

Regulatory Analysis Addenda

**Final Rule to Address
Mitigation of Beyond-Design-Basis Events**

U.S. Nuclear Regulatory Commission

December 2018



Contents

List of Exhibits.....	ii
Abbreviations and Acronyms.....	iii
1. Introduction.....	1
1.1 Background.....	2
1.2 Statement of the Problem and U.S. Nuclear Regulatory Commission Objectives for the Rulemaking.....	2
2. Identification and Preliminary Analysis of Alternative Approaches.....	3
2.1 Option 1: Take No Action.....	3
2.2 Option 2: Undertake Rulemaking to Make Order EA-12-049, Order EA-12-051, and Industry Initiatives Generically Applicable.....	4
3. Estimation and Evaluation of Benefits and Costs: Presentation of Results.....	4
3.1 Summary of Costs and Benefits of the Regulatory Options.....	5
3.2 Costs of the Final Rule.....	7
3.2.1 Industry Implementation.....	8
3.2.2 Industry Operation.....	8
3.2.3 NRC Implementation.....	8
3.2.4 NRC Operation.....	9
3.3 Benefits of the Final Rule.....	9
3.3.1 Benefits Associated with Public Health (Accident), Occupational Health (Accident), Offsite Property, Onsite Property, and Environmental Considerations.....	9
3.3.2 Benefits Associated with Regulatory Efficiency.....	10
3.4 Uncertainty Analysis.....	10
3.4.1 Uncertainty Analysis Results.....	11
3.4.2 Summary of Uncertainty Analysis.....	12
3.5 Disaggregation.....	12
3.6 Backfitting and Issue Finality.....	13
4. Conclusion.....	14
4.1 Make the Order Requirements Generically Applicable.....	14
4.2 Addresses a Number of Petitions for Rulemaking.....	14
4.3 Summary.....	15
References.....	16

List of Exhibits

Exhibit 3-1	Summary of Incremental Costs and Benefits for Option 1: No-Action Baseline.....	5
Exhibit 3-2	Summary of Total Costs for Undertaking Rulemaking to Make the Orders and Industry Initiatives Generically Applicable.....	6
Exhibit 3-3	Summary of Incremental Costs and Benefits for the Rulemaking Option.....	7
Exhibit 3-4	Industry Implementation Costs.....	11
Exhibit 3-5	Key Variables Whose Uncertainty Drives the Largest Impact on Costs.....	12
Exhibit 3-6	Disaggregated Requirements.....	13
Exhibit 3-7	Disaggregated Cost-Benefit of the Final Rule Regulatory Objectives.....	13
Exhibit A-1	Variables Used in the Uncertainty Analysis.....	18

Abbreviations and Acronyms

ADAMS	Agencywide Documents Access and Management System
AP1000	Advanced Passive 1000 reactor
CFR	<i>Code of Federal Regulations</i>
COL	combined license
EDMG	extensive damage mitigation guideline
FLEX	diverse and flexible coping strategies
FR	<i>Federal Register</i>
hr	hour
MBDBE	mitigation of beyond-design-basis events
MSA	mitigating strategies assessment
NEI	Nuclear Energy Institute
NRC	U.S. Nuclear Regulatory Commission
NTTF	Near-Term Task Force
PERT	program evaluation and review technique
PRM	petition for rulemaking
RG	regulatory guide
RIN	regulation identifier number
ROP	reactor oversight process
SAMG	severe accident management guideline
SFP	spent fuel pool
SFPI	spent fuel pool instrumentation
SPRA	seismic probabilistic risk assessment
SRM	staff requirements memorandum

1. Introduction

This addenda presents the regulatory analysis of the Mitigation of Beyond-Design-Basis Events (MBDBE) final rule as directed by the Commission in staff requirements memorandum (SRM)-SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49)" (NRC 2018b). The NRC is issuing three regulatory guides¹ that provide guidance for the implementation of this final rule. The regulatory guides apply to all current holders of, and applicants for operating licenses under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and combined licenses under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

The SRM substantially revised the final rule removing a number of requirements. This addenda reflects the Commission's SRM direction. At a high level, the following rule provisions were removed from the draft final rule by the Commission SRM.

