Supplemental Regulatory Analysis

Proposed Rulemaking to Address Mitigation of Beyond-Design-Basis Events: Design Features for New Reactors

U.S. Nuclear Regulatory Commission

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Abbreviations and Acronyms

ac	alternating current
ADAMS	Agencywide Documents Access and Management System
APR	advanced light water reactor
APWR	advanced pressurized-water reactor
BLS	U.S. Bureau of Labor Statistics
CFR	*Code of Federal Regulations*
COL	combined license
CPI	consumer price index
DG	draft guide
ELAP	extended loss of ac power
EPR	evolutionary pressurized-water reactor
EPRI	Electric Power Research Institute
FR	*Federal Register*
FY	fiscal year
KHNP	Korea Hydro and Nuclear Power
LOE	level of effort
LUHS	loss of ultimate heat sink
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
NUREG	NRC technical report designation
PEF	Progress Energy Florida, Inc.
PERT	Program Evaluation and Review Technique
SAMG	severe accident management guidelines
SFP	spent fuel pool
SOC	standard occupational classification
SSCs	structures, systems, and components
STPNOC	South Texas Project Nuclear Operating Company

1 Statement of the Problem and Objectives

This supplemental regulatory analysis addresses the design concept that is currently proposed by the U.S. Nuclear Regulatory Commission (NRC) staff in paragraph (d), “Design features,” of Section 50.155, “Mitigation of beyond-design-basis-events,” in Title 10 of the *Code of Federal Regulations* (10 CFR). This paragraph is specific to applicants requesting approval of a new reactor design (either through an operating license or construction permit under 10 CFR Part 50, or a standard design certification, standard design approval, or a combined license (COL) or manufacturing license that does not reference a design certification under 10 CFR Part 52, as described in paragraph (a)(4) of the proposed rule. The proposed requirement would require these applicants to include design features in the plant design sufficient to enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities during an extended loss of all ac power (ELAP) concurrent with either a loss of normal access to the ultimate heat sink (LUHS) or, for passive reactor designs, a loss of normal access to the normal heat sink. For brevity within this document, this event is referred to as an ELAP concurrent with a LUHS, but the clarification for passive reactor designs applies each time the event is referenced. The term “design features,” in this context, means structures, systems, and components (SSCs), including the physical arrangement of such SSCs, and their functional capabilities—key characteristics of the SSCs that result in their contribution to maintain or restore the key safety functions.

This design concept is being proposed by the NRC for three reasons:

1. This concept would leverage the unique opportunity during the design stage to incorporate enhanced capability for mitigating strategies into the design. Before detailed design or construction begins, new reactor applicants have the flexibility to include design features in the plant design that would support implementation 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 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A735). Such design features should reduce and simplify the manual actions necessary to maintain or restore key safety functions, and allow more time to properly assess plant conditions and prolong the use of installed equipment, as compared to current operating reactors that will rely more heavily on portable and offsite equipment to implement their mitigating strategies. The design concept may also involve increasing the capability and capacity (e.g., higher design operating temperature, increased dc power capacity) of SSCs already included in the design basis to address other NRC requirements (e.g., the General Design Criteria in Appendix A 10 CFR Part 50), as opposed to adding new features.

2. This concept is consistent with the “Policy Statement on the Regulation of Advanced Reactors” (73 *Federal Register* (FR) 60612; October 14, 2008) (Ref. 1). This policy statement clarified the Commission’s expectations that advanced reactors should provide enhanced margins of safety and use simplified means to accomplish safety functions, including longer times for operators to diagnose and manage challenges and simplified safety systems that reduce required operator actions. These expectations have been implemented in a number of requirements and policies for new reactors and realized in multiple reactor designs. Therefore, the enhancements described in the item above are expected to provide a risk and safety benefit for new reactors as described in this policy statement.

3. A design-focused approach may be simpler and less costly for individual licensees to implement, train on, and maintain, in addition to the simpler operation described above. For COL applicants referencing a certified design that includes the subject design features (and thereby relies on less portable and offsite equipment compared to operating reactors), the scope of work at their application stage to address site-specific strategies would be reduced. In addition, COL licensees may avert the cost of procuring certain onsite portable equipment that would be necessary if installed features were not included in the design. Further, this design-focused approach would also increase standardization of new reactor designs, because licensees referencing these designs would rely on the installed design features as part of their mitigation strategies, leading to fewer site-specific deviations among the strategies. As described further in the policy statement on “Nuclear Power Plant Standardization” (52 FR 34884; September 15, 1987) (Ref. 2), standardization is an important initiative that can significantly enhance the safety, reliability, and availability of nuclear power plants.

The NRC staff has developed this supplemental regulatory analysis to assess the advantages and disadvantages of various alternatives for implementing this design concept through voluntary and required action, to inform agency decisionmaking on the topic in the rulemaking process.

Each option described in this supplemental regulatory analysis is a sub-element of Option 2 in the regulatory analysis for the proposed rulemaking (ADAMS Accession No. ML15049A212). As described in the regulatory analysis, this option would have the Commission undertake rulemaking to make Order EA-12-049, Order EA-12-051, “Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Effective Immediately) - To All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status,” dated March 12, 2012 (ADAMS Accession No. ML12056A044) and associated industry initiatives generically applicable and (as currently written in the proposed 10 CFR 50.155(d)) establish a requirement that new reactor applicants would include design features in the plant design sufficient to enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and SFP cooling capabilities during an ELAP concurrent with a LUHS. The advantages, disadvantages, and attendant costs described are an increment to those presented for Option 2 in the regulatory analysis.

