides a flexible-schedule option in 10 CFR 50.155(h)(2) that allows each licensee to submit an implementation schedule to the NRC. This approach has been used for past regulations and enables sufficient flexibility to address both potential cumulative effects of regulation and unnecessary resource impacts associated with schedule exemptions.

Recognizing that the schedule flexibility may still not address all situations that arise, the NRC understands that 10 CFR 50.12, "Specific Exemptions," can address such circumstances. In this regard, the NRC reiterates its support for risk-informed approaches for such submittals.

The final rule contains language that is intended to ensure a smooth transition between the order requirements and the MBDBE Rule. Additional implementation details are discussed in the MBDBE Final Rule *Federal Register* notice (Ref. 45).

References

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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.

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

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," Rev. 0, August 29, 2012, ADAMS Accession No. ML12229A174.

15. Nuclear Energy Institute, "Enhancements to Emergency Response Capabilities for Beyond Design Basis Accidents and Events," NEI 13-06, Rev. 1, February 2016, ADAMS Accession No. ML16224A618.

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Appendix A: Supplementary Exhibits

Exhibit A-1 Variables Used in the Uncertainty Analysis

Data Element	Mean Estimate	Distribution	Low Estimate	Best Estimate	High Estimate
Review Rule Requirements					
Number of executive hours per site to review the rule requirements	80 hrs/site	PERT	40 hrs/site	80 hrs/site	160 hrs/site
Number of manager hours per site to review the rule requirements	160 hrs/site	PERT	80 hrs/site	160 hrs/site	320 hrs/site
Number of staff hours per site to review the rule requirements	1,000 hrs/site	PERT	600 hrs/site	1,000 hrs/site	2,000 hrs/site
Integration of Emergency Procedures					
Number of executive hours per site to review the mitigation strategies, EDMGs, and SAMGs to confirm integration with EOPs	8 hrs/site	PERT	4 hrs/site	8 hrs/site	16 hrs/site
Number of manager hours per site to review the mitigation strategies, EDMGs, and SAMGs to confirm integration with EOPs	40 hrs/site	PERT	20 hrs/site	40 hrs/site	80 hrs/site
Number of staff hours per site to review the mitigation strategies, EDMGs, and SAMGs to confirm integration with EOPs	120 hrs/site	PERT	60 hrs/site	120 hrs/site	240 hrs/site
Number of licensing hours per site to review the mitigation strategies, EDMGs, and SAMGs to confirm integration with EOPs	32 hrs/site	PERT	16 hrs/site	32 hrs/site	64 hrs/site
Phase 1 Staffing					
Number of executive hours per site to maintain staffing assessment (multiunit sites) annually	2 hrs/site	PERT	1 hr/site	2 hrs/site	4 hrs/site
Number of manager hours per site to maintain staffing assessment (multiunit sites) annually	4 hrs/site	PERT	3 hrs/site	4 hrs/site	8 hrs/site
Number of staff hours per site to maintain staffing assessment (multiunit sites) annually	36 hrs/site	PERT	16 hrs/site	36 hrs/site	72 hrs/site
Command and Control					
Number of manager hours per site to maintain procedures to document command and control annually	2 hrs/site	PERT	1 hr/site	2 hrs/site	4 hrs/site
Number of staff hours per site to maintain procedures to document command and control annually	8 hrs/site	PERT	4 hrs/site	8 hrs/site	16 hrs/site
Exemption Analysis					
Cost per site to conduct and submit the exemption analysis (decommissioning sites)	$250,000	PERT	$200,000	$250,000	$300,000
Cost per site to conduct and submit the exemption analysis (operating sites)	$500,000	PERT	$300,000	$500,000	$700,000
Cost per site to conduct and submit the exemption analysis (new sites)	$500,000	PERT	$300,000	$500,000	$700,000

Data Element	Mean Estimate	Distribution	Low Estimate	Best Estimate	High Estimate
Number of NRC staff hours per site to review and approve the exemption analysis	1,000 hrs/site	PERT	500 hrs/site	1,000 hrs/site	1,500 hrs/site
Revaluated Hazards Analysis—Flooding MSA					
Group 1 (Path G.3 or Path G.4.1) MSA level of effort per site	690 hrs	PERT	100 hrs	690 hrs	1,000 hrs
Group 2 (Path G.4.2) MSA level of effort per site	2,450 hrs	PERT	1,200 hrs	2,450 hrs	5,000 hrs
Group 3 (Path G.4.3) MSA level of effort per site	1,550 hrs	PERT	1,000 hrs	1,550 hrs	3,000 hrs
Group 4 (Path G.4.4) MSA level of effort per site	2,500 hrs	PERT	1,500 hrs	2,500 hrs	5,000 hrs
Revaluated Hazards Analysis—Seismic MSA					
Path 1 MSA level of effort per site	60 hrs	PERT	40 hrs	60 hrs	120 hrs
Path 2 MSA level of effort per site	450 hrs	PERT	250 hrs	450 hrs	900 hrs
Path 3 MSA level of effort per site	3,800 hrs	PERT	2,000 hrs	3,800 hrs	8,000 hrs
Path 4 MSA level of effort per site	7,300 hrs	PERT	3,500 hrs	7,300 hrs	15,000 hrs
Path 5 MSA level of effort per site	10,000 hrs	PERT	5,000 hrs	10,000 hrs	20,000 hrs
Revaluated Hazards Analysis—SPRA					
Prepare, review, and peer review a new SPRA	$9,166,676	PERT	$5,000,000	$7,500,000	$20,000,000
Upgrade an existing SPRA for use in performing a seismic MSA	$1,500,000	PERT	$600,000	$1,500,000	$3,000,000
Revaluated Hazards Analysis—FLEX Program Revision					
Licensee prepare and submit MSA submittal to NRC	600 hrs	PERT	400 hrs	600 hrs	1,000 hrs
FLEX program revision	300 hrs	PERT	100 hrs	300 hrs	700 hrs
Procedure development and revision	500 hrs	PERT	50 hrs	500 hrs	1,500 hrs
Training per site	500 hrs	PERT	50 hrs	500 hrs	1,500 hrs
Respond to RAIs on submittal	380 hrs	PERT	60 hrs	380 hrs	1,400 hrs
Revaluated Hazards Analysis—Plant Modification Estimates					
Group 1: Minor seismic or flooding modifications per site	$100,000	PERT	$50,000	$100,000	$200,000
Group 2: Limited seismic or flooding modifications per site	$500,000	PERT	$200,000	$500,000	$800,000
Group 3: Considerable seismic or flooding modifications per site	$1,500,000	PERT	$1,000,000	$1,500,000	$2,000,000
Group 4: Significant seismic or flooding modifications per site	$5,000,000	PERT	$2,500,000	$5,000,000	$7,500,000
Group 5: Substantial seismic or flooding modifications per site	$10,000,000	PERT	$7,500,000	$10,000,000	$12,500,000
Group 6: Major seismic or flooding modifications per site	$25,000,000	PERT	$15,000,000	$25,000,000	$35,000,000
Revaluated Hazards Analysis—Communication Capabilities Operations & Maintenance					
Annual cost to maintain communication capabilities (per reactor unit)	$907.60	Uniform	$302.53	$907.60	$1,512.66
Revaluated Hazards Analysis—Industry Operation Cost Estimate Inputs					
Maintain flooding MSA per site	80 hrs/site-year	PERT	40 hrs/site-year	80 hrs/site-year	240 hrs/site-year
Maintain seismic MSA per site	80 hrs/site-year	PERT	40 hrs/site-year	80 hrs/site-year	240 hrs/site-year
Perform annual SPRA review and update	200 hrs/site-year	PERT	40 hrs/site-year	200 hrs/site-year	600 hrs/site-year
FLEX program maintenance per site	160 hrs/site-year	PERT	80 hrs/site-year	160 hrs/site-year	320 hrs/site-year

Data Element	Mean Estimate	Distribution	Low Estimate	Best Estimate	High Estimate
Perform SPRA model updates periodically (e.g., every 4 years)	3,120 hrs/site	PERT	2,080 hrs/site	3,120 hrs/site	4,160 hrs/site
SPRA upgrade peer review (e.g., every 4 years)	630 hrs/site	PERT	420 hrs/site	630 hrs/site	840 hrs/site
Revaluated Hazards Analysis—NRC Implementation					
Flooding MSA submittals—Review flooding MSA submittals. Prepare and issue safety evaluations.					
Path G.3 or Path G.4.1—Existing FLEX strategy adequately considers reevaluated flooding hazard per submittal	150 hrs	PERT	40 hrs	150 hrs	200 hrs
Path G.4.2—FLEX strategy needs to be modified for flooding hazard per submittal	500 hrs	PERT	300 hrs	500 hrs	1,000 hrs
Path G.4.3—AMS strategy is used for flooding hazard per submittal	320 hrs	PERT	200 hrs	320 hrs	600 hrs
Path G.4.4—THMS strategy is used for flooding hazard per submittal	500 hrs	PERT	300 hrs	500 hrs	1,000 hrs
Seismic MSA submittals—Review seismic MSA submittals. Prepare and issue safety evaluations.					
Path 1—GMRS ≤ SSE per submittal	30 hrs	PERT	20 hrs	30 hrs	60 hrs
Path 2—GMRS > SSE, only > 10 Hz per submittal	150 hrs	PERT	80 hrs	150 hrs	300 hrs
Path 3—SSE < GMRS < IHS (1–10 Hz) per submittal	1,200 hrs	PERT	600 hrs	1,200 hrs	2,400 hrs
Path 4—GMRS ≤ 2X SSE (1–10 Hz) per submittal	2,200 hrs	PERT	1,000 hrs	2,200 hrs	5,000 hrs
Path 5—GMRS > 2X SSE (1–10 Hz) per submittal	3,000 hrs	PERT	1,500 hrs	3,000 hrs	6,000 hrs

Appendix B. Historical Cost Analysis

In this appendix, the U.S. Nuclear Regulatory Commission (NRC) estimates the costs associated with Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (Ref. B.1); Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012 (Ref. B.2); and related activities undertaken by the industry following the accident at the Fukushima Dai-ichi nuclear power plant in Japan. The NRC staff analyzed these historical costs to inform both the Commission and the public about 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 to the final rule. However, the final rule includes provisions that require the activities described in this appendix.

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 the industry and the NRC after the Fukushima accident. The sections below describe the methodology used to estimate the costs associated with Order EA-12-049, Order EA-12-051, and related industry initiatives that have been or will be incurred before the final rule's effective date.

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

Order EA-12-049 requires licensees and combined license holders to develop guidance and strategies to be implemented in response to beyond-design-basis external events (BDBEEs). This section discusses the historical costs of implementing Order EA-12-049 according to activities required by the order.

Affected Universe

Order EA-12-049 affects both current and new nuclear power plant 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 estimates costs on a per-site basis. The cost analysis includes three reactor types: boiling-water reactor (BWR), pressurized water reactor (PWR), and Advanced Passive 1000 (AP1000) reactor. Because of 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 evaluates the costs separately for each reactor type (see the cost estimation section below for the NRC's cost estimating approach). In all, the NRC estimates the costs for 62 sites (60 operating reactor sites plus 2 AP1000 sites) to account separately 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).[13] Costs also differ depending on how many reactor units are located on each site. Therefore, the NRC further differentiates the

[13] Because the costs related to Order EA-12-049 are significantly lower for sites with AP1000 reactors, the NRC 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.

affected universe by the number of units on each BWR, PWR, and AP1000 site. Exhibit B-1 shows, by reactor type and number of units, the total number of sites that costs attributable to Order EA-12-049 were accounted for in the historical cost analysis.

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. Fourteen are 1-unit sites, nine are 2-unit sites, and one is a 3-unit site. Five of the 1-unit BWR sites (i.e., Clinton, FitzPatrick, Pilgrim, Oyster Creek, and Vermont Yankee) and one of the 2-unit BWR sites (i.e., Quad Cities) are considered decommissioning sites. 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 Site**

The analysis of Order EA-12-049 also accounts for 38 PWR sites. There are twelve 1-unit, twenty-four 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's requirements for four decommissioning sites (i.e., Crystal River, Kewaunee, San Onofre, and Vermont Yankee), 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. Fort Calhoun is a decommissioning site.

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	
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	
	Salem	
	Sequoyah	
	South Texas Project	
	Surry	
	Turkey Point	
	Vogtle	
	Watts Bar	
12 Sites	**24 Sites**	**2 Sites**

The cost analysis of Order EA-12-049 accounts for 38 PWR sites. There are twelve 1-unit, twenty-four 2-unit, and two 3-unit PWR sites. One of the 1-unit PWR sites (i.e., Fort Calhoun) is a decommissioning site. 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 ("CLI-12-09, Memorandum and Order, 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)," dated March 30, 2012 (Ref. B.3)). Therefore, the analysis of Order EA-12-049 estimates the costs associated with the order's requirements for both AP1000 sites.

The AP1000 reactors possess onsite equipment and several safety design features that allow the reactors to cope longer during a station blackout (SBO) event than BWRs and PWRs can. Because of the AP1000's design features, the impact of the order requirements on sites with

these reactors is smaller than the impact 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 used information from sites' overall integrated plans (OIPs) to estimate the costs of the order. These plans provided information on how compliance with the order will be achieved.

Data Sources for Inputs

The NRC gathered equipment cost data from multiple sources. The staff gathered unit cost data from suppliers and industry sources. In addition, the NRC used the RSMeans cost reference books, *Building Construction Cost Data*, issued 2005 (Ref. B.4), and *Facilities Construction Cost Data*, issued 2000 (Ref. B.5), for certain compliance activities. An Electric Power Research Institute (EPRI) study, Technical Update Report No. 1007760, "Costs of Utility Distributed Generators, 1–10 MW: Twenty-Four Case Studies," issued March 2003 (Ref. B.6), also provided costs for generators, switchgears, and transformers. In addition, the NRC consulted with industry experts to estimate certain cost data.

The NRC estimated loaded labor costs according to data provided by the Bureau of Labor Statistics and wage rates used in related NRC regulatory analysis. The NRC 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: Abstracts from Generic Studies for Use in Preparing Regulatory Impact Analyses," Revision 2, issued February 1992 (Ref. B.7), direct wage rates are loaded using a multiplier of two to account for licensee and contractor labor and overhead (i.e., fringe benefits, general administration, and profit). A loaded wage factor of two is used. 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 mean wage rate for an industry labor category is calculated as the average of the mean hourly wage (in the Electric Power Generation, Transmission, and Distribution Industry) for applicable standard occupational

classification (SOC) codes from the Bureau of Labor Statistics. The labor categories used are Mechanical Engineers (SOC 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).

Estimating Quantity of Equipment Needed

Based on a sample of the 1-unit reactor sites' OIPs, the NRC estimated how many pieces of equipment and supplies were required. The NRC used the results from these BWR and PWR OIPs to estimate the quantities needed at a typical 1-unit site. The NRC 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 also used sources outside the OIPs if the OIPs did not provide sufficient detail to estimate quantities. For example, communications gear is required equipment under Order EA-12-049, but the OIPs do not specify the number or type of communication equipment that had to be procured. Instead, the NRC referred to a document prepared by FirstEnergy Nuclear Operating Company (FENOC) in response to an NRC request for information under Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(f) (Ref. B.14) in which the licensee identified the number and types of communication equipment shared by three FENOC sites (Ref. B.8). The NRC used these data to approximate the quantity of additional communication equipment needed to comply with the order.

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

Description of Assumptions Used in the Analysis

The NRC applied the following assumptions in this analysis.

Compliance Activities and Equipment Needs

The NRC developed a model reference site for each reactor type (i.e., BWR, PWR, and AP1000). Each model includes a list of compliance activities that must be performed to comply with Order EA-12-049. The NRC used these models, which are based on the contents of a sampling of OIPs, to approximate the cost of the order.

The NRC 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 derived quantities of equipment by adjusting the 1-unit site estimates. Required quantities of some of the flex support guidelines (FSGs) equipment depends on the number of reactors on site (i.e., *N*). As stated in Nuclear Energy Institute (NEI) 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, issued August 2012 (Ref. B.9), an $N + 1$ equipment capability applies to portable FLEX equipment (i.e., that equipment that directly supports maintenance of the key safety functions). Any other support equipment requires only *N* capability. Exhibit B-6 shows how the NRC adjusted equipment needs according to the number of reactors on site.

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 assumes that licensees of operating BWR and PWR plants and newly constructed AP1000 reactors will incur savings and costs over 24-, 26-, and 63-year periods, 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 spent fuel pool (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 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 assumed that each site will incur costs to comply with the order over the first 2 years following the end of the license extension (to cover compliance with Order EA-12-049 during decommissioning).

Present Value Calculation

The NRC 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 mapped the activities described in the OIPs[14] to the following six categories that best described their function:

(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 on site and deployed before 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 the use of portable equipment, as well as procuring the portable equipment.

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

(3) *Offsite portable equipment*: The offsite portable equipment category reflects the activities needed to prepare the National Strategic Alliance for FLEX Emergency Response (SAFER) Response Centers (NSRCs). This includes one-time costs to stock critical equipment and to staff and train the organization running the NSRCs. Under the implementation of Order EA-12-049, the industry has established two NSRCs (one near Memphis, TN, and one near Phoenix, AZ). The NSRCs are to be capable of delivering supplemental emergency equipment to any U.S. nuclear energy facility within 24 hours. The equipment and materials provided by the NSRCs supplement the additional portable equipment purchased at each U.S. nuclear energy facility.

(4) *Supporting functions*: The supporting functions category captures activities that support the first three categories listed. For example, upgrading emergency lighting and analyzing fuel storage needs and consumption rates all 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 NSRCs (e.g., staffing, rent, testing and maintenance, and transportation capabilities). These costs are shared across the 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 focused on variations that posed significant cost implications for the analysis. The NRC identified two variations that affected cost most significantly: reactor type (i.e., BWR, PWR, or 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 required to mitigate an SBO event are significant enough to warrant this distinction. The staff considered subdividing the BWRs and PWRs to acknowledge the differences in plant vintage and mitigation strategies; however, the number and significance of such variations was not sufficient to warrant additional analysis. The NRC accounted for cost differences between 1-, 2-, and 3-unit sites. This is because $N + 1$ sets of some SBO mitigation strategies equipment, where N is the number of reactor units on site, must be available on site, which can have a significant impact on costs.

The NRC identified representative compliance activities from the OIPs submitted by several BWR and PWR plants, as identified in Exhibit B-7.[15] The OIPs described site-specific activities (e.g., relating to specific buses, switchgear, and locations). For this analysis, the NRC extrapolated from these site-specific activities to identify generic actions and equipment needed.

[15] The NRC 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 industrywide.

The NRC's selection of OIPs covered a variety of site characteristics, including nuclear steam supply system type, containment type, operator, and applicable hazards. Because the approach uses selected examples of specific activities from a sampling of sites to estimate industrywide costs, it could skew cost estimates. However, the NRC 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
Grand Gulf	Donald C. Cook	Vogtle
Duane Arnold	Joseph M. Farley	
Edwin I. Hatch	Shearon Harris	
Dresden*	Braidwood*	
Monticello*	Calvert Cliffs*	
Vermont Yankee*[16]	McGuire*	
	Millstone*	
	R. E. Ginna*	
	Sequoyah*	

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

Cost Variations Not Accounted for in the Analysis

The analysis presents the estimated cost of imposing the requirements of Order EA-12-049 for two significant variations: reactor type (e.g., BWR, PWR, and AP 1000) and number of units per site. In addition to these variations, the staff considered whether other design or operational differences could cause the cost to vary for individual sites. The NRC assessed whether differences could arise because of variations in the nuclear steam supply system vendor, the architectural-engineering firm, the plant vintage, individual plant modifications, or core power. Although these categories do have design and operational differences, they are similar in their alternating current (ac) power systems. The staff used its professional judgment to identify eight additional categories (other than reactor type and number of units) that could affect the costs incurred in relation to Order EA-12-049.

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

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

Source of the variation: In their OIPs, some sites departed from NEI 12-06 (Ref. B.9) by either (1) crediting existing onsite ac power sources for the initial response (this includes crediting hardened, dedicated shutdown systems for extended loss of ac power (ELAP) mitigation) or

[16] The OIP issued by Vermont Yankee was issued before the announcement of its shutdown. The NRC believes its OIP is a relevant model.

(2) defining what constitutes a "robust" structure with respect to seismic events differently than does 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 a "robust" structure, a significant cost savings for sites would result from a less stringent set of codes or criteria for determining what constitutes an adequate design to withstand an extreme seismic event.

Significance of cost impact on implementation or operational activities: The NRC concluded that variations found in OIPs related to the initial response could result in some savings for sites choosing to depart from NEI 12-06 (Ref. B.9). However, the NRC does not estimate the cost savings of these alternative approaches because the impact on the overall cost of the order is expected to be insignificant.

2. Design limitations affecting 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: Design inadequacies with respect to an ELAP event would have to be remedied. Such inadequacies could result in activities such as constructing a seismically qualified or tornado-missile-proof tank(s) to provide water. 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 have to be upgraded to qualify and protect them appropriately.

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. Design, labor, and materials costs would be substantial. In addition, sites would have to engage a highly skilled workforce to connect the new tanks to the existing auxiliary feedwater/emergency feedwater/reactor core isolation cooling system and would have to procure highly qualified components, such as N-stamp valves. However, the NRC believes that very few sites face design limitations to the degree that would require substantial and costly modifications. Therefore, the NRC estimated the costs associated with addressing the design limitations that are most typical among the current fleet.

3. Limited battery capacity

Source of the variation: Some sites have only 2 hours of battery capacity to carry necessary electrical loads following an SBO event, while other sites have up to 8 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 4 hours. Sites with limited-capacity batteries would have 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 accounted for some costs related to battery capacity 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: Because of 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 have to procure additional equipment, such as diesel-driven pump(s). In addition, licensees would have to write associated procedures, perform additional testing, and train personnel. Some plants may need large dewatering pumps because of 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 that are regularly used in agriculture or mining to meet 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 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 the NRC to issue a notice under 10 CFR Part 21, “Reporting of Defects and Noncompliance” (Ref. B.15) that questioned the capability of the new seal design to lower the leak rate significantly when cooling is lost.

Impact on implementation or operational activities resulting from the variation: Multiple vendors are 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 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 have 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 that is similar to the rate 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 rework the mitigation strategies described in the OIP. The timing of events and mitigation strategies would have 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 because of RCS inventory loss and shrinkage during RCS cooldown). Alternatively, a licensee may choose to replace the RCP seal to provide a low leakage rate when the seal cooling is lost. The costs involved in addressing RCP low-leakage seals could range from insignificant to substantial. The NRC 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; it is planned to remove and test these seals in October 2015. The NRC is reviewing a topical report, PWROG-14001-P/NP, "PRA Model for Generation III Westinghouse Shutdown Seal," Revision 1, issued July 2014 (Ref. B.10), which supports the Generation III seals. 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 (Ref. B.11).

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

Source of the variation: Igniters are required in PWR ice condenser containments and Mark III BWRs because these containments rely on steam condensation to control containment pressure. Therefore, these containments experience rapid development of flammable hydrogen concentrations following a severe accident. Mark I and Mark II containments also rely on steam condensation, but they control the hydrogen threat by making the wetwell atmosphere inert. To prevent postaccident containment failure, igniters are installed in strategic locations in ice condenser and Mark III containment designs to burn off the hydrogen gas before the containment atmosphere can reach a concentration that could 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 ensure that containment integrity is maintained, the power source for these igniters may have 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 for 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 the pumps, rather than on having redundant water sources.

Significance of impact on implementation or operational activities: Large hardened tanks are costly. The most costly tanks would be those that have to be protected against seismic, tornado missile, and hurricane events. The NRC accounted for some costs associated with upgrading water sources but could not account for all potential variation in costs 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 reevaluating seismic and flooding hazards using the most up-to-date seismic and external flood methods and information. This action, which was prompted by the 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 modify 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 "Draft Interim Staff Guidance JLD-ISG-12-05, Guidance for Performing the Integrated Assessment for Flooding," Revision 0, dated September 20, 2012 (Ref. B.12), have not reflected a significant impact on the FSGs developed in response to Order EA-12-049. Any costs resulting from the reevaluations performed under Near-Term Task Force Recommendation 2.1 are attributable to the Mitigation of Beyond-Design-Basis Events Rule and not to the order.[17]

[17] Licensees are conducting MSAs using NRC-approved industry guidance in NEI 12-06, Revision 3 (Ref. B.16). Activities being completed as part of NTTF Recommendation 2.1, some of which relate to Order EA-12-049 through the MSAs, are included as part of the regulatory baseline for Option 1.

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

Order EA-12-051 required licensees and combined license holders to install equipment to reliably monitor the water level in spent fuel pools (SFPs) in order to ensure that 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 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 four decommissioning sites (i.e., Crystal River, Kewaunee, San Onofre, and Vermont Yankee) from the requirements set forth by Order EA-12-051. The licensees for the Clinton, FitzPatrick, Fort Calhoun, Oyster Creek, Pilgrim, and Quad Cities sites have announced intentions to decommission by the end of 2019. The NRC assumes in this analysis that the licensees for these sites will submit a rescission letter that the NRC will approve;[18] therefore, the analysis does not include any costs for these 10 sites. Based on data assembled by the NRC, Exhibit B-8 also shows the NRC's estimate for the number of sites that would purchase two, four, or six SFP instruments.

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

Number of 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 estimates the costs of related industry initiatives that followed the Fukushima accident 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 before 2017. Costs associated with voluntary industry initiatives began as early as 2012.

[18] SECY-14-0114, "Sixth 6-Month Status Update on Response to Lessons Learned from Japan's March 11, 2011, Great Tōhoku Earthquake and Subsequent Tsunami," dated October 21, 2014 (Ref. B.17), gives more information on the exemption of decommissioning sites from compliance with Order EA-12-051.

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 the 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 implementing 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	$150,000	$1,600,000,000	$9,900,000	$2,200,000,000	$1,700,000,000	$2,000,000,000
NRC	N/A	N/A	$530,000	$530,000	$2,100,000	$1,800,000	$2,000,000
Subtotal	*$24,000,000*	*$150,000*	*$1,600,000,000*	*$10,000,000*	*$2,200,000,000*	*$1,700,000,000*	*$2,000,000,000*
EA-12-051							
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*	*$56,000,000*	*$570,000*	*$73,000,000*	*$28,000,000*	*$42,000,000*
Total							
Industry	$29,000,000	$170,000	$1,900,000,000	$11,000,000	$2,500,000,000	$1,900,000,000	$2,300,000,000
NRC	N/A	N/A	$9,400,000	$700,000	$12,000,000	$5,000,000	$7,700,000
Total	**$29,000,000**	**$170,000**	**$1,900,000,000**	**$12,000,000**	**$2,500,000,000**	**$1,900,000,000**	**$2,300,000,000**

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

B.2.1 Costs of Implementing Order EA-12-049

Exhibit B-10 summarizes the monetized costs related to Order EA-12-049, which resulted in a cost between $1.7 billion and $2 billion (using a 7-percent and 3-percent discount rate, respectively). The sections below describe these monetized costs in more detail.

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	$150,000	N/A	$9,900,000	$650,000,000	$270,000,000	$420,000,000
Subtotal	*$24,000,000*	*$150,000*	*$1,600,000,000*	*$9,900,000*	*$2,200,000,000*	*$1,700,000,000*	*$2,000,000,000*
NRC							
Licensing Activities	N/A	N/A	$530,000	N/A	$530,000	$490,000	$510,000
Inspection Activities	N/A	N/A	N/A	$530,000	$1,600,000	$1,300,000	$1,500,000
Subtotal	*N/A*	*N/A*	*$530,000*	*$500,000*	*$2,100,000*	*$1,800,000*	*$2,000,000*
TOTAL							
Industry	$24,000,000	$150,000	$1,600,000,000	$9,900,000	$2,200,000,000	$1,700,000,000	$2,000,000,000
NRC	N/A	N/A	$530,000	$530,000	$2,100,000	$1,800,000	$2,000,000
Total	**$24,000,000**	**$150,000**	**$1,600,000,000**	**$10,000,000**	**$2,200,000,000**	**$1,700,000,000**	**$2,000,000,000**

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

B.2.1.1 Industry Implementation

Exhibit B-11 lists the upfront costs to the 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 million (based on 65 affected sites).[19]

[19] Although Order EA-12-049 imposed costs on only 62 sites, the NRC 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 cost per site in the remainder of the historical analysis.

Exhibit B-11. Present Value of the 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		$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 exhibit are presented in 2013 dollars.

The costs in Exhibit B-11 are derived from the combined costs of the compliance activities associated with Order EA-12-049 that are applicable to each reactor type (i.e., BWR, PWR, and AP1000). Because the compliance activities differ between reactor types, the following sections provide the implementation costs for each individual reactor type.