1. Reevaluated hazards draft final requirements contained in 10 CFR 50.155(b)(2)

These requirements were removed from the final rule by the Commission SRM.

2. Staffing requirements contained in draft final 10 CFR 50.155(b)(5)

These requirements were removed from the rule by the Commission SRM. However, the supporting guidance continues to address staffing as part of an acceptable means for implementation of the rule requirements.

3. Reasonable protection for reevaluated hazards contained in draft final 10 CFR 50.155(c)(3)

These requirements were no longer needed as a result of the Commission SRM direction to remove reevaluated hazard requirements.

4. Communications requirements contained in draft final 10 CFR 50.155(c)(4)

These requirements were removed from the rule by the Commission SRM. However, the supporting guidance continues to address communications as part of an acceptable means for implementation of the rule requirements.

5. Training with regard to qualification and the systems approach to training contained in draft final 10 CFR 50.155(d)

These elements of the training requirements were removed from the final rule by the Commission SRM.

6. Drills or exercises requirements contained in draft final 10 CFR 50.155(e)

These requirements were removed from the rule by the Commission SRM. However, the supporting guidance continues to address drills or exercises as part of an acceptable means for implementation of the rule requirements.

¹ The three regulatory guides are RG 1.226, "Flexible Mitigation Strategies for Beyond-Design-Basis Events" (NRC 2017b), RG 1.227, "Wide-Range Spent Fuel Pool Level Instrumentation" (NRC 2017c), and RG 1.228, "Integrated Response Capabilities for Beyond-Design-Basis Events" (NRC 2017d).

7. Flexible scheduling requirements contained in draft final 10 CFR 50.155(h)(2)

This flexible scheduling requirements were provided for licensees that needed to address the reevaluated hazards requirements. Because the Commission SRM removed the reevaluated hazards requirements, this flexibility was no longer needed.

1.1 Background

Since the draft final rulemaking package, SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events" (NRC 2016) was submitted to the Commission, the NRC staff and the industry have completed most of the actions addressed by the rule and have made substantial process on the remaining issues. Given the Commission direction, this addenda to the regulatory analysis documents the incremental impacts of the Commission approved final rule.

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

The NRC has developed this final rule to make the requirements in the Mitigation Strategies and Spent Fuel Pool Instrumentation (SFPI) Orders generically applicable, giving consideration to lessons learned from implementation of the orders and public comment on the MBDBE proposed rule and addresses issues raised by petitions for rulemaking (PRMs) that were submitted to the NRC.

- Make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable. The rule places the requirements of Order EA-12-049, "Issuance of Order To Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Mitigation Strategies Order) (NRC 2012a) and Order EA-12-051, "Issuance of Order To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (SFPI Order) (NRC 2012b) in the NRC's regulations so that they apply to all current and future power reactor applicants and provides regulatory clarity and stability to power reactor licensees. All operating power reactor licensees and 11 combined license (COL) holders² currently are subject to these orders' requirements via order or license condition. In the absence of this rule, these requirements would need to be imposed on new reactor applicants or licensees through additional orders or license conditions as was done for all COLs issued to date.

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, which are captured in the updated guidance for mitigation strategies. Pursuing rulemaking allows the NRC to make the order requirements generically applicable with adjustments to account for any lessons learned. These adjustments would result in more effective regulation but would not extend beyond the existing scope of the existing orders. The final rule contains provisions to withdraw the orders and administratively remove the license conditions once a licensee has permanently ceased operation, permanently removed fuel from the reactor vessel,

² The 11 COL holders, when the regulatory analysis was prepared in 2016, 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.

and submitted the 10 CFR 50.82(a)(1) or 10 CFR 52.110(a) certifications of permanent cessation of operations and permanent removal of fuel from the reactor vessel.

- Address a number of PRMs submitted to the NRC. This final rule addresses and completes the regulatory actions planned for the five PRMs³ 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 Near-Term Task Force (NTTF) report and request that the NRC undertake rulemaking in a number of areas that are addressed by this rule. This rule also addresses, in part, PRM-50-96 submitted by Mr. Thomas Popik; however, broader issues raised in that petition regarding geomagnetic disturbances are outside the scope of this rule and remain under consideration by the NRC.