2 Backfit Screening

The NRC has determined that the backfit rule, 10 CFR 50.109, “Backfitting,” does not apply to the alternatives described in this supplemental regulatory analysis. These alternatives provide guidance, clarify policy, or establish requirements that are forward-looking in nature. The backfit rule was not intended to apply to every NRC action that changes the expectations of future applicants. The alternatives, including the proposed requirement in 10 CFR 50.155(d), would impose no new requirements on (1) an applicant that obtains a permit or license before the effective date of the final rule, (2) a design certification rule in Appendices A through E to 10 CFR Part 52, (3) the current fleet of operating nuclear power reactors, or (4) the concurrent COL licensees. For similar reasons, none of the alternatives would be inconsistent with the issue finality provisions for licenses and certifications under 10 CFR Part 52.

3 Identification and Analysis of Alternative Approaches

As described above, this supplemental regulatory analysis identifies four sub-alternatives for consideration within Option 2 in the regulatory analysis. Alternative 2d is the option currently reflected in this proposed rule under 10 CFR 50.155(d).

- Alternative 2a: Take no action unique to new reactors
- Alternative 2b: Issue guidance for new application and license reviews
- Alternative 2c: Revise the advanced reactor policy statement
- Alternative 2d: Include paragraph 50.155(d) in the proposed rule

3.1 Alternative 2a: Take no action unique to new reactors

Under Alternative 2a, paragraph (d) would not be included in 10 CFR 50.155, and no unique action would be taken to impose requirements or provide additional guidance for new reactor applicants related to design features that enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities during an ELAP concurrent with a LUHS. That is, new reactors would be subject to the same requirements, expectations, and guidance as operating reactors in using portable and offsite equipment to address site-specific strategies. This alternative has the same costs as the Option 2 described in the regulatory analysis, as all licensees and applicants would be treated uniformly regardless of the time of licensing or certification. Therefore, it serves as a baseline to measure the costs and benefits against the other identified sub-alternatives.

New reactor applicants and licensees might nonetheless find it practical and appropriate to incorporate design features in the plant design, or to credit design features already included in the plant design, as part of their overall approach to implementing paragraph (b) of the proposed 10 CFR 50.155. The Commission expectations for new and advanced reactors apply generally, particularly those outlined in the advanced reactor policy statement mentioned above and the severe-accident policy statement, "Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants" (50 FR 32138; August 8, 1985) (Ref. 3). These policy statements, combined with additional provisions in regulations and guidance for new reactors, have resulted in numerous design enhancements for reactors designed after the current operating fleet. The advantages, disadvantages, and attendant costs of implementing such voluntary changes, however, are speculative in the absence of specific guidance, expectations, or requirements. Any design enhancements under Alternative 2a would be included at the discretion of the new reactor applicant or licensee and are not documented under this alternative in this supplemental regulatory analysis.

The advantages and disadvantages of this alternative are provided in Table 1.

Table 1 Alternative 2a – Advantages and Disadvantages

Advantages	Disadvantages
1. No additional costs beyond the overall Option 2.	1. Provides no additional benefits for new reactor designs beyond the Option 2 discussed in the regulatory analysis. 2. Encourages enhancements only indirectly and generally through the advanced reactor policy

Advantages	Disadvantages
	statement, rather than requiring them. Application of the policy statement would be voluntary and the simpler, safer design described in the policy statement may not be realized with respect to the specific topic of mitigating strategies. 3. Reduces the benefit of enhanced standardization for applicants choosing an approach different from the Commission policy and guidance, as more site-specific strategies would be needed in the absence of design features.

3.2 Alternative 2b: Issue guidance for new application and license reviews

Under Alternative 2b, paragraph (d) would not be included in 10 CFR 50.155, but the NRC staff would issue guidance clarifying the staff position related to new reactors' implementation of paragraph (b) of the proposed 10 CFR 50.155. That is, new reactor applicants that follow the guidance would be expected to build their early-phase mitigation strategies for an ELAP concurrent with a LUHS around design features that enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities. This guidance would be used by NRC staff in reviewing the acceptability of new reactor applicant compliance with 10 CFR 50.155.

Guidance appropriate for Alternative 2b has already been developed by the NRC staff and included in Appendix A to DG-1301, "Flexible Mitigation Strategies for Beyond-Design-Basis Events." If paragraph (d) were not included in 10 CFR 50.155, this guidance would need to be revised, but the technical considerations would be consistent with what has already been developed. This draft guide would be subject to public comment. The overall cost for developing this guide is presented in the analysis below.

Under this alternative, the inclusion of design features in the overall mitigating strategy would be an NRC expectation executed through guidance rather than a regulatory requirement. Therefore, some standardization should be gained among applicants that conform to the guidance, as all COL applicants referencing a certified design that includes these design features would follow the same design approach. In addition, consistent outcomes would result for all designers following the guidance, though the specific design choices would not be standardized. Since there would be no requirement, however, individual designers or licensees could propose alternative approaches that could also be acceptable. Additional cost would be incurred in the review to develop alignment between applicants and the NRC on an acceptable approach. The advantages, disadvantages, and attendant costs of applicants that select an approach different from the NRC guidance would be the consideration of the applicant and are not documented in this supplemental regulatory analysis.

The advantages and disadvantages of this alternative are provided in Table 2.