Boiling-Water Reactors

The sections below 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 compliance activities related to initial response. The initial response compliance activities include constructing, installing, and modifying equipment for coping strategies to maintain SFP cooling. The NRC estimates that the undiscounted total cost associated with initial response compliance activities for BWRs is $59 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.	$390,000	$770,000	$1,200,000	$13,000,000
Build clean water receiver tank with availability to supply reactor core isolation cooling (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 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 exhibit are presented in 2013 dollars.
*** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-13 reports on the upfront costs of compliance activities related to onsite portable equipment 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 estimates that the undiscounted total cost associated with the onsite portable equipment compliance activities is approximately $290 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $8.2 million, $16 million, and $24 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 prestage 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

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
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-volt (V) FLEX diesel generator (DG).	$2,100	$4,100	$6,200	$72,000
Install power cables from outside connection point to alternate decay heat removal 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 suppression pool makeup (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 16B31 to provide sufficient capacity to power train B residual heat removal support loads from 480-V FLEX DG.	$2,100	$4,100	$6,200	$72,000
Modify connection of 4,160-volts alternating current (Vac) NSRC FLEX DG to the Class1E 16AB 4,160 Vac.	$750,000	$1,500,000	$2,300,000	$26,000,000
Modify the SFP line by installing two connections for two 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
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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-14 shows the upfront costs of compliance activities related to offsite portable equipment for BWRs. Offsite portable equipment compliance activities include procuring offsite equipment and installing equipment for coping strategies to maintain SFP cooling. Note that this cost estimate does not include the licensee's share of NSRC costs; that is discussed separately and in greater detail in the NSRC costs section. The NRC 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**

Exhibit notes:
* This does not include procuring equipment stored at the NSRCs.
** Results are rounded.
*** All costs in this exhibit are presented in 2013 dollars.
**** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-15 documents the costs of compliance activities related to supporting functions for 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 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 light-emitting diode (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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-16 presents the costs of compliance activities related to external event considerations for BWRs. The external event considerations compliance activities involve establishing a flood staging area and building onsite FLEX storage buildings to protect equipment. The NRC estimates that the undiscounted total cost associated with the compliance activities related to external event considerations is approximately $200 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $5.3 million, $8.3 million, and $11 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 (protected 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

Exhibit B-17 summarizes the initial costs of compliance activities related to programmatic controls for 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 emergency operating procedures (EOPs), extensive damage mitigation guidelines (EDMGs), and severe accident management guidelines (SAMGs) and established a strategies playbook with the respective NSRC. Additionally, sites developed training modules and programs and conducted analyses to determine whether staffing and commodities were adequate. The NRC estimates that the undiscounted total cost associated with the programmatic controls activities is $46 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 NSRC.	$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
Modify plant procedures to take FSGs into account. 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's 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

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 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
Perform an analysis to determine commodity requirements.	$6,700	$6,700	$6,700	$160,000
Maintain involvement with industry group activities.	$63,000	$66,000	$69,000	$1,500,000
Perform 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

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

Pressurized-Water Reactors

The sections below 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 compliance activities related to initial response for PWRs. The initial response compliance activities include constructing, installing, upgrading, and modifying equipment for coping strategies to maintain SFP cooling. The NRC estimates that the undiscounted total cost associated with initial response compliance activities for PWRs is approximately $210 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 DG.	$87,000	$170,000	$260,000	$5,700,000
Install a robust, shielded connection on each reactor makeup water storage tank.	$1,500,000	$3,100,000	$4,600,000	$100,000,000
Upgrade nonseismic condensate transfer pump suction nozzle to seismic qualification.	$24,000	$47,000	$71,000	$1,600,000

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.	$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 (high wind and missile protected and contains borated water).	$390,000	$770,000	$1,200,000	$25,000,000
Modify power controls for SG power-operated relief valves from an instrument bus powered by direct current (dc).	$6,200	$12,000	$19,000	$410,000
Install permanent nitrogen bottle racks near each SG power-operated relief valve 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 system and add an alternate seal injection pump discharge path to the 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-19 summarizes the initial costs of compliance activities related to onsite portable equipment for 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 estimates that the undiscounted total cost associated with onsite portable equipment compliance activities is approximately $170 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
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.	$330,000	$660,000	$980,000	$22,000,000

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
Provide a branch from the CVCS drain line. Modify vent connection. Resize the CVCS crosstie drain line.				
Add FLEX pump discharge connection points to both trains of the essential service water system.	$190,000	$370,000	$560,000	$12,000,000
Install a connection point downstream of the emergency feedwater pump.	$110,000	$220,000	$330,000	$7,300,000
Modify spare breaker for 480-V FLEX DG connection. Install new vertical section on switchgear for 4,160-V 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-20 documents the upfront costs of compliance activities related to offsite portable equipment for PWRs. Offsite portable equipment compliance activities included procuring offsite equipment and installing equipment for coping strategies to maintain SFP cooling. Note that this cost estimate does not include the licensee's share of NSRC costs; that is discussed separately and in greater detail in NSRC costs section. The NRC estimates that the undiscounted total cost associated with offsite portable equipment compliance activities is approximately $53 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

*** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-21 presents the costs of compliance activities related to supporting functions for PWRs. The supporting function compliance activities involved upgrading the lighting to conserve battery life and installing connection points. The NRC estimates that the undiscounted total cost associated with supporting function compliance activities is approximately $150 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.	$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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-22 reports the costs of compliance activities related to external event considerations for PWRs. The external event considerations compliance activities involved establishing a flood staging area and building onsite FLEX storage buildings to protect equipment. The NRC estimates that the undiscounted total cost associated with external event considerations compliance activities is approximately $280 million. The cost per an affected 1-unit, 2-unit, and 3-unit site is $5.3 million, $8.3 million, and $11 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
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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR site.

Exhibit B-23 presents the costs of compliance activities related to programmatic controls for 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 NSRC. Additionally, sites developed training modules and programs and conducted

analyses to determine whether staffing and commodities were adequate. The NRC estimates that the undiscounted total cost associated with programmatic controls compliance activities is $77 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 NSRC.	$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
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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR site.

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

AP1000 Reactors

This section details the initial compliance activities required of a site with an AP1000 reactor (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 compliance activities related to programmatic controls for 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 NSRC. Additionally, sites developed training modules and programs and conducted analyses to determine whether staffing and commodities are adequate. The NRC 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 NSRC.	$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
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
Perform an analysis to determine commodity requirements.	$6,700	$13,000
Maintain involvement with industry group activities.	$66,000	$790,000
Perform 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** There are two 2-unit AP1000 sites.

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

National SAFER Response Center Costs

To comply with the Order EA-12-049 requirements, the industry decided to prestage equipment and resources at an offsite location. These resources, which will be available to sites within 24 hours after an event, must provide the capability to sustain core cooling, containment, and SFP cooling indefinitely following a BDBEE. The industry has established two NSRCs (one in Phoenix, AZ, and one near Memphis, TN). Exhibit B-25 presents the types of equipment that are expected to be available through the NSRCs, the quantities of equipment available, and the estimated unit costs. This list of equipment was compiled on the basis of the information provided in the sampled OIPs (see Exhibit B-7 for the list of sites sampled). The undiscounted total cost for both NSRCs is estimated to be $54 million. The costs for equipping the NSRCs will be shared equally by all 62 sites. Therefore, the estimated cost per site is $870,000.

Exhibit B-25. Cost of Offsite Equipment at NSRCs

Equipment	Quantity in a "Set"	Unit Cost	Total Cost per NSRC (5 Sets)	Total Costs for 2 NSRCs (10 Sets)
	A	B	C =A x B x 5	D =A x B x 10
4-kilovolt (kV) and 6.9-kV DG	3	$900,000	$14,000,000	$27,000,000
4-kV and 6.9-kV DG switchgear and 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
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

Equipment	Quantity in a "Set"	Unit Cost	Total Cost per NSRC (5 Sets)	Total Costs for 2 NSRCs (10 Sets)
	A	B	C =A x B x 5	D =A x B x 10
Female national pipe taper stainless steel 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 feet)	4	$2,000	$40,000	$80,000
High-pressure hose (100 feet)	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, and 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 hoses	48	$3,000	$720,000	$1,400,000
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 kilowatts (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 outlet, Storz inlet	1	$1,000	$5,000	$10,000
Storz to national hose thread (NH) swivel rocker lug female thread	2	$200	$2,000	$4,000

Equipment	Quantity in a "Set"	Unit Cost	Total Cost per NSRC (5 Sets)	Total Costs for 2 NSRCs (10 Sets)
	A	B	C =A x B x 5	D =A x B x 10
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**
			Average Cost Per Site	**$870,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

The NRC also estimates the upfront costs to staff the NSRCs and train the workers operating the NSRCs, as well as to move the equipment into the NSRCs. Exhibit B-26 lists the estimated unit costs for these activities. The undiscounted total cost for both NSRCs is $18 million. The costs for the NSRCs will be shared equally by all 62 sites. The estimated average cost per site is approximately $280,000.

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

Cost Item	Cost per NSRC	Total Cost (2 NSRCs)
Staffing and training	$8,000,000	$16,000,000
Outfitting (e.g., warehousing, transport, positioning equipment)	$750,000	$1,500,000
Moving	$8,000	$16,000
Total	**$8,800,000**	**$18,000,000**
	Average Cost Per Site	**$280,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

B.2.1.2 Industry Operation

Exhibit B-27 reports the industry's average annual costs. The NRC estimates that the industry will incur an average annual cost of approximately $9.9 million. The present value of these costs is approximately $270 million (using a 7-percent discount rate) and $420 million (using a 3-percent discount rate). With 65 sites, the estimated annual cost per site is $150,000.[20]

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

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

Section	Cost Per Site	Total Cost			
	Annual Cost	Average Annual Cost	Undiscounted	Present Value (7 percent)	Present Value (3 percent)
Programmatic controls (annual)	$150,000	$9,900,000	$650,000,000	$270,000,000	$420,000,000
Total	**$150,000**	**$9,900,000**	**$650,000,000**	**$270,000,000**	**$420,000,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

The costs in Exhibit B-27 are derived from the combined costs of the compliance activities from each reactor type (i.e., BWR, PWR, and AP1000). Because the compliance activities differ between reactor types, the following sections provide the costs for BWR, PWR, and AP1000 sites individually.

Boiling-Water Reactors

Exhibit B-28 presents the costs of annual compliance activities related to programmatic controls for 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 that this cost estimate does not include the licensee's share of NSRC costs; that is discussed separately and in greater detail in the NSRC costs section. The NRC 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.

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 of 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**

Exhibit notes:
* This does not include ongoing costs for NSRCs.
** Results are rounded.
*** All costs in this exhibit are presented in 2013 dollars.

**** There are fourteen 1-unit BWR sites, nine 2-unit BWR sites, and one 3-unit BWR site.

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

Pressurized-Water Reactors

Exhibit B-29 contains the costs of annual compliance activities related to programmatic controls for 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 that this cost estimate does not include the licensee's share of NSRC costs; that is discussed separately and in greater detail in the NSRC costs section. The NRC 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 of 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
Subtotal	**$160,000**	**$240,000**	**$320,000**	**$8,300,000**

Exhibit notes:
* This does not include ongoing costs for NSRCs.
** Results are rounded.
*** All costs in this exhibit are presented in 2013 dollars.
**** There are twelve 1-unit PWR sites, twenty-four 2-unit PWR sites, and two 3-unit PWR sites.

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

AP1000 Reactors

Exhibit B-30 presents the costs of annual compliance activities related to programmatic controls for 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 that this cost estimate does not include the licensee's share of NSRC costs; that is discussed separately and in greater detail in the NSRC costs section. The NRC 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 of 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**

Exhibit notes:
* This does not include ongoing costs for NSRCs.
** Results are rounded.
*** All costs in this exhibit are presented in 2013 dollars.
**** There are two 2-unit AP1000 sites.

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

National SAFER Response Centers

The industry has chosen to comply with the Order EA-12-049 requirements by prestaging 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. The industry has established two NSRCs (one in Phoenix, AZ, and one near Memphis, TN). Exhibit B-31 presents the types of activities that are expected to be performed by the NSRCs (such as maintenance and transportation). The NRC estimates that transportation costs will be approximately $5.7 million per year for the first 3 years and will decrease to $450,000 per year for all subsequent years. The NRC assumes that costs related to the NSRCs are variable in the sense that after a site submits its exemption analysis, it will no longer contribute to NSRC costs. The undiscounted total cost for both NSRCs is $9 million. The costs for the NSRCs 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 NSRC Activities

COMPONENT	Annual Cost per NSRC	Total Annual Costs (2 NSRCs)
Maintenance activities	$4,000,000	$8,000,000
Transportation capability (after 3 years)	$450,000	$900,000
Total	**$4,500,000**	**$9,000,000**
Total Cost Per Site		**$150,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** The annual transportation capability cost data represent the per year costs incurred by sites after the first 3 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 estimates that 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

B.2.1.4 NRC Operation

The NRC also will incur ongoing operations costs (specifically, for inspection activities). These annual costs are assumed to begin in 2014 and accrue over 2 years.

Exhibit B-33 provides the NRC's total operations costs (i.e., for 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

B.2.2 Costs of Implementing Order EA-12-051

Exhibit B-34 summarizes the estimated costs of implementing Order EA-12-051. Under the historical cost analysis, the requirements contained in Order EA-12-051 impose costs between $210 million and $230 million (using a 7-percent and 3-percent discount rate, respectively). These costs are described in more detail in the sections below.

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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit 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 related to 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 million. The total present value of these costs is approximately $200 million (using a 7-percent discount rate) and $230 million (using a 3-percent discount rate). The average cost per site is estimated at $3.8 million.

Exhibit B-35. Present Value of the 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

Exhibit B-36 contains the compliance activities related to SFP instrumentation. The NRC assumes that after it issued Order EA-12-051, 60 operating sites purchased and installed SFP instrumentation on a rolling basis from 2014 to 2016. The NRC 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.
- Two sites purchased six instruments.

The NRC 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 the NRC'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 NSRC purchased six spare instruments, for a total of 72 spare instruments. The NRC estimates that the cost of a spare instrument is 10 percent of the cost to install one instrument ($1.8 million). The NRC assumes that the industry purchased spares on a rolling basis from 2014 to 2016.

The industry developed implementation guidance (i.e., NEI 12-02 (Ref. B.18)). 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
Prepare and submit first and second 6-month update to integrated plan.	$31,000	$1,900,000
Subtotal		**$250,000,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.2 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 estimates that the industry will incur an annual cost of approximately $1 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 the 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

Exhibits B-38 and B-39 present the costs of annual compliance activities related to SFP instrumentation that will be incurred during sites' operating license terms and during the first 2 years of decommissioning, respectively.

Costs associated with testing SFP instrumentation will be incurred during the operating term and during the first 2 years of the decommissioning period. The NRC assumes that the 58 BWR and PWR sites will incur operating costs beginning in 2017 and ending in 2040 (the average remaining industrywide 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 industrywide operating license term for current AP1000 sites). Section 3.1 of the regulatory analysis gives 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 assumes that for 2 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 2 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 the eighth update to a site's integrated plan will be incurred beginning in 2014 through 2017. The NRC 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 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 estimates that during the sites' operating periods, the industry will incur a cost of $1 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**

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

Assumptions Related to Costs Incurred During the First 2 Years of Decommissioning

The NRC assumes that each of the 60 sites will continue to incur costs relating to testing SFP instrumentation on a biennial basis during the first 2 years of decommissioning. The level of effort required will not vary based on the number of SFP instruments.

Exhibit B-39. Industry Operations Cost: SFP Instrumentation During the First 2 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**

Exhibit notes:
* 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 the 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

Exhibit B-41 presents the costs of annual compliance activities related to SFP instrumentation. The NRC reviewed the industry guidance (i.e., NEI 12-02 (Ref. B.18)) 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 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.2 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 2 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

The NRC will review updates to the sites' integrated plans. The NRC assumes that reviewing the third through eighth 6-month updates will take the NRC half the level of effort 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 process. Therefore, the NRC 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.2 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 million and $42 million (using a 7-percent and 3-percent discount rate, respectively). The sections below describe these monetized costs, as well as the nonmonetary benefits and costs, in more detail.

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
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*
Multiple Source Term Dose Assessment							
Industry	$130,000	$8,500	$8,600,000	$550,000	$24,000,000	$13,000,000	$17,000,000

	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	$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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit 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 multiple source term 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 million. The total present value of these costs is approximately $28 million (using a 3-percent discount rate) and $19 million (using a 7-percent discount rate). The average cost per site is estimated at $730,000 (based on 65 sites).

Exhibit B-45. Present Value of the 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
Multiple Source Term 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit 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 multiple source term 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 analyses, requesting that the NRC exempt them from Order EA-12-049 and Order EA-12-051. Each of the four sites that recently began decommissioning (i.e., Crystal River, Kewaunee, San Onofre, and Vermont Yankee) prepared and submitted exemption analyses to the NRC; for this regulatory analysis, the NRC assumes these exemption analyses were submitted in 2014. At the time this analysis was conducted, Oyster Creek had announced intentions to decommission in 2019; early decommissioning of other sites (e.g., Pilgrim, Fort Calhoun) was not considered in the analysis based on the time of these announcements. The NRC assumes in this analysis that Oyster Creek will submit a rescission letter that the NRC will approve in 2019. The NRC also assumes that currently operating sites will submit and receive approval of exemption analyses 2 years into the decommissioning phase (in 2042). Section 3.1 of the regulatory analysis provides additional detail on the exemption analysis and the NRC's assumptions. The total cost associated with the preparation and submission of the exemption analysis is $33 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix D.1 for additional detail on these cost estimates.

Severe Accident Management Guidelines Guidance

Exhibit B-47 presents the upfront costs associated with industry initiatives focused on SAMGs. The industry developed implementation guidance (i.e., NEI 14-01, "Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents," Draft Revision 0, issued March 2014 (Ref. B.13)); EPRI developed the SAMG TBR, the BWR Owners Group (BWROG) developed the generic BWR severe accident guidelines (SAG), and the PWR Owners Group (PWROG) developed the generic PWR SAMG. The NRC assumes that 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 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit 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 estimates, 35 multiunit operating sites and 1 multiunit decommissioning site with fuel remaining in the SFP (i.e., San Onofre) performed a Phase 1 staffing assessment.[21,22] The NRC 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 Assessments

Activity	Average Cost per Affected Site	Total Cost
Perform Phase 1 staffing assessment (multiunit sites).	$42,000	$1,500,000
Subtotal		**$1,500,000**

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

Multiple Source Term Dose Assessment

Exhibit B-49 presents the implementation costs associated with multiple source term dose assessment activities at 60 affected sites. Fifty-six operating sites and four decommissioning sites with fuel remaining in the SFP (i.e., Crystal River, Kewaunee, Oyster Creek, and Vermont Yankee) implemented multiple source term dose assessment capabilities. The remaining decommissioning site with fuel remaining in the SFP (i.e., San Onofre) did not implement multiple source term dose assessment capabilities. Four sites had previously implemented multiple source term dose assessment capabilities voluntarily (i.e., Duane Arnold, Fermi, Fort

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21 Based on NRC data, no site added emergency response organization (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 as a result of the staffing assessments.

22 The analysis of Order EA-12-049 reflects the historical costs associated with performing the Phase 2 staffing assessment (see Section B.2.1).

Calhoun, and Seabrook). Therefore, the NRC does not estimate the costs for these four sites to implement the capability.

Each of the 60 affected sites reviewed and revised its 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, comprising 26 operating sites and 2 decommissioning sites), or to develop its own software independently (32 sites, comprising 30 operating sites and 2 decommissioning sites). As a result, the NRC estimates that the undiscounted total cost associated with multiple source term dose assessment activities is $8.6 million.

Exhibit B-49. Industry Implementation Cost for Industry Initiatives: Multiple Source Term 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.3 for additional detail on these cost estimates.

B.2.3.2 Industry Operation

The 64 affected sites (the 60 sites for which implementation was considered, plus the four sites that had previously implemented the capability voluntarily) also will incur operations costs as a result of the industry initiatives. These costs include routine and recurring activities (such as updating multiple source term 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 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 $8,600 (based on 64 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)
Multiple source term dose assessment	$8,500	$550,000	$5,500,000	$9,300,000
Total	**$8,600**	**$550,000**	**$5,500,000**	**$9,300,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

Multiple Source Term Dose Assessment

Exhibits B-51 and B-52 present the costs of annual multiple source term dose assessment activities that will be incurred during sites' operating license terms and during the first 2 years of decommissioning, respectively. The NRC assumes that each of the 55 operating sites and the 9 decommissioning sites that implemented the multiple source term dose assessment capability will incur costs to update computer software on an annual basis. The operating sites will incur operating costs from 2015 through 2040, and the two AP1000 sites will incur operating costs from 2015 through 2077. The nine decommissioning sites will incur costs in 2015 through 2019. The NRC 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 multiple source term dose assessment activities.

Assumptions Related to Costs Incurred During the Operating Period

The NRC assumes that each of the 55 operating sites and the 9 decommissioning sites that implemented the multiple source term dose assessment capability will incur an annual cost to update their computer software. The annual cost to the industry of this activity is estimated to be $550,000.

Exhibit B-51. Industry Operations Cost for Industry Initiatives: Multiple Source Term Dose Assessment (During the Operating Period)

Activity	Average Annual Cost per Affected Site	Annual Cost
Update computer software (operating sites).	$9,100	$464,000
Update computer software (decommissioning sites).	$9,100	$82,000
Subtotal		**$550,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.3 for additional detail on these cost estimates.

Assumptions Related to Costs Incurred During the First 2 Years of Decommissioning

The NRC assumes that each of the 60 affected sites will continue to incur annual costs associated with updating computer software for the first 2 years of decommissioning. The set of affected sites does not include the four sites that have already completed these first 2 years

(i.e., Crystal River, Kewaunee, San Onofre, and Vermont Yankee). The cost to update computer software will not vary by design type or operating status. The NRC estimates that the industry will incur $510,000 in annual costs during the first 2 years of decommissioning.

Exhibit B-52. Industry Operations Cost for Industry Initiatives: Multiple Source Term Dose Assessment (During the First 2 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix D.3 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, and developing multiple source term 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
Multiple Source Term Dose Assessment	$150,000	$140,000	$150,000
Total	**$8,500,000**	**$2,300,000**	**$4,500,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit 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 reviewed the exemption analyses for four decommissioning sites (i.e., Crystal River, Kewaunee, San Onofre, and Vermont Yankee) and assumes that it will

use a similar process for Clinton, FitzPatrick, Fort Calhoun, Oyster Creek, Pilgrim, and Quad Cities, which announced intentions to decommission between 2017 and 2019. The NRC assumed that the staff will review the exemption analysis for each of the 56 operating sites during the second year of decommissioning. The NRC estimates the total undiscounted cost to review and approve exemption analyses 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**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit 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.[23] 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 Assessments

Activity	Total Cost
Review sites' staffing plan evaluations.	$220,000
Conduct inspection activities.	$30,000
Subtotal	**$250,000**

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

Multiple Source Term Dose Assessment

Exhibit B-56 presents the implementation costs incurred by the NRC as a result of the multiple source term 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 multiple source term dose assessment is estimated to be approximately $150,000.

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[23] The NRC assumes that it 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: Multiple Source Term Dose Assessment

Activity	Total Cost
Develop computer software, training, and user's guide.	$150,000
Subtotal	**$150,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.3 for additional detail on these cost estimates.

B.2.3.4 NRC Operation

The NRC expects there will be annual costs to the NRC to update multiple source term 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 the NRC's Operations Cost

Section	Total Cost		
	Annual Cost	Present Value (7 percent)	Present Value (3 percent)
Multiple source term dose assessment	$15,000	$180,000	$400,000
Total	**$15,000**	**$180,000**	**$400,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.

Multiple Source Term Dose Assessment

Exhibit B-58 presents the NRC's annual costs as a result of the multiple source term dose assessment requirements. The NRC expects that there will be annual updates to the NRC-provided computer software. As a result, the NRC estimates annual costs to the NRC of approximately $15,000.

Exhibit B-58. NRC Implementation Cost for Industry Initiatives: Multiple Source Term Dose Assessment

Activity	Annual Cost
Update computer software.	$15,000
Subtotal	**$15,000**

Exhibit notes:
* Results are rounded.
** All costs in this exhibit are presented in 2013 dollars.
*** See Appendix C.3 for additional detail on these cost estimates.

Appendix B References

B.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, Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A736.

B.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.

B.3 U.S. Nuclear Regulatory Commission, "CLI-12-09, Memorandum and Order, 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.

B.4 Waier, P. R. *Building Construction Cost Data*, 63rd ed., RS Means Co., 2005.

B.5 Mossman, J. M., & Plotner, S. C. *Facilities Construction Cost Data*, 15th ed., RS Means Co., 2000.

B.6 Electric Power Research Institute, "Costs of Utility Distributed Generators, 1–10 MW: Twenty-Four Case Studies," Technical Update Report No. 1007760, March 2003. Retrieved from: http://www.publicpower.org/files/Deed/FinalReportCostsofUtilityDistributedGenerators.pdf.

B.7 U.S. Nuclear Regulatory Commission, "Generic Cost Estimates: Abstracts from Generic Studies for Use in Preparing Regulatory Impact Analyses," NUREG/CR-4627, Rev. 2, February 1992, ADAMS Accession No. ML13137A259.

B.8 FirstEnergy Nuclear Operating Company, "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," March 12, 2012, Attachment L-12-193, 2012, ADAMS Accession No. ML12163A320.

B.9 Nuclear Energy Institute 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Rev. 0, August 2012, ADAMS Accession No. ML12242A378.

B.10 Westinghouse, "PRA Model for the Generation III Westinghouse Shutdown Seal," PWROG-14001-NP, Rev. 1, July 2014, ADAMS Accession No. ML14190A332.

B.11 PWR Owners Group, "Flowserve White Paper to the Response of the N-Seal Reactor Coolant Pump (RCP) Seal Package to Extended Loss of All Power (ELAP)," Revision A, August 3, 2015 (nonproprietary), ADAMS Accession No. ML15222A366.

B.12 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.

B.13 Nuclear Energy Institute 14-01, “Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents,” Rev. 1, February 2016, ADAMS Accession No. ML16224A619.

B.14 *Code of Federal Regulations*, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Title 10, “Energy.”

B.15 *Code of Federal Regulations*, “Reporting of Defects and Noncompliance,” Part 21, Title 10, “Energy.”

B.16 Nuclear Energy Institute, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” NEI 12-06, Rev. 3, ADAMS Accession No. ML16267A274.

B.17 U.S. Nuclear Regulatory Commission, “Sixth 6-Month Status Update on Response to Lessons Learned from Japan’s March 11, 2011, Great Tōhoku Earthquake and Subsequent Tsunami,” Commission Paper SECY-14-0114, October 21, 2014, ADAMS Accession No. ML14234A496.

B.18 Nuclear Energy Institute 12-02, “Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,” Rev. 1, August 2012, ADAMS Accession No. ML12240A307.

Appendix C. Detailed Cost Buildup for the Historical Incremental Effort for the Operating Plants

C.1 Phase 1 Staffing (Industry Initiatives)

§ 50.155(b) *Integrated response capability.* Each applicant or licensee shall develop, implement, and maintain an integrated response capability that includes:

(5) Sufficient staffing to support implementation of the capabilities required in paragraphs (b)(1) through (b)(3) of this section in conjunction with the EOPs to respond to events.

Assumptions:

1. Industry will complete all activities related to staffing before the final rule becomes effective in 2017. Therefore, these costs are historical incremental effort due to the Fukushima response. (See Appendix B.)
2. Each of the 35 multiunit operating sites and one multiunit decommissioning site (i.e., San Onofre) incurred a one-time cost to perform the Phase 1 staffing assessment as requested by the U.S. Nuclear Regulatory Commission's (NRC's) letter under Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(f) letter.
3. No site added emergency response organization (ERO) personnel to its minimum staffing in response to the Phase 1 staffing assessment. Therefore, industry would not incur any operational costs because of the staffing assessments.
4. Historical costs associated with Phase 2 staffing assessments are reflected in the analysis of Order EA-12-049, "Issuance of Order To Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012. (See Appendix B.)
5. The NRC incurred a one-time cost to review sites' staffing plan evaluations and to conduct inspection activities.
6. The NRC would perform ongoing oversight; however, this incremental effort would be integrated into existing inspection activities. Therefore, the analysis does not estimate incremental costs for the NRC's oversight.
7. Level-of-effort estimates are based on the NRC's professional judgment.

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort due to Final Rule		
	Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
INDUSTRY IMPLEMENTATION (ONE-TIME)									
Perform Phase 1 staffing assessment (multiunit sites)	Executive	$160/hour	36	8 hours/site	$1,277	$45,973	N/A		
	Manager	$104/hour	36	80 hours/site	$8,337	$300,125			
	Staff	$84/hour	36	360 hours/site	$30,186	$1,086,696			
	Clerical	$50/hour	36	24 hours/site	$1,203	$43,298			
	Licensing	$129/hour	36	8 hours/site	$1,030	$37,068			
Total Industry Implementation Cost						$1,513,161			
INDUSTRY OPERATIONS (ANNUAL)									
None									
NRC IMPLEMENTATION (ONE-TIME)									
Review sites' staffing plan evaluations	NRC staff	$124/hour	N/A	1,800 hours	$223,200	$223,200	N/A		
Conduct inspection activities	NRC staff	$124/hour	60	4 hours/site	$496	$29,760	N/A		
Total NRC Implementation Cost						$252,960			
NRC OPERATIONS (ANNUAL)									
None.									

C.2 Spent Fuel Pool Instrumentation (Order EA-12-051)

§ 50.155(f) *Spent Fuel Pool Monitoring*.