To achieve these objectives, the rule amends 10 CFR Part 50 and 10 CFR Part 52 to require mitigation strategies for responding to beyond-design-basis events.

2. Identification and Preliminary Analysis of Alternative Approaches

The NRC analyzed two options consistent with the Commission direction provided in SRM-SECY-16-0142:

- (1) Option 1: Take no action.
- (2) Option 2: Undertake rulemaking to make requirements in the Mitigation Strategies and SFPI Orders generically applicable, giving consideration to lessons learned from implementation of the orders and public comments on the MBDBE proposed rule and to address issues raised by PRMs that were submitted to the NRC.

The following sections provides the analysis of these options.

2.1 Option 1: Take No Action

This option 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 option includes that industry will continue to implement and maintain severe accident management guidelines (SAMGs) through a voluntary industry initiative and extensive damage mitigation guidelines (EDMGs) as required by 10 CFR 50.54(hh)(2). This option is equivalent to the status quo and serves as a baseline to measure against the other identified options.

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

³ 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."

(NRC 2015a), 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 Nuclear Energy Institute (NEI) 12-06, Revision 4 (NEI 2016). These industry voluntary initiatives 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.

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 and Order EA-12-051 Generically Applicable

This option (i.e., the final rule) would address the NRC's objective to make the requirements in Order EA-12-049 and Order EA-12-051 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. This option conforms with the Commission direction provided in SRM-SECY-16-0142.

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

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

To provide additional information on the benefits of proceeding with regulatory action on this issue, the staff has conducted the following supplemental analysis. The analysis uses the applicable assumptions, inputs, data, and methods described in enclosure 6 to SECY-16-0142 to determine the incremental benefits of the final rule.

3.1 Summary of Costs and Benefits of the Regulatory Options

This section presents the costs and benefits of the final rule with respect to two options: (1) take no action and (2) undertake a rulemaking to make Order EA-12-049 and Order EA-12-051 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). Note that all costs presented in this analysis are rounded to two significant figures.

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 (NRC 2013). 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 3-1.

Exhibit 3-1 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 option 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 Mitigation Strategies and SFPI Orders Generically Applicable

Under this option, the NRC would prepare a final rule to make Order EA-12-049 and Order EA-12-051 generically applicable, to establish regulatory requirements for documentation of changes, and to address a number of PRMs submitted to the NRC following the March 2011 Fukushima Dai-ichi event. The NRC estimates the costs and benefits of this option relative to the no-action baseline. This option would result in incremental one-time costs of (\$7.2 million). These costs result from the industry’s review of the final rule requirements. Exhibit 3-2 presents the total costs associated with this option.

Exhibit 3-2 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)
<u>Review Rule Requirements</u>							
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
<i>Subtotal</i>	(\$110,000)	\$0	(\$7,200,000)	\$0	(\$7,200,000)	(\$7,200,000)	(\$7,200,000)
<u>Staffing Capabilities</u>							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<i>Subtotal</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<u>Communication Capabilities</u>							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<i>Subtotal</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<u>Command and Control Procedures</u>							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<i>Subtotal</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<u>Reevaluated Hazard Evaluation</u>							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<i>Subtotal</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<u>Reevaluated Hazards Change Management</u>							
Industry	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NRC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<i>Subtotal</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<u>Total</u>							
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
Total	(\$110,000)	\$0	(\$7,200,000)	\$0	(\$7,200,000)	(\$7,200,000)	(\$7,200,000)

* Results are rounded.