Table 2 Alternative 2b – Advantages and Disadvantages

Advantages	Disadvantages
1. Reduces and simplifies operator actions, and increases time for those actions, providing a risk and safety benefit consistent with the advanced reactor policy statement. 2. Simplifies the strategies required by license applicants and may potentially reduce the cost of implementing the overall strategy given reduced need for portable and offsite equipment.	1. Imposes cost (quantified below) on new reactor designers to develop design features and describe them in their applications. 2. Imposes cost (quantified below) on NRC staff and industry to develop and issue guidance. 3. This alternative could be viewed as regulating through guidance (i.e., encouraging industry to implement a chosen approach without a regulatory requirement), which may not achieve the desired outcome given the ability of applicants and licensees to justify alternative approaches. 4. Reduces the benefit of enhanced standardization for applicants choosing an approach different from the staff position, as more site-specific strategies would be needed in the absence of design features.

3.3 Alternative 2c: Revise the advanced reactor policy statement

Under Alternative 2c, paragraph (d) would not be included in 10 CFR 50.155, but the NRC would update the Policy Statement on the Regulation of Advanced Reactors to communicate a Commission expectation that new nuclear reactor designs include design features to address ELAP concurrent with a LUHS. In addition, the NRC staff would develop guidance, similar to that described under Alternative 2b (Appendix A to Draft Guide (DG)-1301), to clarify the NRC position related to new reactors' implementation of paragraph (b) of the proposed 10 CFR 50.155.

Under this alternative, the inclusion of design features in the overall mitigating strategy would be an NRC expectation rather than a requirement. This additional expectation in Commission policy, beyond an NRC staff position in guidance (i.e., Alternative 2b), should provide further encouragement to new reactor applicants to include such provisions in their designs, and thus would result in further standardization among the applicants referencing these designs. This approach is consistent with previous Commission policy decisions that enhanced specific expectations because of flexibility available during the design stage. The Supplementary Information section of the proposed rule provides several relevant examples.

Different approaches could still be acceptable; however, applicants would need to justify how they meet the underlying regulatory requirements, policies, and guidance applicable to new reactors. Additional cost would be incurred in the review to develop alignment between applicants and the NRC on an acceptable approach. The advantages, disadvantages, and attendant costs of applicants that select an approach different from the Commission position and NRC staff guidance would be the consideration of the applicant and are not documented in this supplemental regulatory analysis.

The advantages and disadvantages of this alternative are provided in Table 3.

Table 3 Alternative 2c – Advantages and Disadvantages

Advantages	Disadvantages
1. Reduces and simplifies operator actions, and increases time for those actions, providing a risk and safety benefit consistent with the overall philosophy of the advanced reactor policy statement. 2. Clear Commission direction, not just NRC staff position, which may encourage applicants to pursue this design-focused approach. 3. Simplifies the strategies required by license applicants and should reduce the cost of implementing the overall strategy given reduced need for portable and offsite equipment. 4. Provides a greater level of regulatory stability and predictability beyond Alternative 2b through clear Commission policy.	1. Imposes cost on the NRC staff (as well as to stakeholders who choose to comment on a draft policy statement) to update the policy statement on the Regulation of Advanced Reactors (Ref. 1). 2. Imposes cost (quantified below) on new reactor designers to develop design features and describe them in their applications. 3. Imposes cost (quantified below) on NRC staff and industry to develop and issue guidance. 4. Regulates through Commission expectation (i.e., encouraging industry to implement a chosen approach described in the policy statement) without a regulatory requirement, which may not achieve the desired outcome given the ability of applicants and licensees to justify alternative approaches. 5. Reduces the benefit of enhanced standardization for applicants choosing an approach different from the Commission policy and guidance, as more site-specific strategies would be needed in the absence of design features.

3.4 Alternative 2d: Include paragraph 50.155(d) in the proposed rule

Under Alternative 2d, paragraph (d) would be included in 10 CFR 50.155. This paragraph is specific to applicants requesting approval of a new reactor design, as applicable under paragraph (a)(4) of the proposed rule. The proposed rule would require these applicants to include design features in the plant design sufficient to enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities during ELAP concurrent with a LUHS.

This provision would codify an alternative that is expected to result in reduced operator action; increased safety margins; and a safer, standardized, and potentially less costly holistic approach to developing the mitigation strategies. In addition, this alternative is consistent with Commission policy that new reactors will have enhanced safety margins compared to operating reactors. While the NRC expects that the same outcome would result for most, if not all, designs under Alternatives 2b and 2c (given clear guidance and policy positions), a codified provision would provide the most regulatory certainty and uniformity in approach, without the additional interaction and associated cost to align on an acceptable approach.

The Commission has previously imposed new requirements to address beyond-design-basis events. For example, 10 CFR 50.150, “Aircraft Impact Assessment,” requires new reactor applicants, in part, to perform an assessment of the effects on the facility of a large, commercial aircraft and incorporate into the design those design features and functional capabilities to show that, with reduced use of operator actions, the reactor core remains cooled or the containment remains intact, and spent fuel pool cooling or spent fuel pool integrity is maintained. In addition, applicants for new reactor design certifications are subject to severe accident requirements under 10 CFR 52.47(a)(23).