In order to support effective prioritization of event mitigation and recovery actions, each licensee shall provide reliable means to remotely monitor wide-range water level for each spent fuel pool at its site until five years have elapsed since all of the fuel within that spent fuel pool was last used in a reactor vessel for power generation. This provision does not apply to General Electric Mark III upper containment pools.

Assumptions:

1. Industry implementation costs will be incurred before the effective date of the rule (i.e., in response to Order EA-12-051, "Issuance of Order To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012). The analysis categorizes these costs as "historical." Appendix B discusses these historical costs.

2. According to NRC data, 60 operating sites installed spent fuel pool (SFP) instrumentation. The number of instruments required varies per site. Installation costs would decrease by 20 percent for each of the first four instruments installed. For example, installation of one instrument would cost $1.8 million, based on the NRC's unit cost estimates. Installation of two instruments would cost $3.24 million (i.e., the first installation would cost $1.8 million and the second would cost $1.44 million, 80 percent of $1.8 million). Installation of three instruments would cost $4.32 million (i.e., the third installation would cost $1.08 million, 60 percent of $1.8 million).
3. Forty sites purchased and installed two instruments, one site purchased and installed three instruments, 17 sites purchased and installed four instruments, and 2 sites purchased and installed six instruments. These sites would purchase the instruments on a rolling basis from 2014 to 2016. The table shows the total one-time cost that was incurred by the affected sites over the 2-year period.
4. Each site purchased one spare instrument. In addition, each regional response center will have six spares available. The cost of a spare is 10 percent of the cost of installing a single instrument ($1.8 million x 10%). Therefore, the cost of 72 spares is shared among the industry. Industry purchased the instruments on a rolling basis from 2014 to 2016. The table shows the total one-time cost that was incurred over the 2-year period.
5. Industry incurred a one-time cost to develop industry guidance (i.e., Nuclear Energy Institute (NEI) 12-02).
6. Sites required to install the instrumentation incurred a one-time cost to prepare and submit the first and second 6-month update to their integrated plans.
7. Sites required to install the instrumentation incurred an annual cost to prepare and submit the third through eighth 6-month updates to their integrated plans. These updates would require half the amount of effort required for the first and second update.
8. Sites required to install the instrumentation would incur an annual cost to test the instruments. Testing occurs on a biennial basis. The costs have been annualized to reflect this. The incremental cost to test the instruments does not vary by the number of instruments at a site.
9. The NRC incurred a one-time cost to inspect the installation of the SFP instrumentation at each operating site. The NRC would inspect the instruments on a rolling basis from 2014 to 2016. The table shows the total one-time cost that was incurred by the NRC over the 3-year period.
10. The NRC incurred one-time costs to review the first and second updates to integrated plans.
11. The NRC incurred annual costs to review the third through eighth 6-month updates to integrated plans. These updates would require half the amount of effort required to review the first and second update.
12. The NRC would inspect the instruments within the existing Reactor Oversight Program. Annual costs for inspecting the new equipment would be negligible relative to the costs incurred in the baseline. Therefore, the analysis does not include annual NRC inspection costs.
13. Level-of-effort estimates are based on the NRC's professional judgment.

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Equipment or Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
INDUSTRY IMPLEMENTATION (ONE-TIME)									
Purchase and install SFP instrumentation	Two instruments	$3,240,000	40	N/A	$3,240,000	$129,600,000	N/A		
	Three instruments	$4,320,000	1	N/A	$4,320,000	$4,320,000			
	Four instruments	$5,040,000	17	N/A	$5,040,000	$85,680,000			
	Six instruments	$6,480,000	2	N/A	$6,480,000	$12,960,000			
Purchase spare instruments	72 instruments	$180,000	N/A	72	N/A	$12,960,000	N/A		
Develop industry guidance (NEI 12-02)	Executive	$160/hour	N/A	400 hrs	$63,852	$63,852	N/A		
	Manager	$104/hour	N/A	1,200 hrs	$125,052	$125,052			
	Staff	$84/hour	N/A	0 hr	N/A	N/A			
	Clerical	$50/hour	N/A	0 hr	N/A	N/A			
	Licensing	$129/hour		400 hrs	$51,484	$51,484			
Prepare and submit first and second 6-month updates to integrated plan	Executive	$160/hour	60	16 hrs/site	$2,554	$153,245	N/A		
	Manager	$104/hour	60	16 hrs/site	$16,674	$1,000,416			
	Staff	$84/hour	60	80 hrs/site	$6,708	$402,480			
	Clerical	$50/hour	60	4 hrs/site	$200	$12,027			
	Licensing	$129/hour	60	40 hrs/site	$5,148	$308,904			
Total Industry Implementation Cost						$247,637,460			
INDUSTRY OPERATIONS (ANNUAL)									
Prepare and submit third through eighth	Executive	$160/hour	60	8 hrs/site	$1,277	$76,622	N/A		
	Manager	$104/hour	60	80 hrs/site	$8,337	$500,208			

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Equipment or Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
6-month updates to integrated plan	Staff	$84/hour	60	40 hrs/site	$3,354	$201,240			
	Clerical	$50/hour	60	20 hrs/site	$100	$6,014			
	Licensing	$129/hour	60	40 hrs/site	$2,574	$154,452			
Test SFP instrumentation (operating sites)	Executive	$160/hour	30	0 hr/site			N/A		
	Manager	$104/hour	30	2 hrs/site	$208	$6,253			
	Staff	$84/hour	30	16 hrs/site	$1,342	$40,248			
	Clerical	$50/hour	30	8 hrs/site	$401	$12,027			
	Licensing	$129/hour	30	0 hr/site					
Total Industry Operations Cost						$997,064			
NRC IMPLEMENTATION (ONE-TIME)									
Inspect SFP instrumentation	NRC staff	$124/hour	60	8 hrs/site	$992	$59,520	N/A		
Review industry guidance (NEI 12-02)	NRC staff	$124/hour	N/A	N/A	$34,720	$34,720	N/A		
Review first and second 6-month updates to integrated plan	NRC staff	$124/hour	60	40 hrs/site	$4,960	$297,600	N/A		
Total NRC Implementation Cost						$391,840			
NRC OPERATIONS (ANNUAL)									
Review the third through eighth 6-month updates to integrated plan	NRC staff	$124/hour	60	20 hrs/site	$2,480	$148,800	N/A		
Total NRC Operations Cost						$148,800			

C.3 Multiple Source Dose Assessment (Voluntary Initiatives)

Assumptions:

1. These industry implementation costs will be incurred before the effective date of the final rule. The analysis categorizes these costs as "historical." Appendix B discusses these historical costs.
2. Fifty-six operating sites (including six sites that are considered as decommissioning sites in other portions of this analysis: Clinton, FitzPatrick, Oyster Creek, Pilgrim, and Quad Cities) and four decommissioning sites with fuel remaining in the SFP (i.e., Crystal River, Kewaunee, and Vermont Yankee) implemented multiple source dose assessment capabilities. The remaining decommissioning site with fuel remaining in the SFP (i.e., San Onofre) would not implement multiple source dose assessment capabilities. Four sites had already implemented multiple source dose assessment capabilities voluntarily (i.e., Duane Arnold, Fermi, Fort Calhoun, and Seabrook). Therefore, the analysis does not estimate the incremental costs for these four sites.
3. Each of the 56 operating sites and four decommissioning sites with multiple SFPs incurred a one-time cost to review and revise procedures to reflect software updates.
4. Twenty-six operating sites and two decommissioning sites with multiple SFPs (i.e., Crystal River and Oyster Creek) used the RASCAL URI software, which was developed to interface with the NRC's RASCAL software. These sites incurred a one-time cost to customize the computer software for their site-specific needs. There is no cost for the receipt of the software code.
5. Thirty operating sites and two decommissioning sites with multiple SFPs (i.e., Kewaunee and Vermont Yankee) developed software independently. These sites incurred a one-time cost to update their existing software.
6. Each of the affected sites incurred a one-time cost to develop training materials for the ERO team.
7. Each of the affected sites incurred a one-time cost to deliver ERO training on how to conduct individual dose assessments for multiple release points.
8. Each of the affected sites would incur an annual cost to update its software.
9. Annual training and annual inventory checks and functionality training for the new rule requirement would replace existing training and annual inventory checks and functionality training occurring in the baseline. Hence, no incremental costs are estimated for annual training and annual inventory checks and functionality training.
10. The NRC incurred a one-time cost to develop computer software, as well as training and a user's guide.
11. The NRC would incur annual costs to update the computer software.
12. Combined license applicants would address the implementation of a multiple source dose assessment capability consistent with their licensing, construction, and startup schedules. Costs incurred by new reactor applicants are estimated separately.
13. Level-of-effort and contractor-cost estimates are based on the NRC's professional judgment.

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Equipment or Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
INDUSTRY IMPLEMENTATION (ONE-TIME)									
Review and revise procedures (operating sites)	Executive	$160/hour	56	8 hrs/site	$1,277	$71,514	N/A		
	Manager	$104/hour	56	16 hrs/site	$1,667	$93,372			
	Staff	$84/hour	56	24 hrs/site	$2,012	$112,694			
	Clerical	$50/hour	56	8 hrs/site	$401	$22,451			
	Licensing	$129/hour	56	8 hrs/site	$1,030	$57,662			
Review and revise procedures (decommissioning sites)	Executive	$160/hour	4	8 hrs/site	$1,277	$5,108	N/A		
	Manager	$104/hour	4	16 hrs/site	$1,667	$6,669			
	Staff	$84/hour	4	24 hrs/site	$2,012	$8,050			
	Clerical	$50/hour	4	8 hrs/site	$401	$1,604			
	Licensing	$129/hour	4	8 hrs/site	$1,030	$4,119			
Develop computer software	Contractor Costs	$150,000	32	N/A	$150,000	$4,800,000	N/A		
Customize computer software	Contractor Costs	$70,000	28	N/A	$70,000	$1,960,000	N/A		
Develop training materials for ERO team (operating sites)	Executive	$160/hour	56	16 hrs/site	$2,554	$143,028	N/A		
	Manager	$104/hour	56	40 hrs/site	$4,168	$233,430			
	Staff	$84/hour	56	80 hrs/site	$6,708	$375,648			
	Clerical	$50/hour	56	80 hrs/site	$4,009	$224,508			
	Licensing	$129/hour	56	8 hrs/site	$1,030	$57,662			
Develop training materials for ERO team (decommissioning sites)	Executive	$160/hour	4	16 hrs/site	$2,554	$10,216	N/A		
	Manager	$104/hour	4	40 hrs/site	$4,168	$16,674			
	Staff	$84/hour	4	80 hrs/site	$6,708	$26,832			
	Clerical	$50/hour	4	80 hrs/site	$4,009	$16,036			
	Licensing	$129/hour	4	8 hrs/site	$1,030	$4,119			
Deliver ERO training (operating sites)	Executive	$160/hour	56	8 hrs/site	$1,277	$5,108	N/A		
	Manager	$104/hour	56	8 hrs/site	$834	$3,335			
	Staff	$84/hour	56	40 hrs/site	$3,354	$13,416			

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Equipment or Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
	Clerical	$50/hour	56	8 hrs/site	$401	$1,604			
	Licensing	$129/hour	56		0				
Total Industry Implementation Cost						$8,603,334			
INDUSTRY OPERATIONS (ANNUAL)									
Update computer software (operating sites)	Executive	$160/hour	56	0 hr/site			N/A		
	Manager	$104/hour	56	8 hrs/site	$834	$3,335			
	Staff	$84/hour	56	80 hrs/site	$6,708	$375,648			
	Clerical	$50/hour	56	32 hrs/site	$1,604	$89,803			
	Licensing	$129/hour	56	0 hr/site					
Update computer software (decommissioning sites)	Executive	$160/hour	4	0 hr/site			N/A		
	Manager	$104/hour	4	8 hrs/site	$834	$3,335			
	Staff	$84/hour	4	80 hrs/site	$6,708	$26,832			
	Clerical	$50/hour	4	32 hrs/site	$1,604	$6,415			
	Licensing	$129/hour	4	0 hr/site					
Total Industry Operations Cost						$548,718			
NRC IMPLEMENTATION (ONE-TIME)									
Develop computer software, training, and user's guide	Contractor costs	$150,000		N/A	$150,000	$150,000	N/A		
Total NRC Implementation Cost						$150,000			
NRC OPERATIONS (ANNUAL)									
Update computer software	NRC staff	$124/hour		120 hrs	$14,880	$14,880	N/A		
Total NRC Operations Cost						$14,880			

Appendix D. Detailed Cost Buildup for the Historical Incremental Effort for the Decommissioning Plants

D.1 Exemption Analysis

§ 50.155(a) *Applicability.*

(3) When the NRC has docketed the certifications described in § 50.82(a)(1) or § 52.110(a) of this chapter, submitted by a licensee subject to the requirements of this section and section VII of appendix E to 10 CFR part 50, then that licensee shall comply with the requirements of § 50.155(b)–(e) associated with maintaining or restoring secondary containment capabilities, if applicable, and spent fuel pool cooling capabilities, but need not comply with § 50.155(c)(4) and section VII of appendix E to 10 CFR part 50, for the unit described in the § 50.82(a)(1) or § 52.110(a) certifications until the spent fuel pool(s) is empty of all irradiated fuel.

(i) Holders of operating licenses or combined licenses for which the NRC has the docketed the certifications described in § 50.82(a)(1) or § 52.110(a) of this chapter need not meet the requirements of this section except for paragraph (b)(2) once the decay heat of the fuel in the spent fuel pool can be removed solely by heating and boiling of water within the spent fuel pool and the boil-off period provides sufficient time for the licensee to obtain off-site resources to sustain the spent fuel pool cooling function indefinitely, as demonstrated by an analysis performed and retained by the licensee.

Assumptions:

1. All activities related to conducting and submitting the exemption analysis (i.e., an analysis demonstrating that (1) the decay heat of the fuel in the spent fuel pool is removed solely by heating and boiling of water within the spent fuel pool and (2) the boil-off period provides sufficient time for the licensee to obtain offsite resources) occur the second year following the end of a site's operating license.
2. Five sites assumed to be decommissioning (i.e., Crystal River, Kewaunee, San Onofre, Oyster Creek, and Vermont Yankee) would conduct and submit an exemption analysis before the proposed rule's effective date.
3. Fifty-eight boiling-water reactor (BWR) and pressurized-water reactor (PWR) sites plus two sites with new reactors would conduct and submit an analysis within 2 years of announcing decommissioning plans.
4. The U.S. Nuclear Regulatory Commission (NRC) would incur a one-time cost to review and approve the analyses.
5. Level-of-effort and contractor-cost estimates are based on the NRC's professional judgment.

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
INDUSTRY IMPLEMENTATION (ONE-TIME)									
Conduct and submit the exemption analysis (current decommissioning sites)	Contractor costs	$500,000	5	N/A	$500,000	$2,500,000	N/A		
Conduct and submit the exemption analysis (BWR & PWR decommissioning sites)	Contractor costs	$500,000	58	N/A	$500,000	$29,000,000	N/A		
Conduct and submit the exemption analysis (BWR & PWR decommissioning sites)	Contractor costs	$500,000	2	N/A	$500,000	$1,000,000	N/A		
			Total Industry Implementation Cost			$32,500,000			
INDUSTRY OPERATIONS (ANNUAL)									
None									
NRC IMPLEMENTATION (ONE-TIME)									
Review and approve the exemption analyses for current decommissioning sites	NRC staff	$124/hr	5	1,000 hrs	$124,000	$620,000	N/A		
Review and approve the exemption analyses for BWR and PWR decommissioning sites	NRC staff	$124/hr	58	1,000 hrs	$124,000	$7,192,000	N/A		
Review and approve the exemption analyses for AP1000 decommissioning sites	NRC staff	$124/hr	2	1,000 hrs	$124,000	$248,000	N/A		
			Total NRC Implementation Cost			$8,060,000			
NRC OPERATIONS (ANNUAL)									
None									

D.2 Spent Fuel Pool Instrumentation (Order EA-12-051)

As a result of Order EA-12-051, "Issuance of Order To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012, licensees would be required to install spent fuel pool (SFP) instrumentation to remotely monitor wide-range SFP levels to support effective prioritization of event mitigation and recovery actions.

Assumptions:

1. These industry implementation costs will be incurred before the effective date of the proposed rule (i.e., in response to Order EA-12-051). The analysis categorizes these costs as "historical." Appendix B discusses these historical costs.
2. On average, 58 operating sites have 24 years remaining on their operating licenses. Section 3.1 of the regulatory analyses discusses the derivation of this average. Each of the 58 operating sites would begin incurring costs as a decommissioning site in 2041.
3. On average, two new reactor sites have 61 years remaining on their operating licenses. Each of the two sites with new reactors (i.e., Summer and Vogtle) would begin incurring costs as a decommissioning site in 2078.
4. Costs would be incurred during the first 2 years of decommissioning.
5. Sites required to install the instrumentation would incur an annual cost to test the instruments. Testing occurs biennially. The costs have been annualized to reflect this. The incremental cost to test the instruments does not vary by the number of instruments at a site.
6. Level-of-effort estimates are based on the NRC's professional judgment.

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Equipment or Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
INDUSTRY IMPLEMENTATION (ONE-TIME)									
None									
INDUSTRY OPERATIONS (ANNUAL)									
Test SFP instrumentation (BWR & PWR decommissioning sites)	Executive	$160/hour	29	0 hr/site					
	Manager	$104/hour	29	2 hrs/site	$208	$6,044			
	Staff	$84/hour	29	16 hrs/site	$1,342	$38,906		N/A	
	Clerical	$50/hour	29	8 hrs/site	$401	$11,626			
	Licensing	$129/hour	29	0 hr/site					
	Executive	$160/hour	1	0 hr/site					
	Manager	$104/hour	1	2 hrs/site	$208	$208			
	Staff	$84/hour	1	16 hrs/site	$1,342	$1,342		N/A	
	Clerical	$50/hour	1	8 hrs/site	$401	$401			
	Licensing	$129/hour	1	0 hr/site					
Total Industry Operations Cost						$58,528			
NRC IMPLEMENTATION (ONE-TIME)									
None									
NRC OPERATIONS (ANNUAL)									
None									

D.3 Multiple Source Dose Assessment (Industry Initiatives)

Industry initiatives would result in licensees maintaining the capability to determine the magnitude of, and to continually assess the impact of, the release of radioactive materials, including from all reactor core and SFP sources, to the environment.

Assumptions:

1. These industry implementation costs will be incurred before the effective date of the proposed rule. The analysis categorizes these costs as "historical." Appendix B discusses these historical costs.
2. According to NRC data, there are 60 operating sites. Four sites have already implemented multiple source dose assessment capabilities voluntarily (i.e., Duane Arnold, Fermi, Fort Calhoun, and Seabrook). Therefore, the analysis does not estimate the incremental costs for these four sites.
3. Costs would be incurred for the first 2 years of decommissioning.
4. Each of the affected sites would incur an annual cost to update its software.
5. Annual training and annual inventory checks and functionality training for the new rule requirement would replace existing training and annual inventory checks and functionality training occurring in the baseline. Therefore, no incremental costs are estimated for annual training and annual inventory checks and functionality training.
6. COL applicants would address the implementation of a multiple source dose assessment capability consistent with their licensing, construction, and startup schedules. Costs incurred by new reactor applicants are estimated separately.
7. Level-of-effort estimates are based on the NRC's professional judgment.

Required Activity	Cost Inputs			Historical Incremental Effort Due to Fukushima Response			Incremental Effort Due to Final Rule		
	Equipment or Labor Category	Unit Cost	Sites Affected	Units	Cost per Affected Site	Total Cost	Units	Cost per Affected Site	Total Cost
INDUSTRY IMPLEMENTATION (ONE-TIME)									
None									
INDUSTRY OPERATIONS (ANNUAL)									
Update computer software (BWR & PWR decommissioning sites)	Executive	$160/hour	54	0 hr/site					
	Manager	$104/hour	54	8 hrs/site	$834	$45,019			
	Staff	$84/hour	54	80 hrs/site	$6,708	$362,232		N/A	
	Clerical	$50/hour	54	32 hrs/site	$1,604	$86,596			
	Licensing	$129/hour	54	0 hr/site					
Update computer software (AP1000 decommissioning sites)	Executive	$160/hour	2	0 hr/site					
	Manager	$104/hour	2	8 hrs/site	$834	$1,667			
	Staff	$84/hour	2	80 hrs/site	$6,708	$13,416		N/A	
	Clerical	$50/hour	2	32 hrs/site	$1,604	$3,207			
	Licensing	$129/hour	2	0 hr/site					
Total Industry Operations Cost						$512,137			
NRC IMPLEMENTATION (ONE-TIME)									
None									
NRC OPERATIONS (ANNUAL)									
None									

Appendix E. Order EA-12-049 Costs for a BWR 1-Unit Site

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS								
Initial Response								
Construct a seismic, missile-protected emergency water storage tank to provide a minimum coping time of 16 hours.								
Site Equipment	Emergency water storage tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	1 unit	14 sites	$158,000	$2,212,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	3,600 hours	14 sites	$186,336	$2,608,704
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	500 hours	14 sites	$41,310	$578,340
Build clean water tank with availability to supply reactor core isolation cooling (RCIC)/high-pressure coolant injection (HPCI) with water of acceptable quality for RCIC/HPCI injection into the reactor pressure vessel (RPV).								
Site Equipment	Clean water tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	1 unit	14 sites	$158,000	$2,212,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	3,600 hours	14 sites	$186,336	$2,608,704
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	500 hours	14 sites	$41,310	$578,340
Install quick-disconnect connection point downstream of the condensate storage tank isolation valve to allow for a gravity drain between the clean water tank and the RCIC/HPCI suction supply piping.								
Site Equipment	Quick-disconnect connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	1 unit	14 sites	$75,000	$1,050,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	40 hours	14 sites	$2,070	$28,986
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	14 sites	$16,524	$231,336
Install cross connect between the RCIC/HPCI suction supply lines.								
Site Equipment	Cross connect	$200,000 / unit	$200,000 / unit	$200,000 / unit	1 unit	14 sites	$200,000	$2,800,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	40 hours	14 sites	$2,070	$28,986
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	14 sites	$33,048	$462,672
Modify high-pressure core spray (HPCS) service water (SW) to install new cross-tie piping. Modify HPCS SW return line to add a manually-aligned cooling tower bypass line that discharges to the ultimate heat sink (UHS) basins. Modify residual heat removal (RHR) C injection piping to make the connection from the HPCS SW cross-tie piping.								
Site Equipment	Cross-tie piping	$167,000 / unit	$167,000 / unit	$167,000 / unit	1 unit	14 sites	$167,000	$2,338,000
Site Equipment	Connection line	$167,000 / unit	$167,000 / unit	$167,000 / unit	1 unit	14 sites	$167,000	$2,338,000
Site Equipment	Connection point	$167,000 / unit	$167,000 / unit	$167,000 / unit	1 unit	14 sites	$167,000	$2,338,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	14 sites	$10,352	$144,928
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	14 sites	$82,620	$1,156,680

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Onsite Portable Equipment								
Procure portable FLEX equipment (N+1).								
Site Equipment	Air compressor (300 HH Sullair Diesel air compressors)	$13,000 / unit	$13,000 / unit	$13,000 / unit	2 units	14 sites	$26,000	$364,000
Site Equipment	Low-pressure/medium-flow pump	$55,000 / unit	$55,000 / unit	$55,000 / unit	2 units	14 sites	$110,000	$1,540,000
Site Equipment	Electric fuel oil transfer pumps and associated equipment	$1,000 / unit	$1,000 / unit	$700 / unit	2 units	14 sites	$1,400	$19,600
Site Equipment	Deployment vehicles	$24,000 / unit	$35,000 / unit	$30,000 / unit	2 units	14 sites	$60,000	$840,000
Site Equipment	Flatbed trailers	$8,000 / unit	$18,000 / unit	$12,000 / unit	2 units	14 sites	$24,000	$336,000
Site Equipment	Hose and fittings	$2,000 / unit	$2,000 / unit	$2,000 / unit	2 units	14 sites	$4,000	$56,000
Site Equipment	Strainers	$10 / unit	$20 / unit	$10 / unit	2 units	14 sites	$20	$280
Site Equipment	Monitor nozzles for spent fuel pool (SFP) spray	$1,000 / unit	$1,000 / unit	$1,000 / unit	2 units	14 sites	$2,000	$28,000
Site Equipment	Portable diesel generator sets (SAMA diesel generators) (4, 400 kW)	$75,000 / unit	$125,000 / unit	$100,000 / unit	2 units	14 sites	$200,000	$2,800,000
Site Equipment	Portable diesel generator (480 Vac, 200 kW)	$50,000 / unit	$101,000 / unit	$77,000 / unit	2 units	14 sites	$154,000	$2,156,000
Site Equipment	Portable diesel generator (120 Vac, 15 kW)	$5,000 / unit	$10,000 / unit	$8,000 / unit	2 units	14 sites	$16,000	$224,000
Site Equipment	High-volume fans	$300 / unit	$1,000 / unit	$500 / unit	2 units	14 sites	$1,000	$14,000
Site Equipment	Duct (cooling/heating units)	$300 / unit	$300 / unit	$300 / unit	2 units	14 sites	$600	$8,400
Site Equipment	Radiation protection equipment: survey instruments	$1,000 / unit	$4,000 / unit	$2,000 / unit	20 units	14 sites	$40,000	$560,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	20 units	14 sites	$2,000	$28,000
Site Equipment	Debris removal equipment	$180,000 / unit	$425,000 / unit	$288,000 / unit	2 units	14 sites	$576,000	$8,064,000
Site Equipment	Nitrogen/air bottles	$100 / unit	$200 / unit	$100 / unit	8 units	14 sites	$800	$11,200
Site Equipment	Diesel tank cart	$3,000 / unit	$8,000 / unit	$6,000 / unit	2 units	14 sites	$12,000	$168,000
Site Equipment	Communications gear: docking station	$2,000 / unit	$2,000 / unit	$2,000 / unit	1 unit	14 sites	$2,000	$28,000
Site Equipment	Communications gear: mobile phones	$1,000 / unit	$1,000 / unit	$1,000 / unit	1 unit	14 sites	$1,000	$14,000
Site Equipment	Communications gear: emergency kits	$1,000 / unit	$3,000 / unit	$2,000 / unit	5 units	14 sites	$10,000	$140,000
Site Equipment	Communications gear: fixed-mast antennas	$200 / unit	$300 / unit	$200 / unit	2 units	14 sites	$400	$5,600
Site Equipment	Communications gear: antenna cable	$100 / unit	$1,000 / unit	$600 / unit	2 units	14 sites	$1,200	$16,800
Site Equipment	Communications gear: rechargeable batteries	$80 / unit	$100 / unit	$100 / unit	15 units	14 sites	$1,500	$21,000
Site Equipment	Communications gear: four-bay satellite phone battery chargers	$500 / unit	$600 / unit	$600 / unit	8 units	14 sites	$4,800	$67,200
Site Equipment	Communications gear: single-bay satellite phone battery	$200 / unit	$200 / unit	$200 / unit	8 units	14 sites	$1,600	$22,400
Site Equipment	Communications gear: direct current (dc) automobile outlet charger cords to charge single- and four-bay	$20 / unit	$20 / unit	$20 / unit	8 units	14 sites	$160	$2,240
Site Equipment	Communications gear: solar panel chargers	$200 / unit	$200 / unit	$200 / unit	4 units	14 sites	$800	$11,200
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	1 unit	14 sites	$5,000	$70,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	2 units	14 sites	$800	$11,200
Site Equipment	Motor starters	$400 / unit	$400 / unit	$400 / unit	2 units	14 sites	$800	$11,200
Site Equipment	Receptacles	$50 / unit	$50 / unit	$50 / unit	2 units	14 sites	$100	$1,400
Site Equipment	Power cables and conduits	$20 / unit	$20 / unit	$20 / unit	500 units	14 sites	$10,000	$140,000
Site Equipment	Portable lighting and batteries	$100 / unit	$100 / unit	$100 / unit	20 units	14 sites	$2,000	$28,000