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

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

Incremental Costs	Incremental Benefits
<p>Industry: (\$7.2 million) one-time implementation cost</p> <p>NRC: No incremental cost.</p> <p>Total: (\$7.2 million)</p>	<p>Increases regulatory efficiency.</p> <p>Provides for strategies and guidelines that are useable and cohesive to address beyond-design-basis event scenarios.</p> <p>Addresses lessons learned from the Fukushima accident and orders implementation.</p> <p>Provides for adequate staffing, command and control, and communication capabilities for severe external and multiunit events.</p> <p>Meets the intent of the Consolidated Appropriations Act.</p> <p>Provides defense in depth by giving confidence in the availability of mitigating strategies equipment following severe external flooding and seismic events.</p>

3.2 Costs of the Final Rule

This section details the estimated costs of the final rule (Option 2). Under the final rule option, the final rule includes the following requirements that were imposed under Order EA-12-049, which are sunk costs and 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)(2). The costs associated with this rule provision are treated as sunk 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.
- Paragraph 50.155(b)(1) requires strategies and guidelines to mitigate beyond-design-basis external events from natural phenomena that result in a loss of all alternating current power concurrent with either a loss of normal access to the ultimate heat sink or, for passive reactor designs, a loss of normal access to the normal heat sink. These strategies and guidelines are consistent with the existing diverse and flexible coping strategies (FLEX) support guidelines. 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 sunk costs. These costs include maintaining documentation (i.e., updates to procedures, programs, or plans), training, and plant configuration control to remain in compliance with the final rule.
- Paragraph 50.155(b)(2) contains the requirements for EDMGs that previously existed in 10 CFR 50.54(hh)(2) and are described in the Power Reactor Security Requirements final rule (74 FR 13925, March 27, 2009). The movement of these requirements consolidates the requirements for beyond-design-basis strategies and guidance into a single section to promote efficiency in their consideration and allow for better integration. Currently operating power reactor licensees have all achieved compliance with these requirements. The costs associated with this rule provision were previously incurred as

a result of the requirements promulgated under 10 CFR 50.54(hh)(2) and are treated as sunk costs.

- Paragraph 50.155(c)(2) requires licensees to provide reasonable protection of the equipment relied on for mitigation strategies, as previously required by Order EA-12-049. 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 sunk costs.
- Paragraph 50.155(d) requires licensees to provide for the training of personnel that perform activities in accordance with the capabilities required by 10 CFR 50.155(b)(1) and (b)(2). This training requirement was previously required by Order EA-12-049. Regulatory guidance for this order (NEI 2016)) provides acceptable methods to comply with this training requirement. 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 sunk costs.
- Paragraph 50.155(e) 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 treated as sunk costs.
- Paragraph 50.155(f) requires licenses to perform evaluations of proposed changes sufficient to reach a conclusion that the MBDBE rule requirements continue to be met, and to document and maintain this evaluation to support NRC oversight of these activities.

This option results in incremental costs of (\$7.2 million), as shown in Exhibit 3-3. The sections below describe these monetized costs in more detail.

3.2.1 Industry Implementation

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

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 2019 (the year the rule is expected to be effective).

3.2.2 Industry Operation

The NRC estimates that the final rule would not impose any incremental industry operation costs.

3.2.3 NRC Implementation

The NRC estimates that the final rule would not impose any incremental NRC implementation costs.

3.2.4 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 withdraw orders and remove license conditions⁴ 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 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 withdrawal 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 withdraw Order EA-12-049 and Order EA-12-051 for all licensees that received those orders once the MBDBE rule goes into effect and licensees are in compliance with it. Based on this approach, the NRC will not incur additional administrative burden following the promulgation of this rule to resolve inconsistencies with or withdraws redundant orders or remove license conditions once the final rule goes into effect.

3.3 Benefits of the Final Rule

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

- Option 1: No-action option. This option would not result in any incremental benefits above those resulting from the orders.
- Option 2: Undertake rulemaking to make Order EA-12-049 and Order EA-12-051 generically applicable. This option (i.e., the final rule) would result in regulatory efficiency improvements, which are discussed in Sections 3.3.1 and 3.3.2.

3.3.1 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 continue to maintain the benefits to public health (accident), occupational health (accident), offsite property, onsite property, and environmental considerations resulting from Order EA-12-049 and Order EA-12-051.

3.3.2 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.

⁴ 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 (NRC 2018a).

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 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), 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.

3.4 Uncertainty Analysis

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.⁵

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 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 technique (PERT) distribution.⁶ 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.