Applicants would need to describe the design features that were included in their design and how those design features comply with 10 CFR 50.155(d). The NRC staff would review the parts of the application related to these design features and make a regulatory finding on them as part of the licensing processes referenced in paragraph (a)(4) of the proposed 10 CFR 50.155. To support this review, the NRC staff would develop guidance, similar to that described under Alternatives 2b and 2c (Appendix A to DG-1301), to clarify the staff position related implementation of paragraph (d) of the proposed 10 CFR 50.155. Later changes to these design features, if warranted, would be subject to standard change processes described in 10 CFR 50.54, "Conditions of licenses," 10 CFR 50.90, "Application for amendment of license, construction permit or early site permit," the appropriate 10 CFR Part 52 appendix for a design certification, or 10 CFR 50.155(g).

Table 4 Alternative 2d – Advantages and Disadvantages

Advantages	Disadvantages
1. Reduces and simplifies operator actions, and increases time for those actions, providing a risk and safety benefit consistent with the advanced reactor policy statement. 2. Ensures that applicants will pursue this design-focused approach. 3. Simplifies the strategies required by license applicants and reduces the cost of implementing the overall strategy given reduced need for portable and offsite equipment. 4. Provides regulatory stability and predictability through clear regulatory requirements and associated NRC guidance.	1. Imposes cost (quantified below) on the NRC staff (as well as to stakeholders who choose to comment on the proposed rule) to complete the rulemaking process for this proposed rule provision. 2. Imposes cost (quantified below) on new reactor designers to develop design features and describe them in their applications. Likely no net cost to NRC staff as review would be integrated and resources could be shifted from license review to a design-stage review. 3. Imposes cost (quantified below) on NRC staff and industry to develop and issue guidance.

4 Analysis of Benefits and Costs

4.1 Identification of Affected Attributes

The attributes that the proposed rule could affect were identified by using the list of potential attributes provided in Chapter 5 of NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," issued January 1997 (Ref. 4).

As described above, the benefits and costs associated with each alternative are an increment to those presented for Option 2 in the regulatory analysis for this rulemaking. Alternative 2a would be equivalent to the overall Option 2 and would have no incremental change in benefit or cost.

Alternatives 2b, 2c, or 2d would provide both additional benefits (e.g., simplified operation and greater safety margins) and additional costs (e.g., rulemaking, development, and implementation of design features or capabilities not included in the design basis). In addition, these alternatives could potentially avert some costs inherent in Option 2 associated with portable equipment or other strategies that would not be needed if the design features described above were included in the plant design.

A summary of the effect on these potential attributes is as follows:

- Public Health (Accident) — Alternatives 2b, 2c, and 2d would result in design features that would, through a simpler and safer design, reduce the risk that public health will be affected by radiological releases resulting from an ELAP concurrent with a LUHS.

- Occupational Health (Accident) — Alternatives 2b, 2c, and 2d would result in design features that would, through reduced and simplified operator action, reduce the risk that occupational health will be affected by radiological releases resulting from an ELAP concurrent with a LUHS.

- Onsite Property — Alternatives 2b, 2c, and 2d would result in design features that would, through a simpler and safer design, reduce the risk that onsite property will be affected by radiological releases resulting from an ELAP concurrent with a LUHS.

- Offsite Property — Alternatives 2b, 2c, and 2d would result in design features that would, through a simpler and safer design, reduce the risk that offsite property will be affected by radiological releases resulting from an ELAP concurrent with a LUHS.

- Industry Implementation — Alternatives 2b, 2c, and 2d would result in design features in new reactor designs that enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities. The proposed action would resolve design-related ELAP issues at an early stage of the regulatory review process. This would result in a more robust mitigation capability for an ELAP event.

- Industry Operation — Alternatives 2b, 2c, and 2d would result in design features in new reactor designs that include routine and recurring activities such as equipment lifecycle costs (i.e., maintenance and replacement) during the licensed operation for the facility. Applicants would incur costs through the consideration and inclusion of design features in their applications, and licensees would incur lifecycle costs to implement these design features at their sites. To the extent that the design features credit design-basis systems (potentially with additional capacity or capability), applicants or licensees might incur incremental costs to analyze and qualify portions of these systems.

- NRC Implementation — Under the proposed alternatives, the NRC would incur costs to develop guidance, policy, and/or rules for the design features requirement and to review applications addressing the design features requirement. The NRC would also incur the costs of completing this regulatory action.

- Regulatory Efficiency[1] — The proposed action would result in enhanced regulatory efficiency through regulatory and compliance improvements by ensuring that design features are included early in the regulatory review process. In addition, the proposed action would require applicants for new nuclear power reactors to include a discussion of these design features with their application. Furthermore, as described in the standardization policy statement, efficiency would be gained through the inclusion of design features in a standardized design subject to a single review rather than through individual licensing actions.

- Other Considerations — Increase in Public Confidence — The NRC staff has not identified any impacts upon other stakeholders or the Agreement States. However, the proposed action could lead to an increase in public confidence because ELAP design features would have been addressed and incorporated into the facility design at the early stage of the regulatory review process.

Attributes that are not expected to be affected by this rulemaking provision include the following: public health (routine); occupational health (routine); NRC operation; other government; general public; improvements in knowledge; antitrust considerations; safeguards and security considerations; and environmental considerations.