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Install quick-disconnect connection point on auxiliary steam supply line inside the turbine building heater drain pump rooms and an auxiliary steam supply line to RCIC piping interconnection for injection into RPV by FLEX pump.								
Site Equipment	Quick-disconnect connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	1 unit	14 sites	$75,000	$1,050,000
Site Equipment	Auxiliary steam supply line	$1,000,000 / unit	$1,000,000 / unit	$1,000,000 / unit	1 unit	14 sites	$1,000,000	$14,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	14 sites	$10,352	$144,928
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	14 sites	$33,048	$462,672
Design and pre-stage modified flange adapter for connection of FLEX pump discharge hose to integrated leak rate test piping for RPV makeup through RHR B loop water injection.								
Site Equipment	Modified flange adapter	$10,000 / unit	$10,000 / unit	$10,000 / unit	1 unit	14 sites	$10,000	$140,000
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 units	14 sites	$16,524	$231,336
Modify HPCS SW to install connection points on the HPCS SW piping and new building penetrations at the Category I standby service water (SSW) pump house for the diesel-driven FLEX pump discharge hose connections. Modify SSW B pump discharge piping at the UHS basin so that large, diesel-driven regional response center (RRC) pumps can be connected to the SSW B system and provide cooling water to RHR B heat exchanger. Modify SSW B return piping to add a line to return hot suppression pool water to RRC-supplied heat removal equipment, including the capability of manual alignment to bypass the UHS cooling towers.								
Site Equipment	Discharge hose connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	14 sites	$150,000	$2,100,000
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	14 sites	$150,000	$2,100,000
Site Equipment	Piping line	$500,000 / unit	$500,000 / unit	$500,000 / unit	1 unit	14 sites	$500,000	$7,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	400 hours	14 sites	$20,704	$289,856
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	2,000 hours	14 sites	$165,240	$2,313,360
Add connection points and cabling at control building wall to connect to buses C and D (which power battery chargers and critical alternating current (ac) components) to work with FLEX diesel generators. Add connection points and transfer switches locally at battery chargers (welding receptacle type connection point) to allow connection of power cables from FLEX diesel generators.								
Site Equipment	Connection points	$750,000 / unit	$750,000 / unit	$750,000 / unit	4 units	14 sites	$3,000,000	$42,000,000
Site Equipment	Cabling	$2,000 / unit	$6,000 / unit	$4,000 / unit	4 units	14 sites	$16,000	$224,000
Site Equipment	Transfer switches	$4,000 / unit	$7,000 / unit	$6,000 / unit	2 units	14 sites	$12,000	$168,000
Site Labor	Labor (Electricians)			$52 / hour	200 hours	14 sites	$10,300	$144,200
Procure and install electrical cabling from near switchgear to connection point on exterior of control building. Procure electrical cabling to connect FLEX diesel generators to connection point on the exterior of the control building.								
Site Equipment	Electric cabling	$200 / unit	$600 / unit	$400 / unit	2 units	14 sites	$800	$11,200
Site Labor	Labor (Electricians)			$52 / hour	16 hours	14 sites	$824	$11,536
Modify or refurbish spare breaker on Class 1 E LC 15BA6/16BB6 to make connections from 480-V FLEX diesel generator.								
Site Labor	Labor (Electricians)			$52 / hour	40 hours	14 sites	$2,060	$28,840

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Install power cables from outside connection point to alternate decay heat removal (ADHR) power supply.								
Site Equipment	Power connection cables	$200 / unit	$200 / unit	$200 / unit	1 unit	14 sites	$200	$2,800
Site Labor	Labor (Electricians)			$52 / hour	20 hours	14 sites	$1,030	$14,420
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.								
Site Equipment	Welding type receptacles	$50 / unit	$100 / unit	$50 / unit	2 units	14 sites	$100	$1,400
Site Equipment	Termination box	$400 / unit	$2,000 / unit	$900 / unit	1 unit	14 sites	$900	$12,600
Site Equipment	Disconnects	$100 / unit	$100 / unit	$100 / unit	2 units	14 sites	$200	$2,800
Site Equipment	Cable	$200 / unit	$600 / unit	$400 / unit	2 units	14 sites	$800	$11,200
Site Labor	Labor			$30 / hour	40 hours	14 sites	$1,200	$16,800
Modify motor control center (MCC) 15B21 (power supply to Division I suppression pool makeup (SPMU) valves) by installing a connection point and new permanent cable or conduit to receive backup power from 480-V FLEX diesel generator (refurbish spare breaker if necessary).								
Site Equipment	Connection point	$750,000 / unit	$750,000 / unit	$750,000 / unit	1 unit	14 sites	$750,000	$10,500,000
Site Equipment	Cable/conduit	$200 / unit	$600 / unit	$400 / unit	1 unit	14 sites	$400	$5,600
Site Labor	Labor (Electricians)			$52 / hour	40 hours	14 sites	$2,060	$28,840
Provide cable and raceway (that is seismically supported) from 480-V FLEX diesel generator to battery chargers and battery room exhaust fan.								
Site Equipment	Cable	$100 / unit	$100 / unit	$100 / unit	1,000 units	14 sites	$100,000	$1,400,000
Site Equipment	Raceway	$20 / unit	$30 / unit	$20 / unit	1 unit	14 sites	$20	$280
Site Labor	Labor (Electricians)			$52 / hour	24 hours	14 sites	$1,236	$17,304
Modify or refurbish spare breaker to MCC 16B31 to provide sufficient capacity to power train B RHR support loads from 480-V FLEX diesel generator.								
Site Labor	Labor (Electricians)			$52 / hour	40 hours	14 sites	$2,060	$28,840
Modify connection of 4,160 Vac RRC FLEX diesel generator to the Class1E 16AB 4160 Vac.								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	1 unit	14 sites	$750,000	$10,500,000
Site Labor	Labor (Electricians)			$52 / hour	16 hours	14 sites	$824	$11,536
Modify the SFP line by installing two connections for two separate lines leading to the SFP area for an SFP FLEX hose connection and an SFP FLEX spray connection.								
Site Equipment	Connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	14 sites	$150,000	$2,100,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	100 hours	14 sites	$5,176	$72,464
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	14 sites	$16,524	$231,336
Install hard pipe with dual isolation valve from valve P41F185A to new SFP FLEX connection.								
Site Equipment	Hard pipe and dual isolation valve	$10,000 / unit	$10,000 / unit	$10,000 / unit	1 unit	14 sites	$10,000	$140,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	40 hours	14 sites	$2,070	$28,986
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	14 sites	$16,524	$231,336

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Offsite Portable Equipment								
Licensee's share of RRC costs.								
RRC Equipment	Licensee's share of RRC equipment costs			$874,000 / unit	1 unit	14 sites	$874,000	$12,236,000
RRC Setup	Licensee's share of RRC setup costs			$283,000 / unit	1 unit	14 sites	$283,000	$3,962,000
Procure offsite Phase 3 equipment.								
Site Equipment	Radiation protection equipment: Survey Instruments	$500 / unit	$4,000 / unit	$2,000 / unit	20 units	14 sites	$40,000	$560,000
Site Equipment	Radiation protection equipment: Dosimetry	$100 / unit	$100 / unit	$100 / unit	20 units	14 sites	$2,000	$28,000
Site Equipment	Commodities: Food	$5,000 / unit	$6,000 / unit	$5,000 / unit	1 unit	14 sites	$5,000	$70,000
Site Equipment	Commodities: Water	$400 / unit	$400 / unit	$400 / unit	2 units	14 sites	$800	$11,200
Install transfer panel (disconnect switch) in turbine building.								
Site Equipment	Transfer panel (disconnect switch)	$500 / unit	$500 / unit	$500 / unit	1 unit	14 sites	$500	$7,000
Site Labor	Labor (Electricians)			$52 / hour	60 hours	14 sites	$3,090	$43,260
Supporting Functions								
Change emergency control room lighting to light-emitting diode (LED) bulbs to reduce load on batteries and reduce heat load in the main control room.								
Site Equipment	LED bulbs	$100 / unit	$100 / unit	$100 / unit	12 units	14 units	$1,200	$16,800
Site Labor	Labor (Electricians)			$52 / hour	40 hours	14 sites	$2,060	$28,840
An analysis will be performed to determine site-specific fuel consumption rates and available supplies.								
Site Labor	Labor			$84 / hour	120 hours	14 sites	$10,062	$140,868
External Event Considerations								
To ensure that the portable equipment can be connected under flooding conditions, a plant modification is required to establish a flood staging area for portable equipment that preserves the capability to connect this equipment with the design-basis flood present.								
Contractor	Flood staging area	$604,000 / unit	$604,000 / unit	$604,000 / unit	1 unit	14 sites	$604,000	$8,456,000
Design or build onsite FLEX storage buildings given requirements covered above (protect from storms and high winds).								
Contractor	Storage building	$1,700,000 / unit	$3,000,000 / unit	$2,350,000 / unit	2 units	14 sites	$4,700,000	$65,800,000

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an extended loss of ac power/loss of normal access to the ultimate heat sink event such that no fuel damage occurs.								
Site Labor	Labor			$84 / hour	4,000 hours	14 sites	$335,400	$4,695,600
Develop strategies (playbook) with RRC.								
Site Labor	Labor			$84 / hour	320 hours	14 sites	$26,832	$375,648
Develop and conduct staffing analysis.								
Site Labor	Labor			$84 / hour	480 hours	14 sites	$40,248	$563,472
Issue FLEX support guidelines containing the procedures to control the FLEX equipment's physical protection, storage, deployment, and quality; to read instruments locally; and to re-power hydrogen igniters (in Procedure 05-S-01-STRTEFY, "Alternative Strategies"). Also incorporate enhanced battery load-shedding guidance into station procedures for loss of ac power to extend the availability of dc power.								
Site Labor	Labor			$84 / hour	4,000 hours	14 sites	$335,400	$4,695,600
Modify plant procedures to take into account FLEX support guidelines. Procedures to be considered include emergency operating procedure, extensive mitigation damage guideline, and severe accident management guideline strategies.								
Site Labor	Labor			$84 / hour	800 hours	14 sites	$67,080	$939,120
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.								
Site Labor	Labor			$84 / hour	400 hours	14 sites	$33,540	$469,560
Create maintenance and testing procedures.								
Site Labor	Labor			$84 / hour	1,000 hours	14 sites	$83,850	$1,173,900
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	14 sites	$250,000	$3,500,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation of beyond-design-basis external events.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	14 sites	$250,000	$3,500,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,000 hours	14 sites	$167,700	$2,347,800
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	14 sites	$6,708	$93,912
Involvement with industry group activities.								
Site Labor	Labor			$84 / hour	750 hours	14 sites	$62,888	$880,425
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,000 hours	14 sites	$83,850	$1,173,900

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COST								
Programmatic Controls								
6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	100 hours	14 sites	$8,385	$117,390
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	14 sites	$33,540	$469,560
Conduct training (implemented in accordance with the systematic approach to training (SAT)). The training modules for personnel who will be responsible for implementing the FLEX strategies and for ERO personnel will be implemented and maintained per existing training programs. The details, objectives, frequency, and success measures will follow the plant's SAT process.								
Site Labor	Labor			$84 / hour	1,000 hours	14 sites	$83,850	$1,173,900
Change control. Design requirements for FLEX equipment will be documented and controlled by the existing plant modification process.								
Site Labor	Labor			$84 / hour	160 hours	14 sites	$13,416	$187,824
Maintenance of the FLEX support guidelines.								
Site Labor	Labor			$84 / hour	240 hours	14 sites	$20,124	$281,736
Licensee's share of RRC ongoing costs (staffing, rent, testing, and maintenance).								
RRC Maintenance	Licensee's share of RRC ongoing costs			$129,000 / unit	1 unit	14 sites	$129,000	$1,806,000
Licensee's share of RRC transportation costs (first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (first 3 years)			$184,000 / unit	1 unit	14 sites	$184,000	$2,576,000
Licensee's share of RRC transportation costs (after first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (after first 3 years)			$15,000 / unit	1 unit	14 sites	$15,000	$210,000

Appendix F. Order EA-12-049 Costs for a BWR 2-Unit Site

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS								
Initial Response								
Construct a seismic, missile-protected emergency water storage tank to provide a minimum coping time of 16 hours.								
Site Equipment	Emergency water storage tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	2 units	9 sites	$316,000	$2,844,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	7,200 hours	9 sites	$372,672	$3,354,048
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	9 sites	$82,620	$743,580
Build clean water tank with availability to supply reactor core isolation cooling (RCIC)/high-pressure coolant injection (HPCI) with water of acceptable quality for RCIC/HPCI injection into the reactor pressure vessel (RPV).								
Site Equipment	Clean water tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	2 units	9 sites	$316,000	$2,844,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	7,200 hours	9 sites	$372,672	$3,354,048
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	9 sites	$82,620	$743,580
Install quick-disconnect connection point downstream of the condensate storage tank isolation valve to allow for a gravity drain between the clean water tank and the RCIC/HPCI suction supply piping.								
Site Equipment	Quick-disconnect connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	9 sites	$150,000	$1,350,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	9 sites	$4,141	$37,267
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	9 sites	$33,048	$297,432
Install cross connect between the RCIC/HPCI suction supply lines.								
Site Equipment	Cross connect	$200,000 / unit	$200,000 / unit	$200,000 / unit	2 units	9 sites	$400,000	$3,600,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	9 sites	$4,141	$37,267
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	9 sites	$66,096	$594,864
Modify high-pressure core spray (HPCS) service water (SW) to install new cross-tie piping. Modify HPCS SW return line to add a manually-aligned cooling tower bypass line that discharges to the ultimate heat sink (UHS) basins. Modify residual heat removal RHR C injection piping to make the connection from the HPCS SW cross-tie piping.								
Site Equipment	Cross-tie piping	$167,000 / unit	$167,000 / unit	$167,000 / unit	2 units	9 sites	$334,000	$3,006,000
Site Equipment	Connection line	$167,000 / unit	$167,000 / unit	$167,000 / unit	2 units	9 sites	$334,000	$3,006,000
Site Equipment	Connection point	$167,000 / unit	$167,000 / unit	$167,000 / unit	2 units	9 sites	$334,000	$3,006,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	400 hours	9 sites	$20,704	$186,336
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	2,000 hours	9 sites	$165,240	$1,487,160

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Onsite Portable Equipment								
Procure portable diverse and flexible coping strategies (FLEX) equipment (N+1).								
Site Equipment	Air compressor (300 HH Sullair Diesel air compressors)	$13,000 / unit	$13,000 / unit	$13,000 / unit	3 units	9 sites	$39,000	$351,000
Site Equipment	Low-pressure/Medium-flow pump	$55,000 / unit	$55,000 / unit	$55,000 / unit	3 units	9 sites	$165,000	$1,485,000
Site Equipment	Electric fuel oil transfer pumps and associated equipment	$1,000 / unit	$1,000 / unit	$700 / unit	3 units	9 sites	$2,100	$18,900
Site Equipment	Deployment vehicles	$24,000 / unit	$35,000 / unit	$30,000 / unit	3 units	9 sites	$90,000	$810,000
Site Equipment	Flatbed trailers	$8,000 / unit	$18,000 / unit	$12,000 / unit	3 units	9 sites	$36,000	$324,000
Site Equipment	Hose and fittings	$2,000 / unit	$2,000 / unit	$2,000 / unit	3 units	9 sites	$6,000	$54,000
Site Equipment	Strainers	$10 / unit	$20 / unit	$10 / unit	3 units	9 sites	$30	$270
Site Equipment	Monitor nozzles for spent fuel pool (SFP) spray	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	9 sites	$3,000	$27,000
Site Equipment	Portable diesel generator sets (SAMA diesel generators)	$75,000 / unit	$125,000 / unit	$100,000 / unit	3 units	9 sites	$300,000	$2,700,000
Site Equipment	Portable diesel generator (480 Vac, 200 kW)	$50,000 / unit	$101,000 / unit	$77,000 / unit	3 units	9 sites	$231,000	$2,079,000
Site Equipment	Portable diesel generator (120 Vac, 15 kW)	$5,000 / unit	$10,000 / unit	$8,000 / unit	3 units	9 sites	$24,000	$216,000
Site Equipment	High-volume fans	$300 / unit	$1,000 / unit	$500 / unit	3 units	9 sites	$1,500	$13,500
Site Equipment	Duct (cooling/heating units)	$300 / unit	$300 / unit	$300 / unit	3 units	9 sites	$900	$8,100
Site Equipment	Radiation protection equipment: survey instruments	$1,000 / unit	$4,000 / unit	$2,000 / unit	40 units	9 sites	$80,000	$720,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	40 units	9 sites	$4,000	$36,000
Site Equipment	Debris removal equipment	$180,000 / unit	$425,000 / unit	$288,000 / unit	3 units	9 sites	$864,000	$7,776,000
Site Equipment	Nitrogen/air bottles	$100 / unit	$200 / unit	$100 / unit	16 units	9 sites	$1,600	$14,400
Site Equipment	Diesel tank cart	$3,000 / unit	$8,000 / unit	$6,000 / unit	3 units	9 sites	$18,000	$162,000
Site Equipment	Communications gear: docking station	$2,000 / unit	$2,000 / unit	$2,000 / unit	2 units	9 sites	$4,000	$36,000
Site Equipment	Communications gear: mobile phones	$1,000 / unit	$1,000 / unit	$1,000 / unit	2 units	9 sites	$2,000	$18,000
Site Equipment	Communications gear: emergency kits	$1,000 / unit	$3,000 / unit	$2,000 / unit	10 units	9 sites	$20,000	$180,000
Site Equipment	Communications gear: fixed-mast antennas	$200 / unit	$300 / unit	$200 / unit	4 units	9 sites	$800	$7,200
Site Equipment	Communications gear: antenna cable	$100 / unit	$1,000 / unit	$600 / unit	4 units	9 sites	$2,400	$21,600
Site Equipment	Communications gear: rechargeable batteries	$80 / unit	$100 / unit	$100 / unit	30 units	9 sites	$3,000	$27,000
Site Equipment	Communications gear: four-bay satellite phone battery	$500 / unit	$600 / unit	$600 / unit	16 units	9 sites	$9,600	$86,400
Site Equipment	Communications gear: single-bay satellite phone battery	$200 / unit	$200 / unit	$200 / unit	16 units	9 sites	$3,200	$28,800
Site Equipment	Communications gear: direct current (dc) automobile outlet charger cords to charge single- and four-bay battery chargers	$20 / unit	$20 / unit	$20 / unit	16 units	9 sites	$320	$2,880
Site Equipment	Communications gear: solar panel chargers	$200 / unit	$200 / unit	$200 / unit	8 units	9 sites	$1,600	$14,400
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	2 units	9 sites	$10,000	$90,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	4 units	9 sites	$1,600	$14,400
Site Equipment	Motor starters	$400 / unit	$400 / unit	$400 / unit	4 units	9 sites	$1,600	$14,400
Site Equipment	Receptacles	$50 / unit	$50 / unit	$50 / unit	4 units	9 sites	$200	$1,800
Site Equipment	Power cables and conduits	$20 / unit	$20 / unit	$20 / unit	1,000 units	9 sites	$20,000	$180,000
Site Equipment	Portable lighting and batteries	$100 / unit	$100 / unit	$100 / unit	40 units	9 sites	$4,000	$36,000
Install quick-disconnect connection point on auxiliary steam supply line inside the turbine building heater drain pump rooms and an auxiliary steam supply line to RCIC piping interconnection for injection into RPV by FLEX pump.								
Site Equipment	Quick-disconnect connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	9 sites	$150,000	$1,350,000
Site Equipment	Auxiliary steam supply line	$1,000,000 / unit	$1,000,000 / unit	$1,000,000 / unit	2 units	9 sites	$2,000,000	$18,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	400 hours	9 sites	$20,704	$186,336
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	9 sites	$66,096	$594,864
Design and pre-stage modified flange adapter for connection of FLEX pump discharge hose to integrated leak rate test piping for RPV makeup through RHR B loop water injection.								
Site Equipment	Modified flange adapter	$10,000 / unit	$10,000 / unit	$10,000 / unit	2 units	9 sites	$20,000	$180,000
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	9 sites	$33,048	$297,432

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Modify HPCS SW to install connection points on the HPCS SW piping and new building penetrations at the Category I standby service water (SSW) pump house for the diesel-driven FLEX pump discharge hose connections. Modify SSW B pump discharge piping at the UHS basin so that large, diesel-driven regional response center (RRC) pumps can be connected to the SSW B system and provide cooling water to RHR B heat exchanger. Modify SSW B return piping to add a line to return hot suppression pool water to RRC-supplied heat removal equipment, including the capability of manual alignment to bypass the UHS cooling towers.								
Site Equipment	Discharge hose connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	9 sites	$300,000	$2,700,000
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	9 sites	$300,000	$2,700,000
Site Equipment	Piping line	$500,000 / unit	$500,000 / unit	$500,000 / unit	2 units	9 sites	$1,000,000	$9,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	800 hours	9 sites	$41,408	$372,672
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	4,000 hours	9 sites	$330,480	$2,974,320
Add connection points and cabling at control building wall to connect to buses C and D (which power battery chargers and critical alternating current (ac) components) to work with FLEX diesel generators. Add connection points and transfer switches locally at battery chargers (welding receptacle type connection point) to allow connection of power cables from FLEX diesel generators.								
Site Equipment	Connection points	$750,000 / unit	$750,000 / unit	$750,000 / unit	8 units	9 sites	$6,000,000	$54,000,000
Site Equipment	Cabling	$2,000 / unit	$6,000 / unit	$4,000 / unit	8 units	9 sites	$32,000	$288,000
Site Equipment	Transfer switches	$4,000 / unit	$7,000 / unit	$6,000 / unit	4 units	9 sites	$24,000	$216,000
Site Labor	Labor (Electricians)			$52 / hour	400 hours	9 sites	$20,600	$185,400
Procure and install electrical cabling from near switchgear to connection point on exterior of control building. Procure electrical cabling to connect FLEX diesel generators to connection point on exterior of control building.								
Site Equipment	Electric cabling	$200 / unit	$600 / unit	$400 / unit	4 units	9 sites	$1,600	$14,400
Site Labor	Labor (Electricians)			$52 / hour	32 hours	9 sites	$1,648	$14,832
Modify or refurbish spare breaker on Class 1 E LC 15BA6/16BB6 to make connections from 480-V FLEX diesel generator.								
Site Labor	Labor (Electricians)			$52 / hour	80 hours	9 sites	$4,120	$37,080
Install power cables from outside connection point to alternate decay heat removal (ADHR) power supply.								
Site Equipment	Power connection cables	$200 / unit	$200 / unit	$200 / unit	2 units	9 sites	$400	$3,600
Site Labor	Labor (Electricians)			$52 / hour	40 hours	9 sites	$2,060	$18,540
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.								
Site Equipment	Welding type receptacles	$50 / unit	$100 / unit	$50 / unit	4 units	9 sites	$200	$1,800
Site Equipment	Termination box	$400 / unit	$2,000 / unit	$900 / unit	2 units	9 sites	$1,800	$16,200
Site Equipment	Disconnects	$100 / unit	$100 / unit	$100 / unit	4 units	9 sites	$400	$3,600
Site Equipment	Cable	$200 / unit	$600 / unit	$400 / unit	4 units	9 sites	$1,600	$14,400
Site Labor	Labor			$30 / hour	80 hours	9 sites	$2,400	$21,600
Modify motor control center (MCC) 15B21 (power supply to Division I suppression pool makeup (SPMU) valves) by installing a connection point and new permanent cable or conduit to receive backup power from 480-V FLEX diesel generator (refurbish spare breaker if necessary).								
Site Equipment	Connection point	$750,000 / unit	$750,000 / unit	$750,000 / unit	2 units	9 sites	$1,500,000	$13,500,000
Site Equipment	Cable/conduit	$200 / unit	$600 / unit	$400 / unit	2 units	9 sites	$800	$7,200
Site Labor	Labor (Electricians)			$52 / hour	80 hours	9 sites	$4,120	$37,080
Provide cable and raceway (that is seismically supported) from 480-V FLEX diesel generator to battery chargers and battery room exhaust fan.								
Site Equipment	Cable	$100 / unit	$100 / unit	$100 / unit	2,000 units	9 sites	$200,000	$1,800,000
Site Equipment	Raceway	$20 / unit	$30 / unit	$20 / unit	2 units	9 sites	$40	$360
Site Labor	Labor (Electricians)			$52 / hour	48 hours	9 sites	$2,472	$22,248

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Modify or refurbish spare breaker to MCC 16B31 to provide sufficient capacity to power train B RHR support loads from 480-V FLEX diesel generator.								
Site Labor	Labor (Electricians)			$52 / hour	80 hours	9 sites	$4,120	$37,080
Modify connection of 4,160 Vac RRC FLEX diesel generator to the Class1E 16AB 4,160 Vac.								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	2 units	9 sites	$1,500,000	$13,500,000
Site Labor	Labor (Electricians)			$52 / hour	32 hours	9 sites	$1,648	$14,832
Modify the SFP line by installing two connections for two separate lines leading to the SFP area for an SFP FLEX hose connection and an SFP FLEX spray connection.								
Site Equipment	Connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	9 sites	$300,000	$2,700,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	9 sites	$10,352	$93,168
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	9 sites	$33,048	$297,432
Install hard pipe with dual isolation valve from valve P41F185A to new SFP FLEX connection.								
Site Equipment	Hard pipe and dual isolation valve	$10,000 / unit	$10,000 / unit	$10,000 / unit	2 units	9 sites	$20,000	$180,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	9 sites	$4,141	$37,267
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	9 sites	$33,048	$297,432
Offsite Portable Equipment								
Licensee's share of RRC costs.								
RRC Equipment	Licensee's share of RRC equipment costs			$874,000 / unit	1 unit	9 sites	$874,000	$7,866,000
RRC Setup	Licensee's share of RRC setup costs			$283,000	1 unit	9 sites	$283,000	$2,547,000
Procure offsite Phase 3 equipment.								
Site Equipment	Radiation protection equipment: survey instruments	$500 / unit	$4,000 / unit	$2,000 / unit	40 units	9 sites	$80,000	$720,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	40 units	9 sites	$4,000	$36,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	2 units	9 sites	$10,000	$90,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	4 units	9 sites	$1,600	$14,400
Install transfer panel (disconnect switch) in turbine building.								
Site Equipment	Transfer panel (disconnect switch)	$500 / unit	$500 / unit	$500 / unit	2 units	9 sites	$1,000	$9,000
Site Labor	Labor (Electricians)			$52 / hour	120 hours	9 sites	$6,180	$55,620
Supporting Functions								
Change emergency control room lighting to LED bulbs to reduce load on batteries and reduce heat load in main control room.								
Site Equipment	LED bulbs	$100 / unit	$100 / unit	$100 / unit	24 units	9 sites	$2,400	$21,600
Site Labor	Labor (Electricians)			$52 / hour	80 hours	9 sites	$4,120	$37,080
An analysis will be performed to determine site-specific fuel consumption rates and available supplies.								
Site Labor	Labor			$84 / hour	240 hours	9 sites	$20,124	$181,116

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
External Event Considerations								
To ensure that the portable equipment can be connected under flooding conditions, a plant modification is required to establish a flood staging area for portable equipment that preserves the capability to connect this equipment with the design-basis flood present.								
Contractor	Flood staging area	$604,000 / unit	$604,000 / unit	$604,000 / unit	2 units	9 sites	$1,208,000	$10,872,000
Design or build onsite FLEX storage buildings given requirements covered above (protect from storms and high winds).								
Contractor	Storage building	$1,700,000 / unit	$3,000,000 / unit	$2,350,000 / unit	3 units	9 sites	$7,050,000	$63,450,000
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an ELAP/LUHS event such that no fuel damage occurs.								
Site Labor	Labor			$84	5,000 hours	9 sites	$419,250	$3,773,250
Develop strategies (playbook) with RRC.								
Site Labor	Labor			$84	400 hours	9 sites	$33,540	$301,860
Develop and conduct staffing analysis.								
Site Labor	Labor			$84	480 hours	9 sites	$40,248	$362,232
Issue FLEX support guidelines containing the procedures to control the FLEX equipment's physical protection, storage, deployment, and quality; to read instruments locally; and to re-power hydrogen igniters (in Procedure 05-S-01-STRTEFY, "Alternative Strategies"). Also incorporate enhanced battery load-shedding guidance into station procedures for loss of ac power to extend the availability of dc power.								
Site Labor	Labor			$84 / hour	6,000 hours	9 sites	$503,100	$4,527,900
Modify plant procedures to take into account FLEX support guidelines. Procedures to be considered include EOP, EDMG, and SAMG strategies.								
Site Labor	Labor			$84 / hour	1,200 hours	9 sites	$100,620	$905,580
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.								
Site Labor	Labor			$84 / hour	400 hours	9 sites	$33,540	$301,860
Create maintenance and testing procedures.								
Site Labor	Labor			$84 / hour	1,200 hours	9 sites	$100,620	$905,580
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	9 sites	$250,000	$2,250,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation BDBEEs.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	9 sites	$300,000	$2,700,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,400 hours	9 sites	$201,240	$1,811,160
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	9 sites	$6,708	$60,372
Involvement with industry group activities.								
Site Labor	Labor			$84 / hour	788 hours	9 sites	$66,032	$594,287
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,250 hours	9 sites	$104,813	$943,313

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COST								
Programmatic Controls								
6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	150 hours	9 sites	$12,578	$113,198
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	9 sites	$33,540	$301,860
Conduct training (implemented in accordance with the systematic approach to training (SAT)). The training modules for personnel who will be responsible for implementing the FLEX strategies and for ERO personnel will be implemented and maintained per existing training programs. The details, objectives, frequency, and success measures will follow the plant's SAT process.								
Site Labor	Labor			$84 / hour	1,750 hours	9 sites	$146,738	$1,320,638
Change control. Design requirements for FLEX equipment will be documented and controlled by the existing plant modification process.								
Site Labor	Labor			$84 / hour	240 hours	9 sites	$20,124	$181,116
Maintenance of the FLEX support guidelines.								
Site Labor	Labor			$84 / hour	312 hours	9 sites	$26,161	$235,451
Licensee's share of RRC ongoing costs (staffing, rent, testing, and maintenance).								
RRC Maintenance	Licensee's share of RRC ongoing costs			$129,000 / unit	1 unit	9 sites	$129,000	$1,161,000
Licensee's share of RRC transportation costs (first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (first 3 years)			$184,000 / unit	1 unit	9 sites	$184,000	$1,656,000
Licensee's share of RRC transportation costs (after first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (after first 3 years)			$15,000 / unit	1 unit	9 sites	$15,000	$135,000