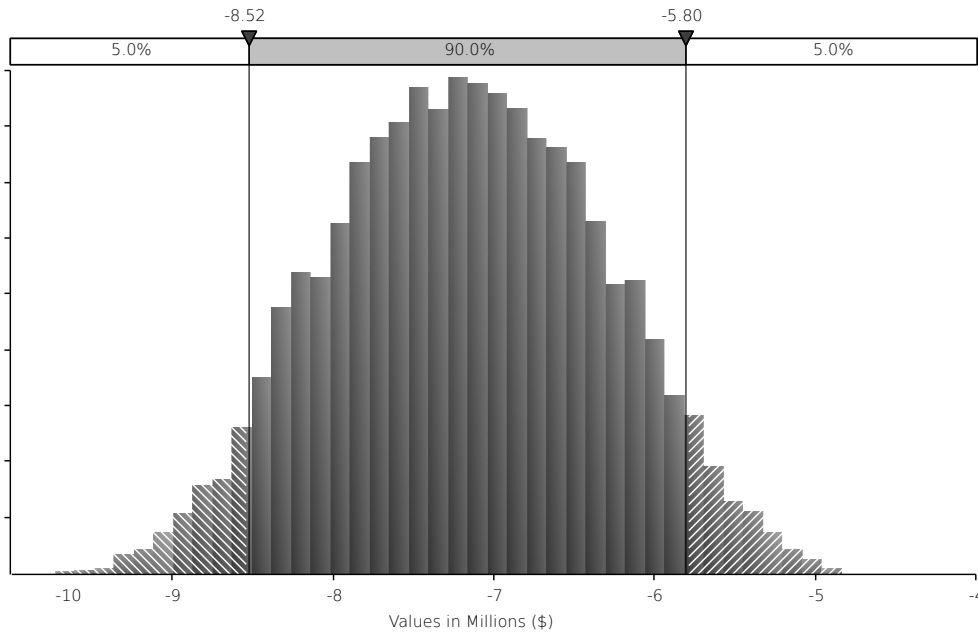
⁵ Information about this software is available online at www.palisade.com.

⁶ 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.

3.4.1 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 3-4 and 3-5 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.

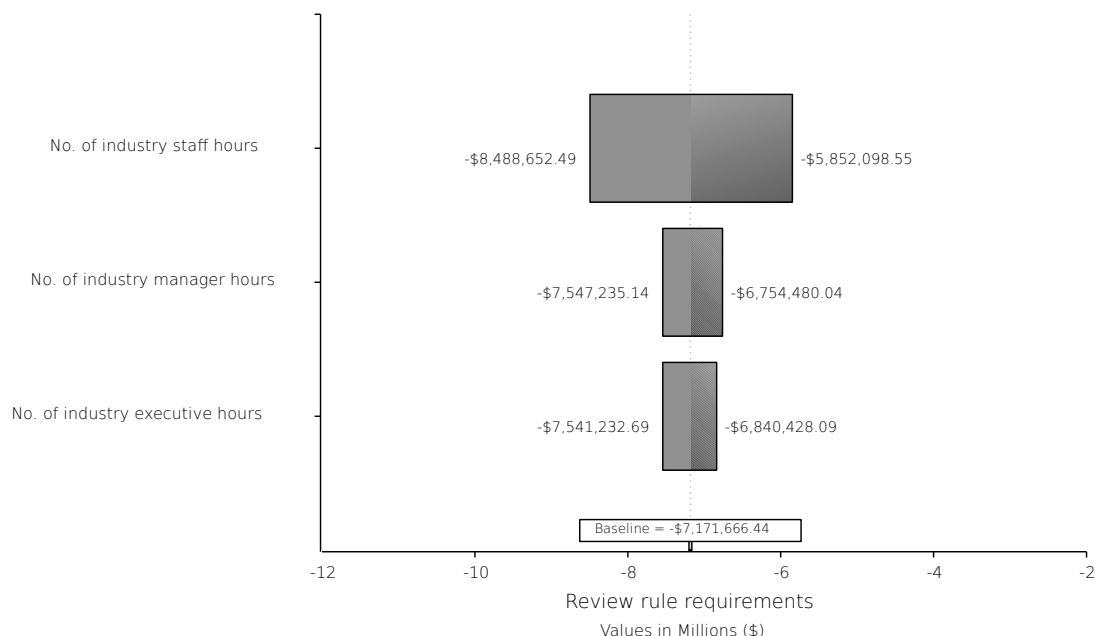
Exhibit 3-4 Industry Implementation Costs



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 3-5 presents the tornado diagram for the total cost of the final rule.