4.2 Analytical Method

This section describes the analytical methods and assumptions used to evaluate benefits and costs associated with the alternatives. The benefits of the alternatives include any desirable changes in affected attributes (e.g., monetary savings, improved safety) while the costs include any undesirable changes in affected attributes (e.g., monetary costs, increased exposures). This supplemental regulatory analysis was developed following the guidance contained in NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," Revision 4, issued in September 2004 (ADAMS Accession No. ML042820192) (Ref. 5) and NUREG/BR-0053, Revision 6, "USNRC Regulations Handbook," issued in 2005 (ADAMS Accession No. ML052720461) (Ref. 6).

As described in Section 4.1, only two attributes—industry implementation and NRC implementation—can be evaluated on a quantitative basis. Ideally, a full benefit-cost analysis would quantify the overall benefits and costs of the regulatory options relative to each attribute. This analysis relies on a qualitative evaluation of several of the affected attributes (public health, occupational health, offsite property, onsite property, and regulatory efficiency) because of the difficulty in quantifying the effect of the proposed rule provision. For example, the estimated public and occupational health benefit (e.g., averted dose) is dependent on the specific design approach selected, level of operator action needed, and other attributes that are speculative before designs are proposed by applicants.

The remaining attributes (industry implementation and NRC implementation) are evaluated quantitatively. This quantitative analysis requires a baseline characterization of the affected

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[1] The regulatory efficiency attribute is evaluated qualitatively, by definition, as discussed in Section 5.5.1.4 of NUREG/BR-0184, Regulatory Analysis Technical Evaluation Handbook" (Ref. 4). Specifically, this attribute attempts to measure regulatory and compliance improvements resulting from the proposed action. These may include changes in industry reporting requirements and the NRC's inspection and review efforts. Achieving consistency with international standards groups may also improve regulatory efficiency for both the NRC and the standards groups. This attribute is qualitative in nature.

universe, including characterization of factors such as the number of affected entities and the application process that licensees would use relative to the alternative baseline identified as Alternative 2a.

Under Office of Management and Budget guidance and NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (Ref. 5), the analysis results are presented as discounted flows of funds using 3 and 7 percent real discount rates. Finally, the NRC staff sums the net present value estimates of the costs and the benefits for each alternative and compares them.

In addition to the extent that there are important qualitative considerations of factors that cannot be quantified, these considerations of factors are discussed in qualitative terms. Based on the quantified costs and benefits and the qualitative consideration of each attribute, the staff will make a recommendation.

4.2.1 Baseline for Analysis

This supplemental regulatory analysis measures the incremental costs of the proposed rule provision relative to a "baseline" that reflects anticipated behavior in the event the NRC undertakes no additional regulatory action (Alternative 2a). This alternative is equivalent to Option 2 in the regulatory analysis.

4.2.2 Affected Entities

These alternatives are applicable to the following entities:

- Applicants for construction permits
- Applicants for operating licenses that reference a new construction permit
- Applicants for standard design certifications
- Applicants for standard design approvals
- Applicants for manufacturing licenses that do not reference a standard design certification or standard design approval
- Applicants for COLs that do not reference a standard design certification, standard design approval, or manufactured reactor

The alternatives would not apply to applicants for new designs under either 10 CFR Part 50 or Part 52 whose design is approved before any revisions to guidance, policy, or requirements are effective. The alternatives would also not apply to a COL or manufacturing license that references a completed standard design approval, standard design certification, or manufacturing license. Further, the alternatives would not apply to the renewal of a standard design certification. In each of these cases, the design features requirement could not be imposed on those applicants or licensees because it would be considered a backfit under 10 CFR 50.109 or inconsistent with the issue finality provisions of 10 CFR Part 52. These entities, however, might comment on draft guidance, policy, or regulations that are issued for public comment. Therefore, their participation is included in the costs below, along with industry groups such as the Nuclear Energy Institute (NEI) and the Electric Power Research Institute (EPRI). Section 6 below describes the NRC's proposed implementation process for engaging current applicants to whom the alternatives would be applicable.

4.2.2.1 Construction Permit Applications

The NRC staff does not expect any construction permit applications to be submitted over the next 10 years that would be affected by the alternatives. The staff considered construction permit application forecasts beyond 2025 as too speculative for this analysis.

4.2.2.2 Operating License Applications

The NRC staff does not expect any operating license applications to be submitted over the next 10 years that would be affected by the alternatives.[2] The staff considered forecasts beyond 2025 as too speculative for this analysis.

4.2.2.3 Design Certification Applications

For design certification applications, this analysis assumes that four applications would be submitted to and reviewed by the NRC. Table 5 presents information on the applicants and schedule of design certification applications that would be affected by the alternatives.

Table 5 Design Certification Schedule

Design Certification Applicant [a]	Submittal date	Estimated Issue Date of Design Certification Rule
AREVA (U.S. EPR)	2008	2020 [b]
Mitsubishi Heavy Industries (US-APWR)	2008	2018
Korea Hydro and Nuclear Power (KHNP) (APR1400)	2015	2019
NuScale Power (NuScale)	2016	2020

a. Values from U.S. NRC webpage, "Application Schedule for New Reactors," updated as of 11/21/2014, retrievable at http://www.nrc.gov/reactors/new-reactors.html.

b. Application review was suspended in March 2015 at the request of the applicant. For purposes of this analysis, the NRC staff assumes that this application will restart in 2018 and the design certification rule will be issued in 2020.

4.2.2.4 Manufacturing License Applications

The NRC staff does not expect any manufacturing license applications to be submitted over the next 10 years that would be affected by the alternatives. The staff considered forecasts beyond 2025 as too speculative for this analysis.