Appendix G. Order EA-12-049 Costs for a BWR 3-Unit Site

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS								
Initial Response								
Construct a seismic, missile-protected emergency water storage tank to provide a minimum coping time of 16 hours.								
Site Equipment	Emergency water storage tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	3 units	1 site	$474,000	$474,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	10,800 hours	1 site	$559,008	$559,008
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,500 hours	1 site	$123,930	$123,930
Build clean water tank with availability to supply reactor core isolation cooling (RCIC)/high-pressure coolant injection (HPCI) with water of acceptable quality for RCIC/HPCI injection into the reactor pressure vessel (RPV).								
Site Equipment	Clean water tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	3 units	1 site	$474,000	$474,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	10,800 hours	1 site	$559,008	$559,008
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,500 hours	1 site	$123,930	$123,930
Install quick-disconnect connection point downstream of the condensate storage tank isolation valve to allow for a gravity drain between the clean water tank and the RCIC/HPCI suction supply piping.								
Site Equipment	Quick-disconnect connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	3 units	1 site	$225,000	$225,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	120 hours	1 site	$6,211	$6,211
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	1 site	$49,572	$49,572
Install cross connect between the RCIC/HPCI suction supply lines.								
Site Equipment	Cross connect	$200,000 / unit	$200,000 / unit	$200,000 / unit	3 units	1 site	$600,000	$600,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	120 hours	1 site	$6,211	$6,211
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,200 hours	1 site	$99,144	$99,144
Modify high-pressure core spray (HPCS) service water (SW) to install new cross-tie piping. Modify HPCS SW return line to add a manually-aligned cooling tower bypass line that discharges to the ultimate heat sink (UHS) basins. Modify residual heat removal (RHR) C injection piping to make the connection from the HPCS SW cross-tie piping.								
Site Equipment	Cross-tie piping	$167,000 / unit	$167,000 / unit	$167,000 / unit	3 units	1 site	$501,000	$501,000
Site Equipment	Connection line	$167,000 / unit	$167,000 / unit	$167,000 / unit	3 units	1 site	$501,000	$501,000
Site Equipment	Connection point	$167,000 / unit	$167,000 / unit	$167,000 / unit	3 units	1 site	$501,000	$501,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	600 hours	1 site	$31,056	$31,056
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	3,000 hours	1 site	$247,860	$247,860

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Onsite Portable Equipment								
Procure portable diverse and flexible coping strategies (FLEX) equipment (N+1).								
Site Equipment	Air compressor (300 HH Sullair Diesel air compressors)	$13,000 / unit	$13,000 / unit	$13,000 / unit	4 units	1 site	$52,000	$52,000
Site Equipment	Low-pressure/Medium-flow pump	$55,000 / unit	$55,000 / unit	$55,000 / unit	4 units	1 site	$220,000	$220,000
Site Equipment	Electric fuel oil transfer pumps and associated equipment	$1,000 / unit	$1,000 / unit	$700 / unit	4 units	1 site	$2,800	$2,800
Site Equipment	Deployment vehicles	$24,000 / unit	$35,000 / unit	$30,000 / unit	4 units	1 site	$120,000	$120,000
Site Equipment	Flatbed trailers	$8,000 / unit	$18,000 / unit	$12,000 / unit	4 units	1 site	$48,000	$48,000
Site Equipment	Hose and fittings	$2,000 / unit	$2,000 / unit	$2,000 / unit	4 units	1 site	$8,000	$8,000
Site Equipment	Strainers	$10 / unit	$20 / unit	$10 / unit	4 units	1 site	$40	$40
Site Equipment	Monitor nozzles for spent fuel pool (SFP) spray	$1,000 / unit	$1,000 / unit	$1,000 / unit	4 units	1 site	$4,000	$4,000
Site Equipment	Portable diesel generator sets (SAMA diesel generators)	$75,000 / unit	$125,000 / unit	$100,000 / unit	4 units	1 site	$400,000	$400,000
Site Equipment	Portable diesel generator (480 Vac, 200 kW)	$50,000 / unit	$101,000 / unit	$77,000 / unit	4 units	1 site	$308,000	$308,000
Site Equipment	Portable diesel generator (120 Vac, 15 kW)	$5,000 / unit	$10,000 / unit	$8,000 / unit	4 units	1 site	$32,000	$32,000
Site Equipment	High-volume fans	$300 / unit	$1,000 / unit	$500 / unit	4 units	1 site	$2,000	$2,000
Site Equipment	Duct (cooling/heating units)	$300 / unit	$300 / unit	$300 / unit	4 units	1 site	$1,200	$1,200
Site Equipment	Radiation protection equipment: survey instruments	$1,000 / unit	$4,000 / unit	$2,000 / unit	60 units	1 site	$120,000	$120,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	60 units	1 site	$6,000	$6,000
Site Equipment	Debris removal equipment	$180,000 / unit	$425,000 / unit	$288,000 / unit	4 units	1 site	$1,152,000	$1,152,000
Site Equipment	Nitrogen/air bottles	$100 / unit	$200 / unit	$100 / unit	24 units	1 site	$2,400	$2,400
Site Equipment	Diesel tank cart	$3,000 / unit	$8,000 / unit	$6,000 / unit	4 units	1 site	$24,000	$24,000
Site Equipment	Communications gear: docking station	$2,000 / unit	$2,000 / unit	$2,000 / unit	3 units	1 site	$6,000	$6,000
Site Equipment	Communications gear: mobile phones	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	1 site	$3,000	$3,000
Site Equipment	Communications gear: emergency kits	$1,000 / unit	$3,000 / unit	$2,000 / unit	15 units	1 site	$30,000	$30,000
Site Equipment	Communications gear: fixed-mast antennas	$200 / unit	$300 / unit	$200 / unit	6 units	1 site	$1,200	$1,200
Site Equipment	Communications gear: antenna cable	$100 / unit	$1,000 / unit	$600 / unit	6 units	1 site	$3,600	$3,600
Site Equipment	Communications gear: rechargeable batteries	$80 / unit	$100 / unit	$100 / unit	45 units	1 site	$4,500	$4,500
Site Equipment	Communications gear: four-bay satellite phone battery	$500 / unit	$600 / unit	$600 / unit	24 units	1 site	$14,400	$14,400
Site Equipment	Communications gear: single-bay satellite phone battery	$200 / unit	$200 / unit	$200 / unit	24 units	1 site	$4,800	$4,800
Site Equipment	Communications gear: direct current (dc) automobile outlet charger	$20 / unit	$20 / unit	$20 / unit	24 units	1 site	$480	$480
Site Equipment	Communications gear: solar panel chargers	$200 / unit	$200 / unit	$200 / unit	12 units	1 site	$2,400	$2,400
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	3 units	1 site	$15,000	$15,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	6 units	1 site	$2,400	$2,400
Site Equipment	Motor starters	$400 / unit	$400 / unit	$400 / unit	6 units	1 site	$2,400	$2,400
Site Equipment	Receptacles	$50 / unit	$50 / unit	$50 / unit	6 units	1 site	$300	$300
Site Equipment	Power cables and conduits	$20 / unit	$20 / unit	$20 / unit	1,500 units	1 site	$30,000	$30,000
Site Equipment	Portable lighting and batteries	$100 / unit	$100 / unit	$100 / unit	60 units	1 site	$6,000	$6,000
Install quick-disconnect connection point on auxiliary steam supply line inside the turbine building heater drain pump rooms and an auxiliary steam supply line to RCIC piping interconnection for injection into RPV by FLEX pump.								
Site Equipment	Quick-disconnect connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	3 units	1 site	$225,000	$225,000
Site Equipment	Auxiliary steam supply line	$1,000,000 / unit	$1,000,000 / unit	$1,000,000 / unit	3 units	1 site	$3,000,000	$3,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	400 hours	1 site	$20,704	$20,704
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	1 site	$66,096	$66,096
Design and pre-stage modified flange adapter for connection of FLEX pump discharge hose to integrated leak rate test piping for RPV makeup through RHR B loop water injection.								
Site Equipment	Modified flange adapter	$10,000 / unit	$10,000 / unit	$10,000 / unit	3 units	1 site	$30,000	$30,000
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	1 site	$49,572	$49,572

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Modify HPCS SW to install connection points on the HPCS SW piping and new building penetrations at the Category I standby service water (SSW) pump house for the diesel-driven FLEX pump discharge hose connections. Modify SSW B pump discharge piping at the UHS basin so that large, diesel-driven regional response center (RRC) pumps can be connected to the SSW B system and provide cooling water to RHR B heat exchanger. Modify SSW B return piping to add a line to return hot suppression pool water to RRC-supplied heat removal equipment, including the capability of manual alignment to bypass the UHS cooling towers.								
Site Equipment	Discharge hose connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	1 site	$450,000	$450,000
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	1 site	$450,000	$450,000
Site Equipment	Piping line	$500,000 / unit	$500,000 / unit	$500,000 / unit	3 units	1 site	$1,500,000	$1,500,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	1,200 hours	1 site	$62,112	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	6,000 hours	1 site	$495,720	$495,720
Add connection points and cabling at control building wall to connect to buses C and D (which power battery chargers and critical alternating current (ac) components) to work with FLEX diesel generators. Add connection points and transfer switches locally at battery chargers (welding receptacle type connection point) to allow connection of power cables from FLEX diesel generators.								
Site Equipment	Connection points	$750,000 / unit	$750,000 / unit	$750,000 / unit	12 units	1 site	$9,000,000	$9,000,000
Site Equipment	Cabling	$2,000 / unit	$6,000 / unit	$4,000 / unit	12 units	1 site	$48,000	$48,000
Site Equipment	Transfer switches	$4,000 / unit	$7,000 / unit	$6,000 / unit	6 units	1 site	$36,000	$36,000
Site Labor	Labor (Electricians)			$52 / hour	600 hours	1 site	$30,900	$30,900
Procure and install electrical cabling from near switchgear to connection point on exterior of control building. Procure electrical cabling to connect FLEX diesel generators to connection point on exterior of control building.								
Site Equipment	Electric cabling	$200 / unit	$600 / unit	$400 / unit	6 units	1 site	$2,400	$2,400
Site Labor	Labor (Electricians)			$52 / hour	48 hours	1 site	$2,472	$2,472
Modify or refurbish spare breaker on Class 1 E LC 15BA6/16BB6 to make connections from 480-V FLEX diesel generator.								
Site Labor	Labor (Electricians)			$52 / hour	120 hours	1 site	$6,180	$6,180
Install power cables from outside connection point to alternate decay heat removal (ADHR) power supply.								
Site Equipment	Power connection cables	$200 / unit	$200 / unit	$200 / unit	3 units	1 site	$600	$600
Site Labor	Labor (Electricians)			$52 / hour	60 hours	1 site	$3,090	$3,090
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.								
Site Equipment	Welding type receptacles	$50 / unit	$100 / unit	$50 / unit	6 units	1 site	$300	$300
Site Equipment	Termination box	$400 / unit	$2,000 / unit	$900 / unit	3 units	1 site	$2,700	$2,700
Site Equipment	Disconnects	$100 / unit	$100 / unit	$100 / unit	6 units	1 site	$600	$600
Site Equipment	Cable	$200 / unit	$600 / unit	$400 / unit	6 units	1 site	$2,400	$2,400
Site Labor	Labor			$30 / hour	120 hours	1 site	$3,600	$3,600
Modify motor control center (MCC) 15B21 (power supply to Division I suppression pool makeup (SPMU) valves) by installing a connection point and new permanent cable or conduit to receive backup power from 480-V FLEX diesel generator (refurbish spare breaker if necessary).								
Site Equipment	Connection point	$750,000 / unit	$750,000 / unit	$750,000 / unit	3 units	1 site	$2,250,000	$2,250,000
Site Equipment	Cable/conduit	$200 / unit	$600 / unit	$400 / unit	3 units	1 site	$1,200	$1,200
Site Labor	Labor (Electricians)			$52 / hour	120 hours	1 site	$6,180	$6,180

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Provide cable and raceway (that is seismically supported) from 480-V FLEX diesel generator to battery chargers and battery room exhaust fan.								
Site Equipment	Cable	$100 / unit	$100 / unit	$100 / unit	3,000 units	1 site	$300,000	$300,000
Site Equipment	Raceway	$20 / unit	$30 / unit	$20 / unit	3 units	1 site	$60	$60
Site Labor	Labor (Electricians)			$52 / hour	72 hours	1 site	$3,708	$3,708
Modify or refurbish spare breaker to MCC 16B31 to provide sufficient capacity to power train B RHR support loads from 480-V FLEX diesel generator.								
Site Labor	Labor (Electricians)			$52 / hour	120 hours	1 site	$6,180	$6,180
Modify connection of 4,160 Vac RRC FLEX diesel generator to the Class1E 16AB 4,160 Vac.								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	3 units	1 site	$2,250,000	$2,250,000
Site Labor	Labor (Electricians)			$52 / hour	48 hours	1 site	$2,472	$2,472
Modify the SFP line by installing two connections for two separate lines leading to the SFP area for an SFP FLEX hose connection and an SFP FLEX spray connection.								
Site Equipment	Connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	1 site	$450,000	$450,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	300 hours	1 site	$15,528	$15,528
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	1 site	$49,572	$49,572
Install hard pipe with dual isolation valve from valve P41F185A to new SFP FLEX connection.								
Site Equipment	Hard pipe and dual isolation valve	$10,000 / unit	$10,000 / unit	$10,000 / unit	2 units	1 site	$20,000	$20,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	120 hours	1 site	$6,211	$6,211
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	1 site	$49,572	$49,572
Offsite Portable Equipment								
Licensee's share of RRC costs.								
RRC Equipment	Licensee's share of RRC equipment costs			$874,000 / unit	1 unit	1 site	$874,000	$874,000
RRC Setup	Licensee's share of RRC setup costs			$283,000 / unit	1 unit	1 site	$283,000	$283,000
Procure offsite Phase 3 equipment.								
Site Equipment	Radiation protection equipment: survey instruments	$500 / unit	$4,000 / unit	$2,000 / unit	60 units	1 site	$120,000	$120,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	60 units	1 site	$6,000	$6,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	3 units	1 site	$15,000	$15,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	6 units	1 site	$2,400	$2,400
Install transfer panel (disconnect switch) in turbine building.								
Site Equipment	Transfer panel (disconnect switch)	$500 / unit	$500 / unit	$500 / unit	3 units	1 site	$1,500	$1,500
Site Labor	Labor (Electricians)			$52 / hour	180 hours	1 site	$9,270	$9,270
Supporting Functions								
Change emergency control room lighting to LED bulbs to reduce load on batteries and reduce heat load in main control room.								
Site Equipment	LED bulbs	$100 / unit	$100 / unit	$100 / unit	36 units	1 site	$3,600	$3,600
Site Labor	Labor (Electricians)			$52 / hour	120 hours	1 site	$6,180	$6,180
An analysis will be performed to determine site-specific fuel consumption rates and available supplies.								
Site Labor	Labor			$84 / hour	360 hours	1 site	$30,186	$30,186

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
External Event Considerations								
To ensure that the portable equipment can be connected under flooding conditions, a plant modification is required to establish a flood staging area for portable equipment that preserves the capability to connect this equipment with the design-basis flood present.								
Contractor	Flood staging area	$604,000 / unit	$604,000 / unit	$604,000 / unit	3 units	1 site	$1,812,000	$1,812,000
Design or build onsite FLEX storage buildings given requirements covered above (protect from storms and high winds).								
Contractor	Storage building	$1,700,000 / unit	$3,000,000 / unit	$2,350,000 / unit	4 units	1 site	$9,400,000	$9,400,000
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an extended loss of ac power/loss of normal access to the ultimate heat sink event such that no fuel damage occurs.								
Site Labor	Labor			$84 / hour	6,000 hours	1 site	$503,100	$503,100
Develop strategies (playbook) with RRC.								
Site Labor	Labor			$84 / hour	480 hours	1 site	$40,248	$40,248
Develop and conduct staffing analysis.								
Site Labor	Labor			$84 / hour	480 hours	1 site	$40,248	$40,248
Issue FLEX support guidelines containing the procedures to control the FLEX equipment's physical protection, storage, deployment, and quality; to read instruments locally; and to re-power hydrogen igniters (in Procedure 05-S-01-STRTEFY, "Alternative Strategies"). Also incorporate enhanced battery load-shedding guidance into station procedures for loss of ac power to extend the availability of dc power.								
Site Labor	Labor			$84 / hour	8,000 hours	1 site	$670,800	$670,800
Modify plant procedures to take into account FLEX support guidelines.								
Site Labor	Labor			$84 / hour	1,600 hours	1 site	$134,160	$134,160
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.								
Site Labor	Labor			$84 / hour	400 hours	1 site	$33,540	$33,540
Create maintenance and testing procedures.								
Site Labor	Labor			$84 / hour	1,400 hours	1 site	$117,390	$117,390
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	1 site	$250,000	$250,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation of beyond-design-basis external events.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	1 site	$350,000	$350,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,800 hours	1 site	$234,780	$234,780
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	1 site	$6,708	$6,708
Involvement with industry group activities.								
Site Labor	Labor			$84 / hour	825 hours	1 site	$69,176	$69,176
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,500 hours	1 site	$125,775	$125,775

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	NUMBER OF AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COST								
Programmatic Controls								
6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	200 hours	1 site	$16,770	$16,770
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	1 site	$33,540	$33,540
Conduct training (implemented in accordance with the systematic approach to training (SAT)). The training modules for personnel who will be responsible for implementing the FLEX strategies and for ERO personnel will be implemented and maintained per existing training programs. The details, objectives, frequency, and success measures will follow the plant's SAT process.								
Site Labor	Labor			$84 / hour	2,500 hours	1 site	$209,625	$209,625
Change control. Design requirements for FLEX equipment will be documented and controlled by the existing plant modification process.								
Site Labor	Labor			$84 / hour	320 hours	1 site	$26,832	$26,832
Maintenance of the FLEX support guidelines								
Site Labor	Labor			$84 / hour	256 hours	1 site	$21,466	$21,466
Licensee's share of RRC ongoing costs (staffing, rent, testing, and maintenance).								
RRC Maintenance	Licensee's share of RRC ongoing costs			$129,000 / unit	1 unit	1 site	$129,000	$129,000
Licensee's share of RRC transportation costs (first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (first 3 years)			$184,000 / unit	1 unit	1 site	$184,000	$184,000
Licensee's share of RRC transportation costs (after first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (after first 3 years)			$15,000 / unit	1 unit	1 site	$15,000	$15,000

Appendix H. Order EA-12-049 Costs for a PWR 1-Unit Site

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS								
Initial Response								
Harden and protect the dedicated shutdown diesel generator to provide power to the motor control center.								
Site Equipment	Building material or prefabricated structures	$20,000 / unit	$20,000 / unit	$20,000 / unit	1 unit	12 sites	$20,000	$240,000
Site Labor	Labor			$84 / hour	400 hours	12 sites	$33,540	$402,480
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	12 sites	$33,048	$396,576
Install a robust, shielded connection on each residual makeup water storage tank (RMWST) that extends through the RMWST shield building providing two diverse connections for transferring the RMWST inventory to the condensate storage tank (CST).								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	2 units	12 sites	$1,500,000	$18,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	100 hours	12 sites	$5,176	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	500 hours	12 sites	$41,310	$495,720
Upgrade nonseismic condensate transfer pump suction nozzle to seismic qualification to increase CST inventory availability time to 40 hours.								
Site Equipment	Seismic condensate transfer pump suction nozzle	$2,000 / unit	$2,000 / unit	$2,000 / unit	1 unit	12 sites	$2,000	$24,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	100 hours	12 sites	$5,176	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	12 sites	$16,524	$198,288
Construct a seismic, missile-protected emergency water storage tank.								
Site Equipment	Emergency water storage tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	1 unit	12 sites	$158,000	$1,896,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	3,600 hours	12 sites	$186,336	$2,236,032
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	500 hours	12 sites	$41,310	$495,720
Construct a seismic, missile-protected tank to provide a protected water source for core cooling and heat removal strategies. A diesel-powered feedwater pump will supply the water to the auxiliary feedwater system piping. Flow distribution instrumentation will be required during the extended loss of alternating current (ac) power (ELAP).								
Site Equipment	Tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	1 unit	12 sites	$158,000	$1,896,000
Site Equipment	Diesel-powered feedwater pump	$50,000 / unit	$50,000 / unit	$50,000 / unit	1 unit	12 sites	$50,000	$600,000
Site Equipment	Flow distribution instrumentation	$30,000 / unit	$30,000 / unit	$30,000 / unit	1 unit	12 sites	$30,000	$360,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	2,000 hours	12 sites	$103,520	$1,242,240
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	12 sites	$82,620	$991,440
Install clean water receiver tank (high wind/missile protected and contains borated water).								
Site Equipment	Borated water storage tank or clean water receiver tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	1 unit	12 sites	$158,000	$1,896,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	3,600 hours	12 sites	$186,336	$2,236,032
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	500 hours	12 sites	$41,310	$495,720
Modify power controls for steam generator (SG) power-operated relief valves (PORVs) from a direct current (dc)-powered instrument bus to allow for continued operation from the main control room.								
Site Labor	Labor (Control and Valve Installers and Repairers, Except Mechanical Door)			$52 / hour	120 hours	12 sites	$6,228	$74,736
Install permanent nitrogen bottle racks near each SG PORV operating station with hose and regulators to align for control to remain available in the control room.								
Site Equipment	Nitrogen bottle racks	$5,000 / unit	$5,000 / unit	$5,000 / unit	2 units	12 sites	$10,000	$120,000
Site Labor	Labor			$84 / hour	16 hours	12 sites	$1,342	$16,099
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	12 sites	$16,524	$198,288
Install Westinghouse low-leakage reactor coolant pump (RCP) seals.								
Site Equipment	Low-leakage RCP seals.	$58,000 / unit	$58,000 / unit	$58,000 / unit	4 units	12 sites	$232,000	$2,784,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	12 sites	$4,141	$49,690
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	12 sites	$33,048	$396,576

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
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.								
Site Equipment	Seismic piping and a connection to the charging header	$10,000 / unit	$10,000 / unit	$10,000 / unit	1 unit	12 sites	$10,000	$120,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	12 sites	$4,141	$49,690
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	12 sites	$16,524	$198,288
Onsite Portable Equipment								
Procure portable diverse and flexible coping strategies (FLEX) equipment (N+1).								
Site Equipment	Vehicles	$24,000 / unit	$35,000 / unit	$30,000 / unit	1 unit	12 sites	$30,000	$360,000
Site Equipment	480 Vac diesel generators (480 kW)	$75,000 / unit	$125,000 / unit	$100,000 / unit	2 units	12 sites	$200,000	$2,400,000
Site Equipment	480 Vac diesel generators (200 kW)	$50,000 / unit	$101,000 / unit	$77,000 / unit	2 units	12 sites	$154,000	$1,848,000
Site Equipment	120 Vac diesel generators (15 kW)	$5,000 / unit	$10,000 / unit	$8,000 / unit	2 units	12 sites	$16,000	$192,000
Site Equipment	Self-powered CST FLEX pumps	$6,000 / unit	$6,000 / unit	$6,000 / unit	2 units	12 sites	$12,000	$144,000
Site Equipment	Self-powered SG FLEX pumps	$6,000 / unit	$6,000 / unit	$6,000 / unit	2 units	12 sites	$12,000	$144,000
Site Equipment	Self-powered spent fuel pool (SFP) FLEX pumps (200% capacity)	$6,000 / unit	$6,000 / unit	$6,000 / unit	2 units	12 sites	$12,000	$144,000
Site Equipment	Electric motor-driven Mode 1-4 reactor coolant system RCS FLEX pumps	$3,000 / unit	$3,000 / unit	$3,000 / unit	2 units	12 sites	$6,000	$72,000
Site Equipment	Electric motor-driven Mode 5-6 RCS FLEX pumps	$1,000 / unit	$1,000 / unit	$1,000 / unit	2 units	12 sites	$2,000	$24,000
Site Equipment	Electric motor-driven diesel fuel FLEX pumps	$500 / unit	$1,000 / unit	$700 / unit	2 units	12 sites	$1,400	$16,800
Site Equipment	Flatbed trailers	$8,000 / unit	$18,000 / unit	$12,000 / unit	2 units	12 sites	$24,000	$288,000
Site Equipment	Trailers with fuel tank	$3,000 / unit	$8,000 / unit	$6,000 / unit	2 units	12 sites	$12,000	$144,000
Site Equipment	Portable fuel containers	$20 / unit	$60 / unit	$40 / unit	2 units	12 sites	$80	$960
Site Equipment	Monitor spray nozzles for SFP spray	$1,000 / unit	$1,000 / unit	$1,000 / unit	2 units	12 sites	$2,000	$24,000
Site Equipment	Hose and fittings	$2,000 / unit	$2,000 / unit	$2,000 / unit	2 units	12 sites	$4,000	$48,000
Site Equipment	Strainers	$10 / unit	$20 / unit	$10 / unit	2 units	12 sites	$20	$240
Site Equipment	Communications gear: docking station	$2,000 / unit	$2,000 / unit	$2,000 / unit	1 unit	12 sites	$2,000	$24,000
Site Equipment	Communications gear: mobile phones	$1,000 / unit	$1,000 / unit	$1,000 / unit	1 unit	12 sites	$1,000	$12,000
Site Equipment	Communications gear: emergency kits	$1,000 / unit	$3,000 / unit	$2,000 / unit	5 units	12 sites	$10,000	$120,000
Site Equipment	Communications gear: fixed-mast antennas	$200 / unit	$300 / unit	$200 / unit	2 units	12 sites	$400	$4,800
Site Equipment	Communications gear: antenna cable	$100 / unit	$1,000 / unit	$600 / unit	2 units	12 sites	$1,200	$14,400
Site Equipment	Communications gear: rechargeable batteries	$80 / unit	$100 / unit	$100 / unit	15 units	12 sites	$1,500	$18,000
Site Equipment	Communications gear: four-bay satellite phone battery chargers	$500 / unit	$600 / unit	$600 / unit	8 units	12 sites	$4,800	$57,600
Site Equipment	Communications gear: single-bay satellite phone battery chargers	$200 / unit	$200 / unit	$200 / unit	8 units	12 sites	$1,600	$19,200
Site Equipment	Communications gear: dc automobile outlet charger cords to charge single- and four-bay battery chargers	$20 / unit	$20 / unit	$20 / unit	8 units	12 sites	$160	$1,920
Site Equipment	Communications gear: solar panel chargers	$200 / unit	$200 / unit	$200 / unit	4 units	12 sites	$800	$9,600
Site Equipment	Portable ventilation fans	$2,000 / unit	$2,000 / unit	$2,000 / unit	4 units	12 sites	$8,000	$96,000
Site Equipment	Portable air compressors	$13,000 / unit	$13,000 / unit	$13,000 / unit	1 unit	12 sites	$13,000	$156,000
Site Equipment	Fuel transfer hoses	$3,000 / unit	$4,000 / unit	$3,000 / unit	2 units	12 sites	$6,000	$72,000
Site Equipment	Radiation protection equipment: survey equipment	$500 / unit	$4,000 / unit	$2,000 / unit	20 units	12 sites	$40,000	$480,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	20 units	12 sites	$2,000	$24,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	1 unit	12 sites	$5,000	$60,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	2 units	12 sites	$800	$9,600
Install diverse suction connections and fill connections on each CST. Install seismically-rugged new pipes and equipment used to provide core cooling and heat removal to the SG.								
Site Equipment	Suction connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	12 sites	$300,000	$3,600,000
Site Equipment	Fill connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	12 sites	$300,000	$3,600,000
Site Equipment	Pipes	$1,000 / unit	$1,000 / unit	$1,000 / unit	1 unit	12 sites	$1,000	$12,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	12 sites	$10,352	$124,224
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	12 sites	$82,620	$991,440