Exhibit 3-5 Key Variables Whose Uncertainty Drives the Largest Impact on Costs



Examining the tornado diagrams gives insight into which inputs have the largest effects on the output mean of this quantitative analysis. Exhibit 3-5 shows that the parameter that has the highest sensitivity ranking and is the most important is the number of hours expended by industry in reviewing the final rule requirements. 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.

3.4.2 Summary of Uncertainty Analysis

The simulation analysis shows that the estimated mean cost for the MBDBE final rule is (\$7.2 million), with 90-percent confidence that the cost is between (\$8.5 million) and (\$5.8 million).

The NRC staff assessed which variables have the largest impact on total costs for this final rule. As shown in Exhibit 3-5, the parameters that have the highest sensitivity ranking are the number of hours expended by in reviewing the final rule requirements.

3.5. 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 final 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 3-6.

Exhibit 3-6 Disaggregated Requirements

New or Revised 10 CFR Requirement	Generically Applicable Requirements	Address Fukushima Dai-ichi-Related PRMs
Section 50.8, "Information Collection Requirements: OMB Approval"	X	X
Section 50.34, "Contents of Applications; Technical Information"	X	X
Section 50.54, "Conditions of Licenses"	X	X
Section 50.155, "Mitigation of Beyond-Design-Basis Events"	X	X
Paragraph 50.155(a), "Applicability"	X	X
Paragraph 50.155(b), "Strategies and guidelines"	X	X
Paragraph 50.155(c), "Equipment"	X	X
Paragraph 50.155(d), "Training requirements"	X	X
Paragraph 50.155(e), "Spent fuel pool monitoring"	X	
Paragraph 50.155(f), "Documentation of changes"	X	
Paragraph 50.155(g), "Implementation"	X	X
Paragraph 50.155(h), "Withdrawal 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(d))	X	
10 CFR Part 50, Appendix E, Section VI, "Emergency Response Data System" (administratively replaced the phrase "onsite modem" and removed the word "unit")	X	
Section 52.80, "Contents of Applications; Additional Technical Information"	X	X

Exhibit 3-7 summarizes the estimated total costs to implement each of the stated regulatory objectives.

Exhibit 3-7 Disaggregated Cost-Benefit of the Final Rule Regulatory Objectives

Regulatory Objective	Current Dollars			Estimated Benefit
	5%	Mean	95%	
1. Make the requirements in Order EA-12-049 and Order EA-12-051 generically applicable	(\$8,500,000)	(\$7,200,000)	(\$5,800,000)	Regulatory efficiency
2. 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*	(\$8,500,000)	(\$7,200,000)	(\$5,800,000)	

* The final rule statistics are the statistics from the simulation curve.

3.6 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

(NRC 2017a). This document presents the reasons why Option 2, the rulemaking option, does not contain any backfits.

4. Conclusion

The staff prepared this addendum to the regulatory analysis in SECY-16-0142 to document the incremental impacts of the Commission approved rule. The conclusion 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.

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 (NRC 2015b)). 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 withdraw Order EA-12-049 and Order EA-12-051 and remove associated license conditions. The net cost to achieve this objective ranges between (\$8.5 million) and (\$5.8 million) with a mean value of (\$7.2 million). These costs also achieve the objective described in Section 1.2.