2 The Bellefonte Nuclear Power Station Units 1 and 2 are excluded from this proposed rule provision because this proposed requirement would only apply to applicants for new nuclear power designs. Specifically, it would not apply to current holders of permits or certifications for nuclear power plant designs (i.e., holder of a construction permit). Tennessee Valley Authority holds construction permits for Bellefonte Units 1 and 2 in which construction is indefinitely delayed under the Commission Policy Statement on Deferred Plants (52 FR 38077, October 14, 1987).

4.2.2.5 Standard Design Approvals

The NRC staff does not expect any standard design approval applications to be submitted over the next 10 years that would be affected by the alternatives. The staff considered forecasts beyond 2025 as too speculative for this analysis.

4.2.2.6 Combined License Applications

Table 6 provides information on the COL applications that the NRC staff has received to date. The NRC staff assumes that no additional COL applications will be submitted over the next 10 years that would be affected by the alternatives. The staff considered forecasts beyond 2025 as too speculative for this analysis.

Table 6 COL Applications

Proposed New Reactor(s)	Design	COL Applicant	Status
Bell Bend Nuclear Power Plant	U.S. EPR	PPL Bell Bend, LLC	Suspended
Bellefonte Nuclear Station, Units 3 and 4	AP1000	Tennessee Valley Authority	Suspended
Callaway Plant, Unit 2	U.S. EPR	AmerenUE	Suspended
Calvert Cliffs, Unit 3	U.S. EPR	Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC	Suspended
Comanche Peak, Units 3 and 4	US-APWR	Luminant Generation Company, LLC (Luminant)	Suspended
Fermi, Unit 3	ESBWR	Detroit Edison Company	Under Review
Grand Gulf, Unit 3	ESBWR	Entergy Operations, Inc.	Suspended
Levy County, Units 1 and 2	AP1000	Progress Energy Florida, Inc. (PEF)	Under Review
Nine Mile Point, Unit 3	U.S. EPR	Nine Mile Point 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (UniStar)	Withdrawn
North Anna, Unit 3	ESBWR	Dominion Virginia Power (Dominion)	Under Review
River Bend Station, Unit 3	ESBWR	Entergy Operations, Inc.	Suspended
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 (STPNOC)	Under Review
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
William States Lee III, Units 1 and 2	AP1000	Duke Energy	Under Review

[a] Values from U.S. NRC webpage, "Combined License Applications for New Reactors," updated as of 7/21/2014, retrievable at http://www.nrc.gov/reactors/new-reactors/col.html.

The COL applications that reference the AP1000, ESBWR, or ABWR are excluded from this proposed rule provision because this proposed requirement would only apply to applicants for new nuclear power designs. Table 7 summarizes the review status of known COL applicants whose application will reference a new reactor design.

Table 7 Number of COL Applications that Reference New Reactor Designs

New Reactor Design	No. of COL Applications by Review Status [a]			
	Under Review	Suspended	Withdrawn	Future COLAs
AREVA (U.S. EPR)	–	• Bell Bend [b] • Calvert Cliffs Unit 3 [c] • Callaway Plant Unit 2	• Nine Mile Point Unit 3	
Mitsubishi Heavy Industries (US-APWR)	–	• Comanche Peak Unit 3 • Comanche Peak Unit 4	–	
KHNP (APR1400)	–	–	–	–
NuScale Power (NuScale)	–	–	–	–

a The NRC staff assumed no future COL applications in the low and most likely estimates. The NRC staff included a total of six COL applications for the high estimate. This estimate includes COL applications under all four review status groupings.

b. The safety portion of the COL application review was suspended in January 2014 at the request of the applicant. For purposes of this analysis, this application is excluded from the best estimate but included in the uncertainty analysis.

c. The COL application review was suspended in February 2015 (ADAMS Accession No. ML15062A050) at the request of the applicant.

4.2.3 Cost Estimating Methodology and Accuracy

To estimate the costs associated for each sub-alternative, the NRC staff used a work breakdown structure approach to deconstruct the alternatives into required activities. For each required activity, the NRC staff further sub-divided the work across labor categories (i.e., executive, manager, staff, clerical, licensing). The NRC staff estimated the required level of effort (LOE) for each labor category for each required activity in order to develop the cost estimate.

For this supplemental regulatory analysis, the NRC staff developed an order-of-magnitude estimate for each cost and benefit based on the limited information available and the range of design features that could be implemented by potential applicants (which provides an indication of the uncertainty in the costs).

4.2.4 Timeframes for Alternatives

The NRC staff assumes that the selected alternative would be implemented in fiscal year (FY) 2017. The NRC staff assumes that any proposed rule or policy statement and associated draft guidance would be issued for public comment in FY 2016 and finalized in FY 2017.

4.2.5 Base Year of Analysis

The base year of this analysis is FY 2015. Therefore, all quantified benefits and costs are inflated or discounted to FY 2015.

4.2.6 Labor Rates

The NRC staff gathered data from several sources to develop the level of effort and unit cost estimates. For all licensee labor, the hourly wage rates for various industry labor categories are based on the U.S. Bureau of Labor Statistics (BLS) May 2013 Occupational Employment and Wages data and is inflated to 2015 dollars using the BLS Consumer Price Index (CPI) inflation calculator to October 2014. Depending on the industry and the occupation, an appropriate mean hourly labor wage is selected. The wage is then increased using a multiplier of 2.0 to account for benefits (insurance premiums, pension, and legally required benefits) to calculate the burdened labor rate.