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Install connection points downstream of the charging pump discharge header for connecting the Mode 1-4 RCS FLEX pump for reactivity control and RCS inventory control or Mode 5-6 RCS FLEX pump for core cooling and RCS inventory control.								
Site Equipment	Connection points	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	12 sites	$150,000	$1,800,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	12 sites	$4,141	$49,690
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	12 sites	$82,620	$991,440
Add branch connections with quick-disconnect fittings to the boric acid transfer pump suction header. Install permanent piping from boric acid tank room to CVCS crosstie. Provide a branch from the CVCS drain line to allow a connection point. Modify vent connection downstream from boron injection tanks for portable pump connection. Resize the CVCS crosstie drain line to 4-inch piping.								
Site Equipment	Branch connections with quick disconnect fittings	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	12 sites	$150,000	$1,800,000
Site Equipment	Piping	$10,000 / unit	$10,000 / unit	$10,000 / unit	1 unit	12 sites	$10,000	$120,000
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	1 unit	12 sites	$75,000	$900,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	12 sites	$10,352	$124,224
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	12 sites	$82,620	$991,440
Add FLEX pump discharge connection points to both trains of the essential service water system.								
Site Equipment	Connection points	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	12 sites	$150,000	$1,800,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	12 sites	$4,141	$49,690
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	12 sites	$33,048	$396,576
Install a connection point downstream of the emergency feedwater pump.								
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	1 unit	12 sites	$75,000	$900,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	40 hours	12 sites	$2,070	$24,845
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	12 sites	$33,048	$396,576
Modify spare breaker BE 113 (preferred) and BF109 (alternate) for 480-V FLEX diesel generator connection. Install new vertical section on switchgear C1 (preferred) and DI (alternate) for 4,160-V FLEX diesel generator connection.								
Site Labor	Labor (Electricians)			$52 / hour	40 hours	12 sites	$2,060	$24,720
For deployment of the 4,160-V FLEX diesel generator, stage the diesel generator north of the diesel generator building. The preferred connection will route a cable via a new penetration through the north wall of the auxiliary building. For the alternate connection, the cable will be routed through the main door of the auxiliary building. The cable will connect to a FLEX connection panel installed in the room. The panel will be permanently wired with Class 1E cable through an existing cable raceway.								
Site Equipment	Cables	$200 / unit	$600 / unit	$400 / unit	3 units	12 sites	$1,200	$14,400
Site Equipment	Connection panel	$100,000 / unit	$100,000 / unit	$100,000 / unit	1 unit	12 sites	$100,000	$1,200,000
Site Equipment	Class 1E cable	$100 / unit	$100 / unit	$100 / unit	1,000 units	12 sites	$100,000	$1,200,000
Site Equipment	Medium voltage cable connectors	$80 / unit	$80 / unit	$80 / unit	15 units	12 sites	$1,200	$14,400
Site Labor	Labor (Electricians)			$52 / hour	160 hours	12 sites	$8,240	$98,880
Install supply and return connections of the train A containment cooler service water piping outside containment to supply supplemental cooling to the containment fan coolers.								
Site Equipment	Connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	12 sites	$150,000	$1,800,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	100 hours	12 sites	$5,176	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	12 sites	$33,048	$396,576
Route a new header directly to the SFP just above the normal water level. The header will be routed outside via a penetration through the fuel handling area west wall and will terminate in a blind flange or Storz quick connection. A manual isolation valve will be located just inside the fuel handling area train bay door.								
Site Equipment	Header (pipe)	$10,000 / unit	$10,000 / unit	$10,000 / unit	1 unit	12 sites	$10,000	$120,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	100 hours	12 sites	$5,176	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	200 hours	12 sites	$16,524	$198,288

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
SFP spray will be required. A permanent modification to install spray nozzles in the fuel handling building will be made. These nozzles will be mounted on the walls approximately 20 feet above the deck, and pointed at the pool. A hard pipe line will be routed from the nozzles to the installed header for the preferred SFP makeup strategy and will utilize the same connection point located outside the auxiliary building. To keep the functions separate, the SFP spray line will connect upstream of the isolation valve on the SFP makeup header and will also have a manual isolation valve. Flow rate requirements will be much greater for SFP spray than for makeup. For this reason, suction will be taken from the intake canal for this strategy.								
Site Equipment	Hard pipe line	$50,000 / unit	$50,000 / unit	$50,000 / unit	1 unit	12 sites	$50,000	$600,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	100 hours	12 sites	$5,176	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	500 hours	12 sites	$41,310	$495,720
Offsite Portable Equipment								
Licensee's share of regional response center (RRC) costs.								
RRC Equipment	Licensee's share of RRC equipment costs			$874,000 / unit	1 unit	12 sites	$874,000	$10,488,000
RRC Setup	Licensee's share of RRC setup costs			$283,000 / unit	1 unit	12 sites	$283,000	$3,396,000
Procure offsite Phase 3 equipment.								
Site Equipment	Radiation protection equipment: survey equipment	$500 / unit	$4,000 / unit	$2,000 / unit	20 units	12 sites	$40,000	$480,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	20 units	12 sites	$2,000	$24,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	1 unit	12 sites	$5,000	$60,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	2 units	12 sites	$800	$9,600
Modify 4,160 Vac bus T11A/D to allow connection of external 4,160 Vac portable diesel generator.								
Site Equipment	Connection point	$750,000 / unit	$750,000 / unit	$750,000 / unit	1 unit	12 sites	$750,000	$9,000,000
Site Labor	Labor (Electricians)			$52 / hour	100 hours	12 sites	$5,150	$61,800
Supporting Functions								
Upgrade the installed self-contained dc emergency lighting units with LED lamps.								
Site Equipment	LED lamps	$100 / unit	$100 / unit	$100 / unit	12 units	12 sites	$1,200	$14,400
Site Labor	Labor (Electricians)			$52 / hour	40 hours	12 sites	$2,060	$24,720
A connection will be made to a drain line located on the supply line to the emergency diesel generator (EDG) from the associated EDG day tank.								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	1 unit	12 sites	$750,000	$9,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	40 hours	12 sites	$2,070	$24,845
Add connection points at diesel fuel oil storage tank 4-inch flanges downstream of valves to support transfer of inventory for use in FLEX equipment.								
Site Equipment	Connection points	$750,000 / unit	$750,000 / unit	$750,000 / unit	2 units	12 sites	$1,500,000	$18,000,000
Site Labor	Labor			$52 / hour	100 hours	12 sites	$5,176	$62,112
External Event Considerations								
Preparation for staging FLEX equipment can involve identifying staging areas, leveling staging areas, building a structure to temporarily hold equipment, and fitting FLEX equipment into the plant as a prestaged item.								
Contractor	Staging area	$604,000 / unit	$604,000 / unit	$604,000 / unit	1 unit	12 sites	$604,000	$7,248,000
Two FLEX storage locations will be provided for the storage of the related FLEX equipment. The FLEX equipment will be protected in accordance with Nuclear Energy Institute (NEI) 12-06, Section 5.3.1.								
Contractor	Storage building	$1,700,000 / unit	$3,000,000 / unit	$2,350,000 / unit	2 units	12 sites	$4,700,000	$56,400,000

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an ELAP/loss of normal access to the ultimate heat sink event such that no fuel damage occurs.								
Site Labor	Labor			$84 / hour	4,000 hours	12 sites	$335,400	$4,024,800
Develop strategies (playbook) with RRC.								
Site Labor	Labor			$84 / hour	320 hours	12 sites	$26,832	$321,984
Develop/conduct a staffing analysis.								
Site Labor	Labor			$84 / hour	480 hours	12 sites	$40,248	$482,976
Develop and implement FLEX support guidelines. Develop procedures to read instruments locally. Procedures on re-powering hydrogen igniters in Procedure 05-S-01-STRTEFY, “Alternative Strategies.” Enhanced battery load-shedding guidance will be incorporated into station procedures for loss of ac power to extend the availability of dc power.								
Site Labor	Labor			$84 / hour	4,000 hours	12 sites	$335,400	$4,024,800
Modify plant procedures to take into account FLEX support guidelines. Procedures to be considered include emergency operating procedure, extensive damage mitigation guidelines, and severe accident management guideline strategies.								
Site Labor	Labor			$84 / hour	800 hours	12 sites	$67,080	$804,960
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.								
Site Labor	Labor			$84 / hour	400 hours	12 sites	$33,540	$402,480
Create maintenance and testing procedures.								
Site Labor	Labor			$84 / hour	1,000 hours	12 sites	$83,850	$1,006,200
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	12 sites	$250,000	$3,000,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation of beyond-design-basis external events.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	12 sites	$250,000	$3,000,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,000 hours	12 sites	$167,700	$2,012,400
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	12 sites	$6,708	$80,496
Involvement with industry group activities.								
Site Labor	Labor			$84 / hour	750 hours	12 sites	$62,888	$754,650
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,000 hours	12 sites	$83,850	$1,006,200

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COSTS								
Programmatic Controls								
Provide 6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	100 hours	12 sites	$8,385	$100,620
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	12 sites	$33,540	$402,480
Training will be performed in 2014 and will be implemented in accordance with the systematic approach to training (SAT). The training modules for personnel who will be responsible for implementing the FLEX strategies and for ERO personnel will be implemented and maintained per existing training programs. The details, objectives, frequency, and success measures will follow the plant's SAT process.								
Site Labor	Labor			$84 / hour	1,000 hours	12 sites	$83,850	$1,006,200
Change control.								
Site Labor	Labor			$84 / hour	160 hours	12 sites	$13,416	$160,992
Maintenance of the FLEX support guidelines.								
Site Labor	Labor			$84 / hour	240 hours	12 sites	$20,124	$241,488
Licensee's share of RRC ongoing costs (staffing, rent, testing, and maintenance).								
RRC Maintenance	Licensee's share of RRC ongoing costs			$129,000 / unit	1 unit	12 sites	$129,000	$1,548,000
Licensee's share of RRC transportation costs (first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (first 3 years)			$184,000 / unit	1 unit	12 sites	$184,000	$2,208,000
Licensee's share of RRC transportation costs (after first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (after first 3 years)			$15,000 / unit	1 unit	12 sites	$15,000	$180,000

Appendix I. Order EA-12-049 Costs for a PWR 2-Unit Site

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS								
Initial Response								
Harden and protect the dedicated shutdown diesel generator to provide power to the motor control center.								
Site Equipment	Building material or prefabricated structures	$20,000 / unit	$20,000 / unit	$20,000 / unit	2 units	24 sites	$40,000	$960,000
Site Labor	Labor			$84 / hour	800 hours	24 sites	$67,080	$1,609,920
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	24 sites	$66,096	$1,586,304
Install a robust, shielded connection on each reactor makeup water storage tank (RMWST) that extends through the RMWST shield building providing two diverse connections for transferring the RMWST inventory to the condensate storage tank (CST).								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	4 units	24 sites	$3,000,000	$72,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	24 sites	$10,352	$248,448
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	24 sites	$82,620	$1,982,880
Upgrade nonseismic condensate transfer pump suction nozzle to seismic qualification to increase CST inventory availability time to 40 hours.								
Site Equipment	Seismic condensate transfer pump suction nozzle	$2,000 / unit	$2,000 / unit	$2,000 / unit	2 units	24 sites	$4,000	$96,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	24 sites	$10,352	$248,448
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	24 sites	$33,048	$793,152
Construct a seismic, missile-protected emergency water storage tank.								
Site Equipment	Emergency water storage tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	2 units	24 sites	$316,000	$7,584,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	7,200 hours	24 sites	$372,672	$8,944,128
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	24 sites	$82,620	$1,982,880
Construct a seismic, missile-protected tank to provide a protected water source for core cooling and heat removal strategies. A diesel-powered feedwater pump will supply the water to the auxiliary feedwater system piping. Flow distribution instrumentation will be required during the extended loss of alternating current (ac) power (ELAP).								
Site Equipment	Tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	2 units	24 sites	$316,000	$7,584,000
Site Equipment	Diesel-powered feedwater pump	$50,000 / unit	$50,000 / unit	$50,000 / unit	2 units	24 sites	$100,000	$2,400,000
Site Equipment	Flow distribution instrumentation	$30,000 / unit	$30,000 / unit	$30,000 / unit	2 units	24 sites	$60,000	$1,440,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	4,000 hours	24 sites	$207,040	$4,968,960
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	2,000 hours	24 sites	$165,240	$3,965,760
Install clean water receiver tank (high wind/missile protected and contains borated water).								
Site Equipment	Tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	2 units	24 sites	$316,000	$7,584,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	7,200 hours	24 sites	$372,672	$8,944,128
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	24 sites	$82,620	$1,982,880
Modify power controls for steam generator (SG) power-operated relief valves (PORVs) from a direct current (dc)-powered instrument bus to allow for continued operation from the main control room.								
Site Labor	Mechanical Door)			$52 / hour	240 hours	24 sites	$12,456	$298,944
Install permanent nitrogen bottle racks near each SG PORV operating station with hose and regulators to align for control to remain available in the control room.								
Site Equipment	Nitrogen bottle racks	$5,000 / unit	$5,000 / unit	$5,000 / unit	4 units	24 sites	$20,000	$480,000
Site Labor	Labor			$84 / hour	32 hours	24 sites	$2,683	$64,397
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	24 sites	$33,048	$793,152
Install Westinghouse low-leakage reactor coolant pump (RCP) seals.								
Site Equipment	Low-leakage RCP seals.	$58,000 / unit	$58,000 / unit	$58,000 / unit	8 units	24 sites	$464,000	$11,136,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	160 hours	24 sites	$8,282	$198,758
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	24 sites	$66,096	$1,586,304

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
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.								
Site Equipment	Seismic piping and a connection to the charging header	$10,000 / unit	$10,000 / unit	$10,000 / unit	2 units	24 sites	$20,000	$480,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	160 hours	24 sites	$8,282	$198,758
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	24 sites	$33,048	$793,152
Onsite Portable Equipment								
Procure portable diverse and flexible coping strategies (FLEX) equipment (N+1).								
Site Equipment	Vehicles	$24,000 / unit	$35,000 / unit	$30,000 / unit	2 units	24 sites	$60,000	$1,440,000
Site Equipment	480 Vac diesel generators (480 kW)	$75,000 / unit	$125,000 / unit	$100,000 / unit	3 units	24 sites	$300,000	$7,200,000
Site Equipment	480 Vac diesel generators (200 kW)	$50,000 / unit	$101,000 / unit	$77,000 / unit	3 units	24 sites	$231,000	$5,544,000
Site Equipment	120 Vac diesel generators (15 kW)	$5,000 / unit	$10,000 / unit	$8,000 / unit	3 units	24 sites	$24,000	$576,000
Site Equipment	Self-powered CST FLEX pumps	$6,000 / unit	$6,000 / unit	$6,000 / unit	3 units	24 sites	$18,000	$432,000
Site Equipment	Self-powered SG FLEX pumps	$6,000 / unit	$6,000 / unit	$6,000 / unit	3 units	24 sites	$18,000	$432,000
Site Equipment	Self-powered spent fuel pool (SFP) FLEX pumps (200% capacity)	$6,000 / unit	$6,000 / unit	$6,000 / unit	3 units	24 sites	$18,000	$432,000
Site Equipment	Electric motor-driven Mode 1-4 reactor coolant system (RCS) FLEX pumps	$3,000 / unit	$3,000 / unit	$3,000 / unit	3 units	24 sites	$9,000	$216,000
Site Equipment	Electric motor-driven Mode 5-6 RCS FLEX pumps	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	24 sites	$3,000	$72,000
Site Equipment	Electric motor-driven diesel fuel FLEX pumps	$500 / unit	$1,000 / unit	$700 / unit	3 units	24 sites	$2,100	$50,400
Site Equipment	Flatbed trailers	$8,000 / unit	$18,000 / unit	$12,000 / unit	3 units	24 sites	$36,000	$864,000
Site Equipment	Trailers with fuel tank	$3,000 / unit	$8,000 / unit	$6,000 / unit	3 units	24 sites	$18,000	$432,000
Site Equipment	Portable fuel containers	$20 / unit	$60 / unit	$40 / unit	3 units	24 sites	$120	$2,880
Site Equipment	Monitor spray nozzles for SFP spray	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	24 sites	$3,000	$72,000
Site Equipment	Hose and fittings	$2,000 / unit	$2,000 / unit	$2,000 / unit	3 units	24 sites	$6,000	$144,000
Site Equipment	Strainers	$10 / unit	$20 / unit	$10 / unit	3 units	24 sites	$30	$720
Site Equipment	Communications gear: docking station	$2,000 / unit	$2,000 / unit	$2,000 / unit	2 units	24 sites	$4,000	$96,000
Site Equipment	Communications gear: mobile phones	$1,000 / unit	$1,000 / unit	$1,000 / unit	2 units	24 sites	$2,000	$48,000
Site Equipment	Communications gear: emergency kits	$1,000 / unit	$3,000 / unit	$2,000 / unit	10 units	24 sites	$20,000	$480,000
Site Equipment	Communications gear: fixed-mast antennas	$200 / unit	$300 / unit	$200 / unit	4 units	24 sites	$800	$19,200
Site Equipment	Communications gear: antenna cable	$100 / unit	$1,000 / unit	$600 / unit	4 units	24 sites	$2,400	$57,600
Site Equipment	Communications gear: rechargeable batteries	$80 / unit	$100 / unit	$100 / unit	30 units	24 sites	$3,000	$72,000
Site Equipment	Communications gear: four-bay satellite phone battery chargers	$500 / unit	$600 / unit	$600 / unit	16 units	24 sites	$9,600	$230,400
Site Equipment	Communications gear: single-bay satellite phone battery chargers	$200 / unit	$200 / unit	$200 / unit	16 units	24 sites	$3,200	$76,800
Site Equipment	Communications gear: dc automobile outlet charger cords to charge single- and four-bay battery chargers	$20 / unit	$20 / unit	$20 / unit	16 units	24 sites	$320	$7,680
Site Equipment	Communications gear: solar panel chargers	$200 / unit	$200 / unit	$200 / unit	8 units	24 sites	$1,600	$38,400
Site Equipment	Portable ventilation fans	$2,000 / unit	$2,000 / unit	$2,000 / unit	8 units	24 sites	$16,000	$384,000
Site Equipment	Portable air compressors	$13,000 / unit	$13,000 / unit	$13,000 / unit	2 units	24 sites	$26,000	$624,000
Site Equipment	Fuel transfer hoses	$3,000 / unit	$4,000 / unit	$3,000 / unit	3 units	24 sites	$9,000	$216,000
Site Equipment	Radiation protection equipment: survey equipment	$500 / unit	$4,000 / unit	$2,000 / unit	40 units	24 sites	$80,000	$1,920,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	40 units	24 sites	$4,000	$96,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	2 units	24 sites	$10,000	$240,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	4 units	24 sites	$1,600	$38,400
Install diverse suction connections and fill connections on each CST. Install seismically-rugged new pipes and equipment used to provide core cooling and heat removal to the SG.								
Site Equipment	Suction connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	8 units	24 sites	$600,000	$14,400,000
Site Equipment	Fill connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	8 units	24 sites	$600,000	$14,400,000
Site Equipment	Pipes	$1,000 / unit	$1,000 / unit	$1,000 / unit	2 units	24 sites	$2,000	$48,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	400 hours	24 sites	$20,704	$496,896
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	2,000 hours	24 sites	$165,240	$3,965,760

Install connection points downstream of the charging pump discharge header for connecting the Mode 1-4 RCS FLEX pump for reactivity control and RCS inventory control or Mode 5-6 RCS FLEX pump for core cooling and RCS inventory control.	

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Site Equipment	Connection points	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	24 sites	$300,000	$7,200,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	160 hours	24 sites	$8,282	$198,758
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	2,000 hours	24 sites	$165,240	$3,965,760
Add branch connections with quick disconnect fittings to the boric acid transfer pump suction header. Install permanent piping from boric acid tank room to CVCS crosstie. Provide a branch from the CVCS drain line to allow a connection point. Modify vent connection downstream from boron injection tanks for portable pump connection. Resize the CVCS crosstie drain line to 4-inch piping.								
Site Equipment	Branch connections with quick disconnect fittings	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	24 sites	$300,000	$7,200,000
Site Equipment	Piping	$10,000 / unit	$10,000 / unit	$10,000 / unit	2 units	24 sites	$20,000	$480,000
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	24 sites	$150,000	$3,600,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	400 hours	24 sites	$20,704	$496,896
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	2,000 hours	24 sites	$165,240	$3,965,760
Add FLEX pump discharge connection points to both trains of the essential service water system.								
Site Equipment	Connection points	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	24 sites	$300,000	$7,200,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	160 hours	24 sites	$8,282	$198,758
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	24 sites	$66,096	$1,586,304
Install a connection point downstream of the emergency feedwater pump.								
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	2 units	24 sites	$150,000	$3,600,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	24 sites	$4,141	$99,379
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	24 sites	$66,096	$1,586,304
Modify spare breaker BE 113 (preferred) and BF109 (alternate) for 480-V FLEX diesel generator connection. Install new vertical section on switchgear C1 (preferred) and DI (alternate) for 4,160-V FLEX diesel generator connection.								
Site Labor	Labor (Electricians)			$52 / hour	80 hours	24 sites	$4,120	$98,880
For deployment of the 4,160-V FLEX diesel generator, stage the diesel generator north of the diesel generator building. The preferred connection will route a cable via a new penetration through the north wall of the auxiliary building. For the alternate connection, the cable will be routed through the main door of the auxiliary building. The cable will connect to a FLEX connection panel installed in the room. The panel will be permanently wired with Class 1E cable through an existing cable raceway.								
Site Equipment	Cables	$200 / unit	$600 / unit	$400 / unit	6 units	24 sites	$2,400	$57,600
Site Equipment	Connection panel	$100,000 / unit	$100,000 / unit	$100,000 / unit	2 units	24 sites	$200,000	$4,800,000
Site Equipment	Class 1E cable	$100 / unit	$100 / unit	$100 / unit	2,000 units	24 sites	$200,000	$4,800,000
Site Equipment	Medium voltage cable connectors	$80 / unit	$80 / unit	$80 / unit	30 units	24 sites	$2,400	$57,600
Site Labor	Labor (Electricians)			$52 / hour	320 hours	24 sites	$16,480	$395,520
Install supply and return connections of the train A containment cooler service water piping outside containment to supply supplemental cooling to the containment fan coolers.								
Site Equipment	Connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	4 units	24 sites	$300,000	$7,200,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	24 sites	$10,352	$248,448
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	800 hours	24 sites	$66,096	$1,586,304
Route a new header directly to the SFP just above the normal water level. The header will be routed outside via a penetration through the fuel handling area west wall and will terminate in a blind flange or Storz quick connection. A manual isolation valve will be located just inside the fuel handling area train bay door.								
Site Equipment	Header (pipe)	$10,000 / unit	$10,000 / unit	$10,000 / unit	2 units	24 sites	$20,000	$480,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	24 sites	$10,352	$248,448
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	400 hours	24 sites	$33,048	$793,152

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
SFP spray will be required. A permanent modification to install spray nozzles in the fuel handling building will be made. These nozzles will be mounted on the walls approximately 20 feet above the deck, and pointed at the pool. A hard pipe line will be routed from the nozzles to the installed header for the preferred SFP makeup strategy and will utilize the same connection point located outside the auxiliary building. To keep the functions separate, the SFP spray line will connect upstream of the isolation valve on the SFP makeup header and will also have a manual isolation valve. Flow rate requirements will be much greater for SFP spray than for makeup. For this reason, suction will be taken from the intake canal for this strategy.								
Site Equipment	Hard pipe line	$50,000 / unit	$50,000 / unit	$50,000 / unit	2 units	24 sites	$100,000	$2,400,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	200 hours	24 sites	$10,352	$248,448
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,000 hours	24 sites	$82,620	$1,982,880
Offsite Portable Equipment								
Licensee's share of regional response center (RRC) costs.								
RRC Equipment	Licensee's share of RRC equipment costs			$874,000 / unit	1 unit	24 sites	$874,000	$20,976,000
RRC Setup	Licensee's share of RRC setup costs			$283,000 / unit	1 unit	24 sites	$283,000	$6,792,000
Procure offsite Phase 3 equipment.								
Site Equipment	Radiation protection equipment: Survey equipment	$500 / unit	$4,000 / unit	$2,000 / unit	40 units	24 sites	$80,000	$1,920,000
Site Equipment	Radiation protection equipment: Dosimetry	$100 / unit	$100 / unit	$100 / unit	40 units	24 sites	$4,000	$96,000
Site Equipment	Commodities: Food	$5,000 / unit	$6,000 / unit	$5,000 / unit	2 units	24 sites	$10,000	$240,000
Site Equipment	Commodities: Water	$400 / unit	$400 / unit	$400 / unit	4 units	24 sites	$1,600	$38,400
Modify 4,160 Vac bus T11A/D to allow connection of external 4,160 Vac portable diesel generator.								
Site Equipment	Connection point	$750,000 / unit	$750,000 / unit	$750,000 / unit	2 units	24 sites	$1,500,000	$36,000,000
Site Labor	Labor (Electricians)			$52 / hour	200 hours	24 sites	$10,300	$247,200
Supporting Functions								
Upgrade the installed self-contained dc emergency lighting units with LED lamps.								
Site Equipment	LED lamps	$100 / unit	$100 / unit	$100 / unit	24 units	24 sites	$2,400	$57,600
Site Labor	Labor (Electricians)			$52 / hour	80 hours	24 sites	$4,120	$98,880
A connection will be made to a drain line located on the supply line to the emergency diesel generator (EDG) from the associated EDG day tank.								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	2 units	24 sites	$1,500,000	$36,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	80 hours	24 sites	$4,141	$99,379
Add connection points at diesel fuel oil storage tank 4-inch flanges downstream of valves to support transfer of inventory for use in FLEX equipment.								
Site Equipment	Connection points	$750,000 / unit	$750,000 / unit	$750,000 / unit	4 units	24 sites	$3,000,000	$72,000,000
Site Labor	Labor			$52 / hour	200 hours	24 sites	$10,352	$248,448
External Event Considerations								
Preparation for staging FLEX equipment can involve identifying staging areas, leveling staging areas, building a structure to temporarily hold equipment, and fitting FLEX equipment into the plant as a prestaged item.								
Contractor	Staging area	$604,000 / unit	$604,000 / unit	$604,000 / unit	2 units	24 sites	$1,208,000	$28,992,000
Two FLEX storage locations will be provided for the storage of the related FLEX equipment. The FLEX equipment will be protected in accordance with Nuclear Energy Institute (NEI) 12-06, Section 5.3.1.								
Contractor	Storage building	$1,700,000 / unit	$3,000,000 / unit	$2,350,000 / unit	3 units	24 sites	$7,050,000	$169,200,000

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an ELAP/loss of normal access to the ultimate heat sink event such that no fuel damage occurs.								
Site Labor	Labor			$84 / hour	5,000 hours	24 sites	$419,250	$10,062,000
Develop strategies (playbook) with RRC.								
Site Labor	Labor			$84 / hour	400 hours	24 sites	$33,540	$804,960
Develop/conduct a staffing analysis.								
Site Labor	Labor			$84 / hour	480 hours	24 sites	$40,248	$965,952
Develop and implement FLEX support guidelines. Develop procedures to read instruments locally. Procedures on re-powering hydrogen igniters in Procedure 05-S-01-STRTEFY, "Alternative Strategies." Enhanced battery load-shedding guidance will be incorporated into station procedures for loss of ac power to extend the availability of dc power.								
Site Labor	Labor			$84 / hour	6,000 hours	24 sites	$503,100	$12,074,400
Modify plant procedures to take into account FLEX support guidelines. Procedures to be considered include emergency operating procedure, extensive damage mitigation guidelines, and severe accident management guideline strategies.								
Site Labor	Labor			$84 / hour	1,200 hours	24 sites	$100,620	$2,414,880
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.								
Site Labor	Labor			$84 / hour	400 hours	24 sites	$33,540	$804,960
Create maintenance and testing procedures.								
Site Labor	Labor			$84 / hour	1,200 hours	24 sites	$100,620	$2,414,880
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	24 sites	$250,000	$6,000,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation of beyond-design-basis external events.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	24 sites	$312,500	$7,500,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,400 hours	24 sites	$201,240	$4,829,760
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	24 sites	$6,708	$160,992
Involvement with industry group activities.								
Site Labor	Labor			$84 / hour	788 hours	24 sites	$66,032	$1,584,765
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,000 hours	24 sites	$83,850	$2,012,400

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COSTS								
Programmatic Controls								
Provide 6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	150 hours	24 sites	$12,578	$301,860
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	24 sites	$33,540	$804,960
Training will be performed in 2014 and will be implemented in accordance with the systematic approach to training (SAT). The training modules for personnel who will be responsible for implementing the FLEX strategies and for ERO personnel will be implemented and maintained per existing training programs. The details, objectives, frequency, and success measures will follow the plant's SAT process.								
Site Labor	Labor			$84 / hour	1,750 hours	24 sites	$146,738	$3,521,700
Change control.								
Site Labor	Labor			$84 / hour	240 hours	24 sites	$20,124	$482,976
Maintenance of the FLEX support guidelines.								
Contractor				$84 / hour	312 hours	24 sites	$26,161	$627,869
Licensee's share of RRC ongoing costs (staffing, rent, testing, and maintenance).								
RRC Maintenance	Licensee's share of RRC ongoing costs			$129,000 / unit	1 unit	24 sites	$129,000	$3,096,000
Licensee's share of RRC transportation costs (first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (first 3 years)			$184,000 / unit	1 unit	24 sites	$184,000	$4,416,000
Licensee's share of RRC transportation costs (after first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (after first 3 years)			$15,000 / unit	1 unit	24 sites	$15,000	$360,000