The final rule encompasses provisions that are either completed or being implemented at this time under the Mitigation Strategies Order and the SFPI Order. Because the NRC uses a no action baseline to estimate incremental costs, the total cost of the rule is estimated to be approximately \$110,000 per site. This incremental cost is primarily attributed to licensees' efforts to review the rule against the previous implementation of the Mitigation Strategies and SFPI Orders and make any additional changes to plant programs and procedures. The final rule is expected to result in a total one-time cost of approximately (\$7.2 million) even though the MBDBE requirements have largely been implemented prior to the effective date of the rule under the requirements in the Mitigation Strategies Order and the SFPI Order.

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 (NRC 2017a).

4.2 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 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. The net cost to achieve this objective is included in the costs discussed in Section 4.1.

4.3 Summary

Based on the NRC's assessment of the costs and benefits of the rule, the NRC has concluded that the MBDBE final rule is justified.

References

Code of Federal Regulations (CFR), Title 10, *Energy*, Part 50, “Domestic Licensing of Production and Utilization Facilities.” Available at <http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/>.

CFR, Title 10, *Energy*, Part 52 “Licenses, Certifications, and Approvals for Nuclear Power Plants.” Available at <https://www.nrc.gov/reading-rm/doc-collections/cfr/part052/>.

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Nuclear Energy Institute (NEI), “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” NEI 12-06, Rev. 4, December 2016, Agencywide Documents Access and Management System (ADAMS) Accession No. ML16267A274.

U.S. Nuclear Regulatory Commission (NRC), “Power Reactor Security Requirements,” *Federal Register* Volume 74, Issue 58, Page 13925 (74 FR 13925), March 27, 2009.

NRC, “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, 2012a, ADAMS Accession No. ML12054A736.

NRC, “Issuance of Order To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,” Order EA-12-051, March 12, 2012b, ADAMS Accession No. ML12054A682.

NRC, “Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants,” Commission Paper COMSECY-15-0019, June 30, 2015a, ADAMS Accession No. ML15153A105.

NRC, “Staff Requirements—SECY-15-0065— Proposed Rule: Mitigation of Beyond-Design-Basis Events,” dated August 27, 2015b, ADAMS Accession No. ML15239A767.

NRC, “Draft Final Rule – Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49),” SECY-16-0142, December 15, 2016, ADAMS Accession No. ML16301A005.

NRC, “Backfitting and Issue Finality Assessment Supporting the Mitigation of Beyond-Design-Basis Events Final Rule,” January 5, 2017a, ADAMS Accession No. ML16273A010.

NRC, Regulatory Guide (RG) 1.226, “Flexible Mitigation Strategies for Beyond-Design-Basis Events,” Rev. 0, January 18, 2017b, ADAMS Accession No. ML16301A128).

NRC, Regulatory Guide (RG) 1.227, “Wide-Range Spent Fuel Pool Level Instrumentation,” Rev. 0, January 18, 2017c, ADAMS Accession No. ML16211A167.

NRC, Regulatory Guide (RG) 1.228, “Integrated Response Capabilities for Beyond-Design-Basis Events,” Rev. 0, January 18, 2017d, ADAMS Accession No. ML16218A236).

*Regulatory Analysis Addenda:
Final Rule to Address Mitigation of Beyond-Design-Basis Events*

NRC, "Mitigation of Beyond-Design-Basis Events, Final Rule," draft final *Federal Register* Notice, July 30, 2018a, ADAMS Accession No. ML16292A026.

NRC, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49)," SRM-SECY-16-0142, Add date, 2018b, ADAMS Accession No. MLxxxxxxxxx.

Appendix A Supplementary Exhibit

Exhibit A-1 Variables Used in the Uncertainty Analysis

Data Element	Mean Estimate	Distribution	Low Estimate	Best Estimate	High Estimate
Site Inputs					
Total number of operating sites	55				
Number of decommissioning sites with fuel remaining in SFP	10				
Review Rule Requirements					
Number of executive hours per site to review the rule requirements	83 hrs/site	PERT	40 hrs/site	80 hrs/site	140 hrs/site
Number of manager hours per site to review the rule requirements	162 hrs/site	PERT	80 hrs/site	160 hrs/site	250 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	1,400 hrs/site
Labor Rates					
Industry executives	\$166.69				
Industry managers	\$110.37				
Industry staff	\$78.60				