NRC labor rates are determined by the calculation methodology in NUREG/CR-4627, "Generic Cost Estimates," (Ref. 7). This methodology considers only variable costs that are directly related to the implementation, operation, and maintenance of the analyzed activity. Currently, the NRC hourly labor rate is calculated to be $124 based on actual FY2014 incomes, fringe benefits, and other indirect expenses.

Table 8 presents the wage rate estimates used throughout this analysis.

Table 8 Wage Rate Estimates by Labor Category

Labor Category	Mean Wage Rate	Loaded Wage Factor	Loaded Wage Rate
	A	B	C = A x B
Industry Executives [a]	$79.82	2	$159.64
Industry Managers [b]	$52.11		$104.22
Industry Staff [b]	$41.93		$83.86
Industry Clerical Staff [c]	$26.34		$52.68
Industry Licensing Staff [b]	$64.36		$128.72
NRC Staff [d]			$124.00

[a] The mean wage rate for Industry Executives was calculated as the average of the mean hourly wage (in the Electric Power Generation, Transmission, and Distribution Industry) for Top Executives (SOC 11-1011) and Chief Executives (SOC 11-0000) from BLS.

[b] The loaded wage rates for Industry Managers, Industry Staff, and Industry Licensing Staff are based on recent regulatory analysis.

[c] The mean wage rate for Clerical Staff was calculated as the average of the mean hourly wage (in the Electric Power Generation, Transmission, and Distribution Industry) for Office and Administrative Support Occupations (SOC 43-0000), Office Clerks, General (SOC 43-9061), and First-line Supervisors of Office and Administrative Support Workers (SOC 43-1011) from BLS.

[d] The NRC staff labor rates are estimated to be $124 per hour (2015 dollars) calculated based on actual labor and benefit costs from the prior fiscal year detailed by office and grade.

4.2.7 Sign Conventions

The sign convention used in this analysis is that all favorable consequences for the alternative are positive and all adverse consequences for the alternative are negative. Negative values are shown using parentheses (e.g., negative $500 is displayed as ($500)).

4.2.8 Data

Information on the number of nuclear power plant applications docketed or expected to be submitted to the NRC for approval has been derived from industry announcements.

4.2.9 Assumptions

The assumptions include the discussions about baseline activities presented in Section 4.2.1 above (i.e., the absence of incremental cost for Alternative 2a) and the affected entities described in Section 4.2.2 above.

Under Alternatives 2b, 2c, and 2d, the staff assumes that new reactor designers (typically, applicants for design certification) would include the subject design features that enhance coping times and reduce or simplify operator actions. As such, under any of the alternatives, the guidance developed by the staff specific to design features would be directed at new reactor designers rather than individual COL applicants referencing a certified design.

Designers may experience incremental costs to add design features to the plant design. These costs would vary based on the baseline design and the approach taken. Advanced designs that have already adopted a design philosophy that considers the loss of ac power may need no further enhancement. More traditional reactor designs may need modifications to accommodate such design features as larger water tanks to increase available inventory or additional batteries to enhance dc power capacity. For traditional reactor designs, additional design features may be easily included in the currently planned design or may require additional space and support equipment. This could have additional implications for the overall design, such as layout of the plant that could result in additional incremental costs. To account for the uncertainty of these effects, the staff is using a range of potential incremental costs.

The costs of implementing the design features can be represented as a range across the variety of design approaches that might be selected by the design certification applicants listed above. The NRC expects this approach to depend on the design features already included in the plant design (e.g., passive or other ac-power-independent systems). Therefore, the incremental costs compared to Option 2 in the regulatory analysis would vary from an averted cost (in which portable equipment needed for Phase 2 for operating reactors would not be needed because of installed equipment already in the plant's design basis) to some fraction of the cost assumed in Option 2. For advanced designs that already consider the loss of ac power, it is possible that all of the Phase 2 and some of the Phase 3 costs could be averted relative to the costs assumed in the Option 2 analysis. These designs may not need portable on-site equipment and may be able to support longer delivery timeframes for off-site equipment, compared to what is assumed in the Option 2 analysis, resulting in a significant averted cost. For more traditional reactor designs, the averted costs should be a fraction of the costs assumed in Option 2. Traditional reactor designs may not need multiple sets of large portable batteries or may have more simplified systems for managing inventory addition to the reactor coolant system.

This range of design options is reflected in the implementation costs described below. Because none of the COL applicants listed in Table 7 has announced an intention to construct and operate a new reactor within the ten-year timeframe for this analysis, additional costs associated with the lifecycle (e.g., procurement or maintenance) of these design features are not quantified. Recurring costs are not applied to NRC activities as any incremental change in oversight or licensing (after the initial licensing phase) is expected to be small compared to the overall NRC implementation costs of Option 2.

In addition, because Alternative 2d has a clear regulatory requirement, the staff expects it to have the highest degree of standardization and safety enhancement for addressing mitigation of beyond-design-basis events. In the absence of a requirement, the staff expects Alternatives 2b and 2c to be implemented in varying degrees of conformance with guidance and policy. Lower costs could be incurred by designers that incorporate different methods and solutions set forth in guidance and policy and implement fewer design features. Additional cost, however, would be incurred in the review to develop alignment between applicants and the NRC on an acceptable approach that depart from established guidance and policy.