Appendix J. Order EA-12-049 Costs for a PWR 3-Unit Site

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS								
Initial Response								
Harden and protect the dedicated shutdown diesel generator to provide power to motor control center.								
Site Equipment	Building material or prefabricated structures	$20,000 / unit	$20,000 / unit	$20,000 / unit	3 units	2 sites	$60,000	$120,000
Site Labor	Labor			$84 / hour	1,200 hours	2 sites	$100,620	$201,240
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,200 hours	2 sites	$99,144	$198,288
Install a robust, shielded connection on each reactor makeup water storage tank (RMWST) that extends through the RMWST shield building providing two diverse connections for transferring the RMWST inventory to the condensate storage tank (CST).								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	6 units	2 sites	$4,500,000	$9,000,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	300 hours	2 sites	$15,528	$31,056
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,500 hours	2 sites	$123,930	$247,860
Upgrade nonseismic condensate transfer pump suction nozzle to seismic qualification to increase CST inventory availability time to 40 hours.								
Site Equipment	Seismic condensate transfer pump suction nozzle	$2,000 / unit	$2,000 / unit	$2,000 / unit	3 units	2 sites	$6,000	$12,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	300 hours	2 sites	$15,528	$31,056
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	2 sites	$49,572	$99,144
Construct a seismic, missile-protected emergency water storage tank.								
Site Equipment	Emergency water storage tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	3 units	2 sites	$474,000	$948,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	10,800 hours	2 sites	$559,008	$1,118,016
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,500 hours	2 sites	$123,930	$247,860
Construct a seismic, missile-protected tank to provide a protected water source for core cooling and heat removal strategies. A diesel-powered feedwater pump will supply the water to the auxiliary feedwater system piping. Flow distribution instrumentation will be required during the extended loss of alternating current (ac) power (ELAP).								
Site Equipment	Tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	3 units	2 sites	$474,000	$948,000
Site Equipment	Diesel-powered feedwater pump	$50,000 / unit	$50,000 / unit	$50,000 / unit	3 units	2 sites	$150,000	$300,000
Site Equipment	Flow distribution instrumentation	$30,000 / unit	$30,000 / unit	$30,000 / unit	3 units	2 sites	$90,000	$180,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	6,000 hours	2 sites	$310,560	$621,120
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	3,000 hours	2 sites	$247,860	$495,720
Install clean water receiver tank (high wind/missile protected and contains borated water).								
Site Equipment	Tank	$130,000 / unit	$186,000 / unit	$158,000 / unit	3 units	2 sites	$474,000	$948,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	10,800 hours	2 sites	$559,008	$1,118,016
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,500 hours	2 sites	$123,930	$247,860
Modify power controls for steam generator (SG) power-operated relief valves (PORVs) from a direct current (dc)-powered instrument bus to allow for continued operation from the main control room.								
Site Labor	Mechanical Door)			$52 / hour	360 hours	2 sites	$18,684	$37,368
Install permanent nitrogen bottle racks near each SG PORV operating station with hose and regulators to align for control to remain available in the control room.								
Site Equipment	Nitrogen bottle racks	$5,000 / unit	$5,000 / unit	$5,000 / unit	6 units	2 sites	$30,000	$60,000
Site Labor	Labor			$84 / hour	48 hours	2 sites	$4,025	$8,050
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	2 sites	$49,572	$99,144
Install Westinghouse low-leakage reactor coolant pump (RCP) seals.								
Site Equipment	Low-leakage RCP seals.	$58,000 / unit	$58,000 / unit	$58,000 / unit	12 units	2 sites	$696,000	$1,392,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	240 hours	2 sites	$12,422	$24,845
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,200 hours	2 sites	$99,144	$198,288

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Seismically upgrade the alternate seal injection (ASI) system and add an ASI pump discharge path to the chemical and volume control (CVCS) charging header.								
Site Equipment	Seismic piping and a connection to the charging header	$10,000 / unit	$10,000 / unit	$10,000 / unit	3 units	2 sites	$30,000	$60,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	240 hours	2 sites	$12,422	$24,845
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	2 sites	$49,572	$99,144
Onsite Portable Equipment								
Procure portable diverse and flexible coping strategies (FLEX) equipment (N+1).								
Site Equipment	Vehicles	$24,000 / unit	$35,000 / unit	$30,000 / unit	3 units	2 sites	$90,000	$180,000
Site Equipment	480 Vac diesel generators (480 kW)	$75,000 / unit	$125,000 / unit	$100,000 / unit	4 units	2 sites	$400,000	$800,000
Site Equipment	480 Vac diesel generators (200 kW)	$50,000 / unit	$101,000 / unit	$77,000 / unit	4 units	2 sites	$308,000	$616,000
Site Equipment	120 Vac diesel generators (15 kW)	$5,000 / unit	$10,000 / unit	$8,000 / unit	4 units	2 sites	$32,000	$64,000
Site Equipment	Self-powered CST FLEX pumps	$6,000 / unit	$6,000 / unit	$6,000 / unit	4 units	2 sites	$24,000	$48,000
Site Equipment	Self-powered SG FLEX pumps	$6,000 / unit	$6,000 / unit	$6,000 / unit	4 units	2 sites	$24,000	$48,000
Site Equipment	Self-powered spent fuel pool (SFP) FLEX pumps (200% capacity)	$6,000 / unit	$6,000 / unit	$6,000 / unit	4 units	2 sites	$24,000	$48,000
Site Equipment	Electric motor-driven Mode 1-4 reactor coolant system (RCS) FLEX pumps	$3,000 / unit	$3,000 / unit	$3,000 / unit	4 units	2 sites	$12,000	$24,000
Site Equipment	Electric motor-driven Mode 5-6 RCS FLEX pumps	$1,000 / unit	$1,000 / unit	$1,000 / unit	4 units	2 sites	$4,000	$8,000
Site Equipment	Electric motor-driven diesel fuel FLEX pumps	$500 / unit	$1,000 / unit	$700 / unit	4 units	2 sites	$2,800	$5,600
Site Equipment	Flatbed trailers	$8,000 / unit	$18,000 / unit	$12,000 / unit	4 units	2 sites	$48,000	$96,000
Site Equipment	Trailers with fuel tank	$3,000 / unit	$8,000 / unit	$6,000 / unit	4 units	2 sites	$24,000	$48,000
Site Equipment	Portable fuel containers	$20 / unit	$60 / unit	$40 / unit	4 units	2 sites	$160	$320
Site Equipment	Monitor spray nozzles for SFP spray	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	2 sites	$3,000	$6,000
Site Equipment	Hose and fittings	$2,000 / unit	$2,000 / unit	$2,000 / unit	3 units	2 sites	$6,000	$12,000
Site Equipment	Strainers	$10 / unit	$20 / unit	$10 / unit	3 units	2 sites	$30	$60
Site Equipment	Communications gear: docking station	$2,000 / unit	$2,000 / unit	$2,000 / unit	3 units	2 sites	$6,000	$12,000
Site Equipment	Communications gear: mobile phones	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	2 sites	$3,000	$6,000
Site Equipment	Communications gear: emergency kits	$1,000 / unit	$3,000 / unit	$2,000 / unit	15 units	2 sites	$30,000	$60,000
Site Equipment	Communications gear: fixed-mast antennas	$200 / unit	$300 / unit	$200 / unit	6 units	2 sites	$1,200	$2,400
Site Equipment	Communications gear: antenna cable	$100 / unit	$1,000 / unit	$600 / unit	6 units	2 sites	$3,600	$7,200
Site Equipment	Communications gear: rechargeable batteries	$80 / unit	$100 / unit	$100 / unit	45 units	2 sites	$4,500	$9,000
Site Equipment	Communications gear: four-bay satellite phone battery chargers	$500 / unit	$600 / unit	$600 / unit	24 units	2 sites	$14,400	$28,800
Site Equipment	Communications gear: single-bay satellite phone battery chargers	$200 / unit	$200 / unit	$200 / unit	24 units	2 sites	$4,800	$9,600
Site Equipment	Communications gear: dc automobile outlet charger cords to charge single- and four-bay battery chargers	$20 / unit	$20 / unit	$20 / unit	24 units	2 sites	$480	$960
Site Equipment	Communications gear: solar panel chargers	$200 / unit	$200 / unit	$200 / unit	12 units	2 sites	$2,400	$4,800
Site Equipment	Portable ventilation fans	$2,000 / unit	$2,000 / unit	$2,000 / unit	12 units	2 sites	$24,000	$48,000
Site Equipment	Portable air compressors	$13,000 / unit	$13,000 / unit	$13,000 / unit	3 units	2 sites	$39,000	$78,000
Site Equipment	Fuel transfer hoses	$3,000 / unit	$4,000 / unit	$3,000 / unit	3 units	2 sites	$9,000	$18,000
Site Equipment	Radiation protection equipment: survey equipment	$500 / unit	$4,000 / unit	$2,000 / unit	60 units	2 sites	$120,000	$240,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	60 units	2 sites	$6,000	$12,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	3 units	2 sites	$15,000	$30,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	6 units	2 sites	$2,400	$4,800
Install diverse suction connections and fill connections on each CST. Install seismically-rugged new pipes and equipment used to provide core cooling and heat removal to the SG.								
Site Equipment	Suction connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	12 units	2 sites	$900,000	$1,800,000
Site Equipment	Fill connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	12 units	2 sites	$900,000	$1,800,000
Site Equipment	Pipes	$1,000 / unit	$1,000 / unit	$1,000 / unit	3 units	2 sites	$3,000	$6,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	600 hours	2 sites	$31,056	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	3,000 hours	2 sites	$247,860	$495,720

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Install connection points downstream of the charging pump discharge header for connecting the Mode 1-4 RCS FLEX pump for reactivity control and RCS inventory control or Mode 5-6 RCS FLEX pump for core cooling and RCS inventory control.								
Site Equipment	Connection points	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	2 sites	$450,000	$900,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	240 hours	2 sites	$12,422	$24,845
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	3,000 hours	2 sites	$247,860	$495,720
Add branch connections with quick-disconnect fittings to the boric acid transfer pump suction header. Install permanent piping from boric acid tank room to CVCS crosstie. Provide a branch from the CVCS drain line to allow a connection point. Modify vent connection downstream from boron injection tanks for portable pump connection. Resize the CVCS crosstie drain line to 4-inch piping.								
Site Equipment	Branch connections with quick-disconnect fittings	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	2 sites	$450,000	$900,000
Site Equipment	Piping	$10,000 / unit	$10,000 / unit	$10,000 / unit	3 units	2 sites	$30,000	$60,000
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	3 units	2 sites	$225,000	$450,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	600 hours	2 sites	$31,056	$62,112
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	3,000 hours	2 sites	$247,860	$495,720
Add FLEX pump discharge connection points to both trains of the essential service water system.								
Site Equipment	Connection points	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	2 sites	$450,000	$900,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	240 hours	2 sites	$12,422	$24,845
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,200 hours	2 sites	$99,144	$198,288
Install a connection point downstream of the emergency feedwater pump.								
Site Equipment	Connection point	$75,000 / unit	$75,000 / unit	$75,000 / unit	3 units	2 sites	$225,000	$450,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	120 hours	2 sites	$6,211	$12,422
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,200 hours	2 sites	$99,144	$198,288
Modify spare breaker BE 113 (preferred) and BF109 (alternate) for 480-V FLEX diesel generator connection. Install new vertical section on switchgear C1 (preferred) and DI (alternate) for 4160-V FLEX diesel generator connection.								
Site Labor	Labor (Electricians)			$52 / hour	120 hours	2 sites	$6,180	$12,360
For deployment of the 4,160-V FLEX diesel generator, stage the diesel generator north of the diesel generator building. The preferred connection will route a cable via a new penetration through the north wall of the auxiliary building. For the alternate connection, the cable will be routed through the main door of the auxiliary building. The cable will connect to a FLEX connection panel installed in the room. The panel will be permanently wired with Class 1E cable through an existing cable raceway.								
Site Equipment	Cables	$200 / unit	$600 / unit	$400 / unit	9 units	2 sites	$3,600	$7,200
Site Equipment	Connection panel	$100,000 / unit	$100,000 / unit	$100,000 / unit	3 units	2 sites	$300,000	$600,000
Site Equipment	Class 1E cable	$100 / unit	$100 / unit	$100 / unit	3,000 units	2 sites	$300,000	$600,000
Site Equipment	Medium voltage (MV) cable connectors	$80 / unit	$80 / unit	$80 / unit	45 units	2 sites	$3,600	$7,200
Site Labor	Labor (Electricians)			$52 / hour	480 hours	2 sites	$24,720	$49,440
Install supply and return connections of the train A containment cooler service water piping outside containment to supply supplemental cooling to the containment fan coolers.								
Site Equipment	Connections	$75,000 / unit	$75,000 / unit	$75,000 / unit	6 units	2 sites	$450,000	$900,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	300 hours	2 sites	$15,528	$31,056
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,200 hours	2 sites	$99,144	$198,288

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Route a new header directly to the SFP just above the normal water level. The header will be routed outside via a penetration through the fuel handling area west wall and will terminate in a blind flange or Storz quick connection. A manual isolation valve will be located just inside the fuel handling area train bay door.								
Site Equipment	Header (pipe)	$10,000 / unit	$10,000 / unit	$10,000 / unit	3 units	2 sites	$30,000	$60,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	300 hours	2 sites	$15,528	$31,056
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	600 hours	2 sites	$49,572	$99,144
SFP spray will be required. A permanent modification to install spray nozzles in the fuel handling building will be made. These nozzles will be mounted on the walls approximately 20 feet above the deck, and pointed at the pool. A hard pipe line will be routed from the nozzles to the installed header for the preferred SFP makeup strategy and will utilize the same connection point located outside the auxiliary building. To keep the functions separate, the SFP spray line will connect upstream of the isolation valve on the SFP makeup header and will also have a manual isolation valve. Flow rate requirements will be much greater for SFP spray than for makeup. For this reason, suction will be taken from the intake canal for this strategy.								
Site Equipment	Hard pipe line	$50,000 / unit	$50,000 / unit	$50,000 / unit	3 units	2 sites	$150,000	$300,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	300 hours	2 sites	$15,528	$31,056
Site Labor	Engineering and design (Mechanical Engineer)			$83 / hour	1,500 hours	2 sites	$123,930	$247,860
Offsite Portable Equipment								
Licensee's share of regional response center (RRC) costs.								
RRC Equipment	Licensee's share of RRC equipment costs			$874,000 / unit	1 unit	2 sites	$874,000	$1,748,000
RRC Setup	Licensee's share of RRC setup costs			$283,000 / unit	1 unit	2 sites	$283,000	$566,000
Procure offsite Phase 3 equipment.								
Site Equipment	Radiation protection equipment: survey equipment	$500 / unit	$4,000 / unit	$2,000 / unit	60 units	2 sites	$120,000	$240,000
Site Equipment	Radiation protection equipment: dosimetry	$100 / unit	$100 / unit	$100 / unit	60 units	2 sites	$6,000	$12,000
Site Equipment	Commodities: food	$5,000 / unit	$6,000 / unit	$5,000 / unit	3 units	2 sites	$15,000	$30,000
Site Equipment	Commodities: water	$400 / unit	$400 / unit	$400 / unit	6 units	2 sites	$2,400	$4,800
Modify 4,160 Vac bus T11A/D to allow connection of external 4,160 Vac portable diesel generator.								
Site Equipment	Connection point	$750,000 / unit	$750,000 / unit	$750,000 / unit	3 units	2 sites	$2,250,000	$4,500,000
Site Labor	Labor (Electricians)			$52 / hour	300 hours	2 sites	$15,450	$30,900
Supporting Functions								
Upgrade the installed self-contained dc emergency lighting units with LED lamps.								
Site Equipment	LED lamps	$100 / unit	$100 / unit	$100 / unit	36 units	2 sites	$3,600	$7,200
Site Labor	Labor (Electricians)			$52 / hour	120 hours	2 sites	$6,180	$12,360
A connection will be made to a drain line located on the supply line to the emergency diesel generator (EDG) from the associated EDG day tank.								
Site Equipment	Connection	$750,000 / unit	$750,000 / unit	$750,000 / unit	3 units	2 sites	$2,250,000	$4,500,000
Site Labor	Labor (Plumbers, Pipefitters, and Steamfitters)			$52 / hour	120 hours	2 sites	$6,211	$12,422
Add connection points at diesel fuel oil storage tank 4-inch flanges downstream of valves to support transfer of inventory for use in FLEX equipment.								
Site Equipment	Connection points	$750,000 / unit	$750,000 / unit	$750,000 / unit	6 units	2 sites	$4,500,000	$9,000,000
Site Labor	Labor			$52 / hour	300 hours	2 sites	$15,528	$31,056

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
External Event Considerations								
Preparation for staging FLEX equipment can involve identifying staging areas, leveling staging areas, building a structure to temporarily hold equipment, and fitting FLEX equipment into the plant as a prestaged item.								
Contractor	Staging area	$604,000 / unit	$3,000,000 / unit	$604,000 / unit	3 units	2 sites	$1,812,000	$3,624,000
Two FLEX storage locations will be provided for the storage of the related FLEX equipment. The FLEX equipment will be protected in accordance with Nuclear Energy Institute (NEI) 12-06, Section 5.3.1.								
Contractor	Storage building	$1,700,000 / unit	$3,000,000 / unit	$2,350,000 / unit	4 units	2 sites	$9,400,000	$18,800,000
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an ELAP/loss of normal access to the ultimate heat sink event such that no fuel damage occurs.								
Site Labor	Labor			$84 / hour	6,000 hours	2 sites	$503,100	$1,006,200
Develop strategies (playbook) with RRC.								
Site Labor	Labor			$84 / hour	480 hours	2 sites	$40,248	$80,496
Develop/conduct a staffing analysis.								
Site Labor	Labor			$84 / hour	480 hours	2 sites	$40,248	$80,496
Develop and implement FLEX support guidelines. Develop procedures to read instruments locally. Procedures on re-powering hydrogen igniters in Procedure 05-S-01-STRTEFY, "Alternative Strategies." Enhanced battery load-shedding guidance will be incorporated into station procedures for loss of ac power to extend the availability of dc power.								
Site Labor	Labor			$84 / hour	8,000 hours	2 sites	$670,800	$1,341,600
Modify plant procedures to take into account FLEX support guidelines. Procedures to be considered include emergency operating procedure, extensive damage mitigation guideline, and severe accident management guideline strategies.								
Site Labor	Labor			$84 / hour	1,600 hours	2 sites	$134,160	$268,320
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.								
Site Labor	Labor			$84 / hour	400 hours	2 sites	$33,540	$67,080
Create maintenance and testing procedures.								
Site Labor	Labor			$84 / hour	1,400 hours	2 sites	$117,390	$234,780
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	2 sites	$250,000	$500,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation of beyond-design-basis external events.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	2 units	2 sites	$375,000	$750,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,800 hours	2 sites	$234,780	$469,560
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	2 sites	$6,708	$13,416
Involvement with industry group activities.								
Site Labor	Labor			$84 / hour	825 hours	2 sites	$69,176	$138,353
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,000 hours	2 sites	$83,850	$167,700

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY / HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COSTS								
Programmatic Controls								
Provide 6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	200 hours	2 sites	$16,770	$33,540
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	2 sites	$33,540	$67,080
Training will be performed in 2014 and will be implemented in accordance with the systematic approach to training (SAT). The training modules for personnel who will be responsible for implementing the FLEX strategies and for ERO personnel will be implemented and maintained per existing training programs. The details, objectives, frequency, and success measures will follow the plant's SAT process.								
Site Labor	Labor			$84 / hour	2,500 hours	2 sites	$209,625	$419,250
Change control.								
Site Labor	Labor			$84 / hour	320 hours	2 sites	$26,832	$53,664
Maintenance of the FLEX support guidelines.								
Site Labor	Labor			$84 / hour	384 hours	2 sites	$32,198	$64,397
Licensee's share of RRC ongoing costs (staffing, rent, testing, and maintenance).								
RRC Maintenance	Licensee's share of RRC ongoing costs			$129,000 / unit	1 unit	2 sites	$129,000	$258,000
Licensee's share of RRC transportation costs (first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (first 3 years)			$184,000 / unit	1 unit	2 sites	$184,000	$368,000
Licensee's share of RRC transportation costs (after first 3 years).								
RRC Transportation	Licensee's share of RRC transportation costs (after first 3 years)			$15,000 / unit	1 unit	2 sites	$15,000	$30,000

Appendix K. Order EA-12-049 Costs for an AP1000 2-Unit Site

ACTIVITY	UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL IMPLEMENTATION COSTS							
Initial Response							
None							
	$0	$0	$0		2 sites	$0	$0
Onsite Portable Equipment							
None							
	$0	$0	$0		2 sites	$0	$0
Offsite Portable Equipment							
None							
			$0		2 sites	$0	$0
Supporting Functions							
None							
	$0	$0	$0		2 sites	$0	$0
External Event Considerations							
None							
	$0	$0	$0		2 sites	$0	$0

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
Programmatic Controls								
Develop the overall integrated plan. Perform a site-specific evaluation determining baseline coping capabilities, applicable extreme external hazards, and needed enhancements to mitigate an extended loss of alternating current (ac) power/loss of normal access to the ultimate heat sink event such that no fuel damage occurs.								
Site Labor	Labor			$80 / hour	5,000 hours	2 sites	$400,000	$800,000
Develop strategies (playbook) with regional response center.								
Site Labor	Labor			$84 / hour	400 hours	2 sites	$33,540	$67,080
Develop/conduct a staffing analysis.								
Site Labor	Labor			$84 / hour	480 hours	2 sites	$40,248	$80,496
Develop and implement diverse and flexible coping strategies (FLEX) support guidelines. Develop procedures to read instruments locally. Procedures on re-powering hydrogen igniters in Procedure 05-S-01-STRTEFY, "Alternative Strategies." Enhanced battery load-shedding guidance will be incorporated into station procedures for loss of ac power to extend the availability of direct current (dc) power.								
Site Labor	Labor			$84 / hour	6,000 hours	2 sites	$503,100	$1,006,200
Modify plant procedures to take into account FLEX support guidelines. Procedures to be considered include emergency operating procedure, extensive damage mitigation guideline, and severe accident management guideline strategies.								
Site Labor	Labor			$84 / hour	1,200 hours	2 sites	$100,620	$201,240
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.								
Site Labor	Labor			$84 / hour	800 hours	2 sites	$67,080	$134,160
Create maintenance procedures.								
Site Labor	Labor			$84 / hour	1,200 hours	2 sites	$100,620	$201,240
Develop training programs for operation of FLEX equipment.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	2 sites	$250,000	$500,000
Develop training modules for personnel who will be responsible for implementing the FLEX strategies. Train emergency response organization (ERO) personnel to ensure personnel proficiency in the mitigation of beyond-design-basis external events.								
Contractor	Training Development	$250,000 / unit	$250,000 / unit	$250,000 / unit	1 unit	2 sites	$300,000	$600,000
Develop design requirements and supporting analysis for portable FLEX equipment.								
Site Labor	Labor			$84 / hour	2,400 hours	2 sites	$201,240	$402,480
An analysis will be performed to determine commodity requirements.								
Site Labor	Labor			$84 / hour	80 hours	2 sites	$6,708	$13,416
Involvement with industry group activities								
Site Labor	Labor			$84 / hour	788 hours	12 sites	$66,032	$792,383
Procedure setpoint calculations (procedure entry, exit, and decision criteria) and other engineering support.								
Site Labor	Labor			$84 / hour	1,250 hours	12 sites	$104,813	$1,257,750

ACTIVITY		UNIT COST (min)	UNIT COST (max)	UNIT COST (best estimate)	QUANTITY/ HOURS	AFFECTED ENTITIES	COST PER AFFECTED SITE	TOTAL COST
INCREMENTAL OPERATIONS COSTS								
Programmatic Controls								
Provide 6-month status reports on implementation of mitigation strategies.								
Site Labor	Labor			$84 / hour	150 hours	2 sites	$12,578	$25,155
Maintenance and testing.								
Site Labor	Labor			$84 / hour	400 hours	2 sites	$33,540	$67,080
Training will primarily consist of the typical objective-based procedure training that operators receive on these procedures and guidelines accompanied by simulator scenario training that integrate these hypothetical events. The training for the FLEX aspects of the AP1000 design will build upon the training that is already required for the post-72-hour operational requirements. Training material for classroom presentation and simulator scenarios need to be developed in accordance with the systems approach to training in 10 CFR 55.4.								
Site Labor	Labor			$84 / hour	1,750 hours	2 sites	$146,738	$293,475
Change control.								
Site Labor	Labor			$84 / hour	300 hours	2 sites	$25,155	$50,310
Maintenance of the FLEX support guidelines.								
Site Labor	Labor			$84 / hour	312 hours	2 sites	$26,161	$52,322

Appendix L. Order EA-12-049—NRC Costs

Activity	Annual Labor Rate	Estimated FTE (Annualized)	Total Costs
NRC IMPLEMENTATION (ONE-TIME)			
Licensing activities.	$176,000/FTE	3.0 FTE	$528,000
	Subtotal	**3.0 FTE**	**$528,000**
NRC OPERATIONS (ANNUAL)			
Inspection activities.	$176,000/FTE	3.0 FTE	$528,000
	Subtotal	**3.0 FTE**	**$528,000**
	Total NRC Cost		**$1,056,000**

Appendix M. Order EA-12-049—Equipment and Supplies Unit Cost References

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
1	Air Compressor	All Cost	http://www.allcostdata.info/search.html?b2dbsSearch=diesel+air+compressors, accessed September 30, 2016.	$1,472	b
				$2,187	b
				$7,079	b
		Atlas Copco	http://www.atlascopco.us/usus/products/Product.aspx?id=2750262&productgroupid=3511437, accessed September 30, 2016.	$13,816	
		RSMeans: Building Construction Data, 2005		$936	b, c
				$1,199	b, c
				$1,436	b, c
				$2,372	b, c
				$2,497	b, c
		All Cost	http://www.allcostdata.info/search.html?b2dbsSearch=diesel+air+compressors, accessed September 30, 2016.	$1,472	b
				$2,187	b
				$7,079	b
		Atlas Copco	http://www.atlascopco.us/usus/products/Product.aspx?id=2750262&productgroupid=3511437, accessed September 30, 2016.	$13,816	
		RSMeans: Building Construction Data, 2005		$363	b, c
				$468	b, c
2	Air Compressor Piping	Northern Tool & Equipment	http://www.northerntool.com/shop/tools/product_200366544_200366544?cm_ven=natural&cm_cat=netconcepts&cm_pla=Google&cm_ite=, accessed September 30, 2016.	$52	
			http://www.northerntool.com/shop/tools/product_200484021_200484021?cm_ven=natural&cm_cat=netconcepts&cm_pla=Google&cm_ite=, accessed September 30, 2016.	$147	
3	Auxiliary Steam Supply Line	NRC estimate		$1,046,664	
4	Boron Mixing System	NRC estimate		$20,933	
5	Building Material or Prefabricated Structures	Independent expert		$20,933	
6	Cable Connector	Independent expert		$78	
7	Cable Sets	Independent expert		$2,093	
				$6,280	
		Northern Tool & Equipment	http://www2.northerntool.com/generators/generator-accessories/generator-cordsets-plugs-3.htm, accessed September 30, 2016.	$209	
				$628	
8	Connection Line	Independent expert		$174,444	
		NRC estimate		$104,666	
9	Connection Panel	NRC estimate		$104,666	
10	Cross-Tie Piping	Independent expert		$174,444	
		NRC, NUREG/CR-2800, Supplement 4, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development"		$424,798	
11	Deployable, Mobile, Rechargeable Communications Kit Supporting Satellite and Radio Communications.	Satwest	http://www.satwest.com/Iridium_Emergency_Phone_Kit_Solar_Charger_p/ekit-9595ae.htm, accessed September 30, 2016.	$2,741	
		Satphonestore	http://www.satphonestore.com/iridium-9555-packages/iridium-9505a-emergency-package.html, accessed September 30, 2016.	$1,983	
		Northern Axcess Satellite Communications	http://www.northernaxcess.com/satellite-communication-products/satellite-phones/iridium-satellite-phones/iridium-9555-satellite-phone-adventure-package-pelican-case-solar-panel/, accessed September 30, 2016.	$1,412	
		Satellite Phone Depot	http://www.satellite-phone-depot.com/dk050-iridium-9555-satellite-phone-docking-0509555.html, accessed September 30, 2016.	$1,883	
		Global Satellite	https://www.globalsatellite.us/products/iridium-9555, accessed September 30, 2016.	$1,419	
		XSAT	http://www.xsatshop.com/iridium-satellite-phones.html, accessed September 30, 2016.	$1,203	
		Satphonestore	http://www.satphonestore.com/application-browsing/satellite-phones/satellite-phone-accessories/accessories-antennas/iridium-maastmount-antenna.html, accessed September 30, 2016.	$262	
		Mackay	http://www.mackaysatellite.com/iridium-accessory-9505-9505a-9555-9575-fixed-mast-antenna-at1621142.html, accessed September 30, 2016.	$235	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
		Satcom Store	http://satcomstore.com/9555-handheld-phone-rechargeable-li-ion-battery-bat20801, accessed September 30, 2016.	$84	
		TR Telecom	http://www.trtelecom.com.au/iridium-9555-rechargeable-battery, accessed September 30, 2016.	$125	
		GMPCS Personal Communications	http://www.gmpcs-us.com/Accessory/9555-Rechargeable-Li-ion-Battery.htm, accessed September 30, 2016.	$96	
		Bluecosmo Satellite Communications	http://www.bluecosmo.com/satellite-accessories/batteries-chargers/satstation-iridium-9555-bat20801-four-bay-battery-charger, accessed September 30, 2016.	$523	
		SatTrans	http://www.sattransusa.com/irid-chrg-ss4-9555.html, accessed September 30, 2016.	$591	
		Northern Axcess Satellite Communications	http://www.northernaxcess.com/satellite-communication-products/satellite-accessories/external-battery-chargers/satstation-four-bay-battery-charger-for-iridium-9575-extreme-9555-9505a-9505-9500-satellite-phones/, accessed September 30, 2016.	$602	
		GMPCS Personal Communications	http://www.gmpcs-us.com/Accessory/Four-Bay-Set-For-9555-Charger.htm, accessed September 30, 2016.	$602	
		Satcom Store	http://satcomstore.com/iridium-9555-four-bay-charger, accessed September 30, 2016.	$591	
		Satphonestore	http://www.satphonestore.com/satstation-iridiumbatterycharger-single-bay-bat20801.html, accessed September 30, 2016.	$162	
		Satcom Store	http://satcomstore.com/iridium-9555-single-bay-charger, accessed September 30, 2016.	$162	
		Roadpost Satcom	http://www.roadpost.com/Nomad-135-Solar-Panel-P769C333.aspx?UserID=128797385&SessionID=7a4cvNHT9bCJ8GWX4vV2, accessed September 30, 2016.	$240	
		SatTrans	http://www.sattransusa.com/ir95ac.html, accessed September 30, 2016.	$208	
		MJ Sales, Inc.	http://www.mjsales.net/itemsearch.asp?FamilyID=852, accessed September 30, 2016.	$21	
		M-Cramer Satellitenservices	http://www.m-cramer-shop.de/index.php?manufacturers_id=55&sort=6a&filter_id=37&language=en, accessed September 30, 2016.	$1,146	d
		Satphone	http://store.satphone.co.uk/Catalog/Fleet-Phone/IsatDOCK-Cable-Kit-ACTIVE-40m, accessed September 30, 2016.	$709	d
		MJ Sales, Inc.	https://www.mjsales.net/items.asp?FamilyID=1036&this_Cat1ID=281&Cat2ID=98, accessed September 30, 2016.	$129	
12	Diesel Fuel Tank (Portable)	Equipmentland	http://www.equipmentland.com/product_images/vendor_images/transcube/TransCube-Fuel-Tanks-EQL.pdf, accessed September 30, 2016.	$4,990	
		Generator Joe	http://www.generatorjoe.net/product.asp?0=674&1=693&3=3760, accessed September 30, 2016.	$6,227	
13	Diesel Fuel Transfer Pump	Grainger	http://www.grainger.com/product/GPI-Fuel-Transfer-Fuel-Pump-WP35695/_/N-hu2Z1z0nj1o?_=1386863567018&s_pp=false	$778	
				$919	
			http://www.grainger.com/product/FILL-RITE-Fuel-Transfer-Pump-24UY34?s_pp=false, accessed September 30, 2016.	$1,020	
		Northern Tool & Equipment	http://www.northerntool.com/shop/tools/product_200434941_200434941, accessed September 30, 2016.	$555	
			http://www.northerntool.com/shop/tools/product_200434942_200434942, accessed September 30, 2016.	$628	
		Proflow Dynamics	http://store.proflowdynamics.com/modules/store/DC-Transfer-Pumps_C223.cfm, accessed September 30, 2016.	$592	
		Dultmeier Sales	http://www.dultmeier.com/products/0.851.867.5390/9783, accessed September 30, 2016.	$3,940	
		Pumpbiz	http://www.pumpbiz.com/shopping_product_list.asp?pcid=5467, accessed September 30, 2016.	$5,114	
				$8,305	
				$8,689	
14	Diesel Generator	Baldor	http://www.baldor.com/products/generators/pt.asp, accessed September 30, 2016.	$3,749	
				$5,228	
		Northern Tool & Equipment	http://www.northerntool.com/shop/tools/product_200360138_200360138, accessed September 30, 2016.	$1,256	
		Independent expert		$5,233	
				$10,467	
		Wayfair	http://www.wayfair.com/Winco-Power-Systems-15-Kw-Single-Phase-120-240-V-Natural-Gas-and-Propane-Double-Fuel-Standby-Generator-PSS15B4W-WNC1085.html, accessed September 30, 2016.	$6,161	
		Baldor	http://www.baldor.com/support/Literature/Load.ashx/CA2400?LitNumber=CA2400, accessed September 30, 2016.	$22,020	
		Aurora Generators Inc.	http://www.auroragenerators.com/generators/portable-diesel-generators#!/~/product/category=2991958&id=13028031, accessed September 30, 2016.	$1,255	
		Baldor	http://www.baldor.com/products/generators/pt.asp, accessed September 30, 2016.	$5,228	
		Sears	http://www.sears.com/all-power-america-6500w-diesel-generator-w-electric/p-07107337000P?prdNo=1&blockNo=1&blockType=G1, accessed September 30, 2016.	$1,429	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
		Baldor	http://www.baldor.com/products/generators/ts.asp, accessed September 30, 2016.	$25,421	
				$30,430	
				$35,180	
				$267,541	
		RSMeans: Building Construction Cost Data, 2005		$35,582	
		Depco Power Systems	http://www.depco.com/101-250kw-generator-sets/, accessed September 30, 2016.	$106,171	
				$104,143	
		Generator Joe	http://www.generatorjoe.net/price.asp?30=75001+and+100000, accessed September 30, 2016.	$90,277	
		Hardy Diesel Generators	http://www.hardydiesel.com/diesel-generators-120-250-kw.html, accessed September 30, 2016.	$54,380	
		Independent expert		$52,333	
				$78,500	
		Independent expert		$78,500	
				$130,833	
		EPRI, "Costs of Utility Distributed Generators, 1–10MW: Twenty-Four Case Studies"	http://www.publicpower.org/files/Deed/FinalReportCostsofUtilityDistributedGenerators.pdf, accessed September 30, 2016.	$670,526	
				$839,262	
		Amazon	http://www.amazon.com/600-KW-Perkins-Diesel-Generator/dp/B009M7EL8E, accessed September 30, 2016.	$79,180	
		FG Wilson	http://www.fgwilson.com/cda/files/3208301/7/P750-1(4PP)GB(0213).pdf, accessed September 30, 2016. http://www.fgwilson.com/diesel_generator_sets/350to750kVA, accessed September 30, 2016.	$0	
		Generac	http://www.generac.com/Industrial/Diesel/, accessed September 30, 2016.	$0	
		Hardy Diesel Generators	http://www.hardydiesel.com/mitsubishi-generators/mitsubishi-600-kw-diesel-generator.html accessed September 30, 2016.	$99,381	
		Kohler Power Systems	http://www.kohlerpower.com/industrial/detail.htm?sectionNumber=13261&categoryNumber=11961&prodnum=21540402, accessed September 30, 2016.	$0	
		RS Means: Facilities Construction Cost Data, 2000		$141,596	
		NRC estimate		$104,666	
		EPRI, "Costs of Utility Distributed Generators, 1–10MW: Twenty-Four Case Studies"	http://www.publicpower.org/files/Deed/FinalReportCostsofUtilityDistributedGenerators.pdf, accessed September 30, 2016.	$898,717	
				$920,449	
				$927,605	
				$936,881	
				$952,783	
				$1,015,065	
15	Diesel Generator Fuel Transfer Hose	Dultmeier Sales	http://www.dultmeier.com/products/0.851.867.5390/9784, http://www.dultmeier.com/products/0.851.867.5390/10889, http://www.dultmeier.com/products/0.851.867.5390/9783, http://www.dultmeier.com/products/0.851.867.5390/10888, accessed September 30, 2016.	$2,705	
				$3,078	
				$3,873	
				$4,192	
16	Diesel Generator Switchgear	EPRI, "Costs of Utility Distributed Generators, 1–10MW: Twenty-Four Case Studies"	http://www.publicpower.org/files/Deed/FinalReportCostsofUtilityDistributedGenerators.pdf, accessed September 30, 2016.	$12,560	
17	Diesel Generator Switchgear and Transformer	EPRI, "Costs of Utility Distributed Generators, 1–10MW: Twenty-Four Case Studies"	http://www.publicpower.org/files/Deed/FinalReportCostsofUtilityDistributedGenerators.pdf, accessed September 30, 2016.	$55,259	
				$73,466	
				$77,739	
18	Discharge Hose	Ultimate Industrial Solutions	http://www.ultimateindustrial.com/jason-4328-0500-100-nitrile-fuel-discharge-hose-300-psi-5-x-100-feet/, accessed September 30, 2016.	$3,510	
19	Disconnect	NRC estimate		$105	
20	Dosimetry	Arrow-Tech	http://www.dosimeter.com/direct-reading-dosimeters/direct-reading-dosimeter-w138-0-200mr-with-sapphire-window/, accessed September 30, 2016.	$154	
21	Duct	Global Industrial	http://www.globalindustrial.com/p/hvac/ventilation/flexible-ducts/s-tl-thermaflex-flexible-hvac-duct-14-diameter?infoParam.campaignId=T9A&gclid=CLWlsLDAsrsCFQ3hQgodR2wAcg, accessed September 30, 2016.	$293	
		Home Depot	http://www.homedepot.com/p/Master-Flow-14-in-x-25-ft-Insulated-Flexible-Duct-R6-Silver-Jacket-F6IFD14X300/100211848, accessed September 30, 2016.	$267	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
		Lowes	http://www.lowes.com/pd_127632-42471-LW1470_4294934297__?productId=3664140&Ntt=flex&pl=1&currentURL=%3FNtt%3Dflex&facetInfo=&state=R, accessed September 30, 2016.	$264	
22	Electric FLEX Pump	Wayfair	http://www.wayfair.com/Multiquip-106-GPM-Honda-GX-160-High-Pressure-Pump-QP205SH-MTQ1176.html, accessed September 30, 2016.	$1,464	
23	Emergency Water Storage Tank	Independent expert		$136,569	
				$194,878	
		NRC, Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors"	http://www.nrc.gov/docs/ML1324/ML13241A052.pdf, accessed September 30, 2016.	$19,488	
		Tanks For Less	http://www.tanksforless.com/p/1164/20000-gallon-austin-fiberglass-water-tank, accessed September 30, 2016.	$13,657	
24	Facility to Store FLEX Equipment	NRC estimate		$1,046,664	
25	Female national pipe taper stainless steel hydraulic couplings	Amazon	http://www.amazon.com/Dixon-Hydraulic-Quick-Connect-Fitting-Coupling/dp/B00BG1W52I, accessed September 30, 2016.	$55	
26	Flatbed Trailer	Featherlite Trailers	http://www.fthr.com/products/commercial-and-utility-trailers/flatbed, accessed September 30, 2016.	$8,373	
				$9,211	
				$18,840	
27	FLEX Hose Jumper	Discount Ramps	http://www.discountramps.com/hose-protectors.htm, accessed September 30, 2016.	$607	
		Handi-Ramp	http://www.handiramp.com/hoseprotector.htm, accessed September 30, 2016.	$733	
		Turtle Plastics	http://www.fire-end.com/TurtlePlastics-HoseBridge_-Kits.htm, accessed September 30, 2016.	$1,827	
28	Flood Staging Area	NRC estimate		$1,046,664	
29	Flow Distribution Instrumentation	Independent expert		$31,400	
30	Food	EverSafe	http://www.eversafemres.com/mre-wholesale-eversafe-mre-pallet-48-cases/, accessed September 30, 2016.	$4,973	
		Preparedness.com	http://preparedness.com/sumrpaof48ca.html, accessed September 30, 2016.	$6,070	
31	Front Loader	CAT	http://www.cat.com/en_US/products/new/equipment/track-loaders.html, accessed September 30, 2016.	$188,399	
				$272,133	
				$444,832	
		RSMeans: Building Construction Cost Data, 2005		$390	b
32	Fuel Air-Lift Container	NRC estimate		$1,570	
33	Hard Pipe and Dual Isolation Valves	NRC estimate		$10,467	
34	Hard Piping	Independent expert		$10,467	
				$52,333	
		NRC estimate		$1,047	
35	High-Capacity Pump	NRC estimate		$20,933	
36	High-Pressure Hose	Fastenal	http://www.fastenal.com/web/products/details/400380-131280;jsessionid=7BJGT7LfwZZQJv1Fp7pJWDQ0Jd9h8RYGSHp2WYFpzLQnYvvPVpWY!1149440359!1560414073?isPunchout=false, accessed September 30, 2016.	$2,917	
		Grainger	http://www.grainger.com/product/EATON-Bulk-Hose-4VTL8, accessed September 30, 2016.	$1,031	
		Fastenal	http://www.fastenal.com/web/products/details/400380-131280;jsessionid=7BJGT7LfwZZQJv1Fp7pJWDQ0Jd9h8RYGSHp2WYFpzLQnYvvPVpWY!1149440359!1560414073?isPunchout=false, accessed September 30, 2016.	$5,833	
37	High-Pressure Pump	NRC estimate		$20,933	
38	High Volume Fan	Dultmeier Sales	http://www.dultmeier.com/products/0.656.5568.5571.5574/10865, accessed September 30, 2016.	$349	
		Industrial Fans Direct	http://www.industrialfansdirect.com/TE-VI4213-V.html, accessed September 30, 2016.	$637	
39	Holder, Hydrant Wrench, & Spanner Wrench	Kochek Co.	http://www.kochek.com/products/productList.aspx?uid=381-375-342, accessed September 30, 2016.	$159	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
40	Hose trunks	NRC, NUREG-0933, Main Report with Supplements 1–34, "Resolution of Generic Safety Issues," Issue 107, "Main Transformer Failures" (Rev. 3)	http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0933/sec3/107r3.html, accessed September 30, 2016.	$523	
41	Installation of Connection Point	Independent expert		$174,444	
42	Installation of Cross Connect	Independent expert		$209,333	
43	Installation of Permanent Connection Points	NRC estimate		$784,998	
		Independent expert		$78,500	
44	Isolation Valve	Wayfair	http://www.wayfair.com/Noritz-Sweat-Tankless-Isolation-Valve-Kit-VOHA1074.html, accessed September 30, 2016.	$88	
45	Label	Emedco	http://www.emedco.com/circuit-breaker-labels-cl70.html, accessed September 30, 2016.	$25	
		TXBCS	http://www.txbcs.com/cart/index.php?main_page=product_info&cPath=65_68&products_id=185, accessed September 30, 2016.	$10	
46	Large FLEX Pump	All Cost	http://www.allcostdata.info/detail.html/154150800/Fire-pump,-incl-cntrl,-8%22-pump,-diesel,-2500-GPM,-100-PSI,-213, accessed September 30, 2016.	$99,095	
		Pentair	http://www.aurorapump.com/EngineeredProduct_FirePumpSplitCase_Electric.aspx, accessed September 30, 2016.	$68,629	
				$123,926	
47	LED Bulb	NRC, NUREG-1521, "Technical Review of Risk-Informed, Performance-Based Methods for Nuclear Power Plant Protection Analyses"	http://www.appendixr.com/ARS%20CD%202002/nrc/nureg/1521.pdf, accessed September 30, 2016.	$105	
48	Lighting Tower	Larson Electronics	http://www.larsonelectronics.com/p-1764-explosion-proof-light-quadpod-mount-24-inch-400-watt-metal-halide-class-1-div-1-cd.aspx http://www.larsonelectronics.com/p-71420-800-watt-telescoping-light-mast-25-3-stage-light-tower-360-rotating-boom-high-mast-lighting.aspx, accessed September 30, 2016.	$3,127	
				$4,748	
49	Low-Pressure/ Medium-Flow Pump	Independent expert		$57,567	
		NRC estimate		$8,373	
50	Modified Flange Adapter	Independent expert		$10,467	
		NRC estimate		$4,710	
51	Monitor Spray Nozzle and Required Hoses	POK	http://www.pokfire.com/nozzles.htm, accessed September 30, 2016.	$1,259	
52	Motor Starter	Grainger	http://www.grainger.com/category/magnetic-starters-with-thermal-overload/starters-and-contactors/electrical/ecatalog/N-nrt#nav=%2Fcategory%2Fmagnetic-starters-with-thermal-overload%2Fstarters-and-contactors%2Felectrical%2Fecatalog%2FN-nrtZ1yzzeluZ1yzziex%3F_%3D1395941806821, accessed September 30, 2016.	$467	
53	Mounted NEMA-4X	Grainger	http://www.grainger.com/Grainger/RITTAL-Enclosure-5AAF5?BV_UseBVCookie=No&ItemKey=5AAF5&seoUrl=RITTAL-Enclosure-5AAF5, accessed September 30, 2016.	$2,286	
		NEMA Enclosures	http://buy.nemaenclosures.com/wall-mount-type-4x-enclosure-w-back-panel-16-00x16-00x6-53.html, http://buy.nemaenclosures.com/wall-mount-type-4x-enclosure-w-back-panel-24-00x24-00x6-53.html, http://buy.nemaenclosures.com/wall-mount-type-4x-enclosure-w-back-panel-30-00x24-00x8-53.html, accessed September 30, 2016.	$380	
				$440	
				$547	
54	Move-In Cost	NRC estimate		$7,850	
55	Nitrogen Bottle Rack	Independent expert		$5,233	
		USA Safety	http://www.usasafety.com/gas-cylinder-rack-holder-stand-c-30.html, accessed September 30, 2016.	$193	
				$351	
56	Outfitting Costs	NRC estimate		$784,998	
57	Piping Line	Independent expert		$523,332	
		NRC, NUREG-0933, Main Report with Supplements 1–34, "Resolution of Generic Safety Issues," Issue 89, "Stiff Pipe Clamps" (Rev. 2)	http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0933/sec3/089r2.html, accessed September 30, 2016.	$22	
58	Portable Fuel Container	Grainger	http://www.grainger.com/Grainger/type-i-safety-cans/safety-storage/safety/ecatalog/N-l1h, accessed September 30, 2016.	$63	
		Lowes	http://www.lowes.com/Automotive/Gas-Cans/_/N-1z0x2mn/pl#!, accessed September 30, 2016.	$21	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
59	Portable Lighting and Batteries	Independent expert		$105	
60	Portable Toilet	Global Industrial	http://www.globalindustrial.com/g/janitorial-maintenance/bathroom/portable-restrooms/polyjohn-pjn3-fleet-portable-restrooms, accessed September 30, 2016.	$859	
				$899	
		RSMeans: Building Construction Cost Data, 2005		$199	b, c
61	Portable Ventilation Fan	H-MAC systems	http://www.h-mac.com/Canarm-Delhi_bymfg_86-0-2.html, accessed September 30, 2016.	$1,072	
				$2,053	
		Industrial Fans Direct	http://www.industrialfansdirect.com/LFI-U16-4.html, accessed September 30, 2016.	$1,852	
62	Potable Water	Costco	http://www.costco.com/Nestl%C3%A9-Pure-Life-Purified-Water-16.9oz-7224ct-Cases-NLE-101264.product.11751427.html, accessed September 30, 2016.	$419	
		Emergency Essentials	http://beprepared.com/dozen-cans-of-emergency-drinking-water-12-cans.html, accessed September 30, 2016.	$53	
		Ready Made Resources	https://www.readymaderesources.com/cart/storable-food-units/12-cans-emergency-drinking-water-30-year-shelf-life-free-shipping/prod_4480.html?review=write, accessed September 30, 2016.	$73	
		Ready Store	http://www.thereadystore.com/water-storage/emergency-drinking-water/8-45-oz-aqua-blox-water-boxes-case-of-24 http://www.thereadystore.com/water-storage/emergency-drinking-water/1-week-supply-of-canned-drinking-water, accessed September 30, 2016.	$14	
				$123	
63	Power Cables and Conduits	Independent expert		$21	
64	Power Connection Cable	NRC estimate		$157	
65	Pre-Staged Emergency N2 Bottle	ASCO	http://ascotorch.com/mm5/merchant.mvc?Screen=CTGY&Store_Code=ASCO&Category_Code=NITROCYL, accessed September 30, 2016.	$249	
		Praxair Direct	http://www.praxairdirect.com/Product2_10152_10051_14501_-1_11828_11508_11502_ProductDisplayErrorView, accessed September 30, 2016.	$79	
				$110	
66	Raceway	Grainger	http://www.grainger.com/Grainger/raceways/electrical/ecatalog/N-8ea, accessed September 30, 2016.	$18	
				$21	
				$28	
67	Raceway Cable	NRC, NUREG-0933, Main Report with Supplements 1–34, "Resolution of Generic Safety Issues," Issue 156, "Systematic Evaluation Program" (Rev. 8)	http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0933/sec3/156r8.html, accessed September 30, 2016.	$106	
68	RCP Seal	NRC, NUREG-0933, Main Report with Supplements 1–34, "Resolution of Generic Safety Issues," Issue 23, "Reactor Coolant Pump Seal Failures" (Rev. 1)	http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0933/sec3/023r1.html, accessed September 30, 2016.	$60,534	
69	RCS FLEX Pump	NRC estimate		$2,617	
70	Regional Response Center Startup	NRC estimate		$52,333,190	
71	RRC Maintenance Cost	Industry expert		$4,186,655	
72	RRC Staffing and Training Cost	Industry expert		$8,373,310	
73	Self-Priming Pump	The Pump Shop Incorporated – MP Pumps	http://www.pumpshop.com/mppumps/petrolmaxx.html http://www.pumpshop.com/pdf/mp_pumps/petrolmaxx/PETROLEUM-40.pdf, accessed September 30, 2016.	$6,398.26	
74	Seismic Condensate Transfer Pump Suction Nozzle	NRC estimate		$2,093	
75	Seismic Piping and a Connection to Charging Header	Independent expert		$10,467	
76	SFP Instrumentation	NRC estimate		$1,046,664	
77	SG/RVP Hose	Fire Hose Direct	http://www.firehosedirect.com/2-1-2-fire-hose/, accessed September 30, 2016.	$795	
78	SG/RVP Suction Hose	Kochek Co.	http://www.kochek.com/products/productList.aspx?uid=381-164-22-321, accessed September 30, 2016.	$1,026	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
		MSC Industrial Supply Co.	http://www.mscdirect.com/browse/tn/Hose-Tube-Fittings-Valves/Hose/Plastic-Rubber-Synthetic-Hose/Water-Steam-Hose/Water-Discharge-Hose?navid=12105076#navid=12105076+4288232688, accessed September 30, 2016.	$309	
		Process Hose & Equipment	http://processhose.com/6-in-i-d-goodyear-black-versiflo-150-psi-water-suction-and-discharge-hose-bulk-hose-priced-per-foot-no-end-fittings.html?gclid=CKaCuKWbu74CFaYF7AodxwsAnw, accessed September 30, 2016.	$142	
79	Storage Building	NRC estimate		$1,779,328	
				$3,139,991	
80	Storz Adapter	Kochek Co.	http://www.kochek.com/products/productList.aspx?uid=381-239-153-25&pg=1, accessed September 30, 2016., accessed September 30, 2016. http://www.kochek.com/products/productList.aspx?uid=381-239-153-24&pg=1	$228	
				$277	
		The Fire Store	http://www.thefirestore.com/store/product.aspx/productId/11374/Kochek-Storz-to-Rigid-Female-Thread/, accessed September 30, 2016.	$163	
81	Storz to national hose thread (NH) Swivel Rocker Lug Female Thread	Cascade Fire Equipment	http://www.cascadefire.com/index.php/valves-and-fittings/storz-adapters/storz-x-female-swivel-rocker-lug.html, accessed September 30, 2016.	$206	
		Kochek Co.	http://www.kochek.com/products/productList.aspx?uid=381-239-153-255&pg=1, accessed September 30, 2016.	$208	
		Harrington, Inc.	http://harrinc.com/shop/storz-x-female-swivel-rocker-lug-3/, accessed September 30, 2016.	$208	
82	Storz Spanner Wrench with Holder	Kochek Co.	http://www.kochek.com/products/productList.aspx?uid=381-375-341, accessed September 30, 2016.	$131	
83	Storz, Storz Outlet, Storz Inlet	JME Ellsworth	http://www.jmesales.com/catalog/productinfo.aspx?id=10118&cid=4828&skuid=POK9904, accessed September 30, 2016.	$1,062	
84	Strainer	Kochek Co.	http://www.kochek.com/products/productList.aspx?uid=381-155-467, accessed September 30, 2016.	$1,000	
85	Submersible Pump Hose (Portable)	Pumpbiz	http://www.pumpbiz.com/shopping_product_detail.asp?pid=70871#tabs, accessed September 30, 2016.	$394	
86	Suction Hose	Amazon	http://www.amazon.com/Unisource-Discharge-Assembly-Aluminum-Connection/dp/B0063LAZ46, accessed September 30, 2016.	$2,099	
		Nelson Jameson	http://nelsonjameson.com/Challenger-Teflon-Suction-Discharge-Hose-CTL--p8649.html, accessed September 30, 2016.	$8,750	
87	Suction Hose and Discharge Hose	Dunham Rubber & Belting Corporation	http://catalog.dunhamrubber.com/item/ose-tubing-and-ducting-hose-suction-discharge-hose/otter-water-suction-and-discharge-hose/5-otter, accessed September 30, 2016.	$0	
		Grainger	http://www.grainger.com/Grainger/Suction-Strainer-5RWL2?Pid=search, accessed September 30, 2016.	$13	
			http://www.grainger.com/Grainger/DAYTON-Suction-Strainer-1P689?Pid=search, accessed September 30, 2016.	$18	
		MSC Industrial Supply Co.	http://www.mscdirect.com/product/32140006, accessed September 30, 2016.	$2,230	
		RSMeans: Building Construction Data, 2005		$157	b, c
				$225	b, c
88	Super Duty Pickup Truck	Ford	http://www.ford.com/trucks/superduty/, accessed September 30, 2016.	$31,484	
				$32,253	
				$35,702	
				$36,476	
		Ram	http://www.ramtrucks.com/en/lineup/, accessed September 30, 2016.	$24,701	
				$30,793	
				$31,510	
		RSMeans: Building Construction Cost Data, 2005		$599	b, c
				$712	b, c
89	Survey Instrument	Ben Meadows	http://www.benmeadows.com/ez-measure-measuring-wheels_36815285/, accessed September 30, 2016.	$87	
				$170	
			http://www.benmeadows.com/durawheel-measuring-wheels_36815283/, accessed September 30, 2016. http://www.benmeadows.com/calculated-industries-digiroller-plus-ii-digital-measuring-wheel_s_103418/, accessed September 30, 2016.	$187	
		Engineer Supply	http://www.engineersupply.com/theodolites.aspx, accessed September 30, 2016.	$1,036	
			http://www.engineersupply.com/total-stations.aspx, accessed September 30, 2016.	$4,543	
		Independent expert		$523	
90	Temporary Housing	NRC estimate		$104,666	
91	Trailer with Fuel Tank	APC Equipment	http://www.apcequipment.com/4x8-w-200-gallon-tank-load-trail.html, accessed September 30, 2016.	$3,140	
		Quality Fuel Trailers		$5,228	
				$5,647	

No.	Equipment and Supplies	Source	Website	Unit Cost [a]	Notes
			http://www.qualityfueltrailers.com/fuel-trailer-types/vehicle-and-equipment-fuel-trailers/transfueler-fuel-trailers, accessed September 30, 2016.	$6,065	
				$6,484	
				$6,589	
				$7,007	
				$7,321	
				$7,531	
				$8,263	
92	Training Development	NRC estimate		$261,666	
93	Transfer Panel (Disconnect Switch)	NRC estimate		$523	
94	Transfer Switch	Independent expert		$4,187	
				$7,327	
		Northern Tool & Equipment	http://www.northerntool.com/shop/tools/product_200196674_200196674, accessed September 30, 2016.	$419	
				$523	
			http://www.northerntool.com/shop/tools/product_200317085_200317085, accessed September 30, 2016. http://www.northerntool.com/shop/tools/product_200196674_200196674, accessed September 30, 2016.	$733	
95	Transformer	Independent expert		$73,266	
				$94,200	
96	Transportation Capability of RRC (First 3 Years)	NRC estimate		$5,651,984	
				$6,279,983	
97	Transportation Capability of RRC (Ongoing)	NRC estimate		$470,999	
98	Water Purification Skid	US Water Systems	http://www.uswatersystems.com/commercial/harmsco-poly-coat-filter-housing-147-gpm-hbc-7-3.html, accessed September 30, 2016.	$1,572	
		NRC estimate		$41,867	
99	Water Storage	Bowhead Environmental & Safety	http://www.shopbowhead.com/category/products/fuel-water-storage/fuel-water-tanks, accessed September 30, 2016.	$15,438	
		Left Coast Parts	http://www.vendio.com/stores/leftcoastparts/item/business-industrial-other/20000-gallon-irrigation-or-fue/lid=11257461, accessed September 30, 2016.	$4,186	
100	Water Supply Truck	Cleveland Brothers (CAT)	http://www.clevelandbrothers.com/used-products/trucks-trailers/gz-water-wagon-water-trucks/up10912n, accessed September 30, 2016.	$266,899	
		RSMeans: Building Construction Cost Data, 2005		$7,834	b, c
101	Welding Type Receptacle	NRC estimate		$52	

a. The U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers is used as the inflation index to convert the unit costs into 2017 dollars (http://www.bls.gov/cpi/tables.htm).
b. Rental price
c. Monthly rental price varies from 2 percent to 5 percent of purchase price of the equipment, depending on the anticipated life of the equipment and its wearing parts.
d. The exchange rate used was from the Treasury Reporting Rates of Exchange as of December 31, 2013 (http://fms.treas.gov/intn.html).