This degree of conformance also affects the costs imposed on COL applicants and licensees to comply with the remainder of 10 CFR 50.155. If a vendor includes a comprehensive set of design features in a certified design, a COL applicant referencing that design could have a reduced burden in developing and implementing the strategies required of all COL licensees by 10 CFR 50.155(b). If a vendor adds only minimal design features to address guidance, a COL applicant referencing that design may need additional equipment and departures from the certified design to develop and implement their strategies—though still generally less than would be needed if no design features were included in the certified design.

4.3 Analysis

This analysis is based on NRC staff's assessment of the future business scenario for each category of applicant. In each case, only industry and NRC implementation costs would be incurred. Furthermore, because all of the benefits are measured qualitatively in this analysis, only costs, including averted costs, are estimated in these subsections.

4.3.1 Industry Implementation

4.3.1.1 Alternative 2a: Take no action unique to new reactors

This alternative baseline would amend 10 CFR Part 50 to make the requirements in Order EA-12-049, Order EA 12-051, and industry initiatives generically applicable, while also requiring SAMGs. The NRC staff would use existing tools, review criteria, and templates to review the licensing application, similar to those used for operating reactors, without specifically addressing the subject design features that would be included under other alternatives described in this supplemental regulatory analysis. As such, there would be no incremental costs beyond that described for Option 2 in the regulatory analysis.

4.3.1.2 Alternative 2b: Issue guidance for new application and license reviews

This alternative would have the NRC staff develop and issue guidance for an acceptable approach for new reactors to incorporate the subject design features, encouraging a focus on enhancing coping durations, and minimizing reliance on human actions (currently developed as Appendix A to DG-1301). The guidance would include a structured method by which NRC reviewers would evaluate reactor design features to maintain or restore the key safety functions. The NRC further assumes that NEI, EPRI, reactor vendors, current applicants, and future applicants interested in submitting an application for a new reactor design would follow the development of this guidance, provide feedback during public meetings, and comment on the NRC draft guide when issued for public comment. Costs to perform these activities include procedural and administrative activities.

Table 9 presents the industry labor breakdown and miscellaneous incremental costs to implement this sub-alternative. Table 10 presents the discounted costs. The NRC staff estimates that industry will incur an incremental one-time cost of approximately $1.19 million using a 3 percent discount factor or $1.07 million using a 7 percent discount factor.

Although this alternative does not require the inclusion of design features, the NRC assumes that applicants would nonetheless include the subject design features into their plant designs based on the availability of guidance.

Table 9 Alternative 2b – Industry Implementation Inputs

Required Activity	Cost Category	Unit Cost	Units	No. of entities involved
Review and provide feedback and comments on NRC guidance document	Executive	$160/hr	50 hrs	6
	Manager	$104/hr	100 hrs	6
	Staff	$84/hr	150 hrs	6
	Licensing	$53/hr	100 hrs	6
	Travel and miscellaneous expenses		($15,225)	
Select and document DCD design features	Executive	$160/hr	150 hrs	4
	Manager	$104/hr	300 hrs	4
	Staff	$84/hr	2,000 hrs	4
	Licensing	$53/hr	500 hrs	4
	Travel and miscellaneous expenses		($69,796)	

* Unit cost values are shown to the nearest dollar.

Table 10 Alternative 2b – Industry Implementation Costs

Fiscal Year	Activity	Cost (2015 dollars)		
		Undiscounted	3% Discount	7% Discount
2016	Review and provide feedback and comments on NRC guidance document	$ (151,275)	$ (146,869)	$ (141,379)
2017		$ (81,456)	$ (76,780)	$ (71,147)
2019	EPR perform and document design feature review	$ (160,033)	$ (142,187)	$ (122,088)
2020		$ (106,688)	$ (92,030)	$ (76,067)
2017	APWR perform and document design feature review	$ (160,033)	$ (150,846)	$ (139,779)
2018		$ (106,688)	$ (97,635)	$ (87,090)
2017	KHNP perform and document design feature review	$ (106,688)	$ (100,564)	$ (93,186)
2018		$ (106,688)	$ (97,635)	$ (87,090)
2019		$ (53,344)	$ (47,396)	$ (40,696)
2018	NuScale perform and document design feature review	$ (106,688)	$ (97,635)	$ (87,090)
2019		$ (106,688)	$ (94,791)	$ (81,392)
2020		$ (53,344)	$ (46,015)	$ (38,034)
Total		**$ (1,300,000)**	**$ (1,190,000)**	**$ (1,070,000)**

* Total values are rounded to three significant figures.

4.3.1.3 Alternative 2c: Revise the advanced reactor policy statement

This alternative would revise the policy statement on the Regulation of Advanced Reactors (Ref. 1) to communicate the Commission expectations that new nuclear reactor designs include design features to address ELAP concurrent with a LUHS. In addition, the NRC would need to develop and issue guidance for an acceptable approach to implement these specific expectations (currently developed as Appendix A to DG-1301).

The NRC assumes that NEI, EPRI, reactor vendors, current applicants, and future applicants interested in referencing one of the new reactor designs would follow the development of this policy statement and guidance document, provide feedback during public meetings, and comment on the documents when issued for public comment. Costs to perform these activities include procedural and administrative activities.

Table 11 presents the industry labor breakdown and miscellaneous incremental costs to implement this sub-alternative. Table 12 presents the discounted costs. The NRC staff estimates that industry will incur an incremental one-time cost of approximately $1.54 million using a 3 percent discount factor or $1.41 million using a 7 percent discount factor.

Although this alternative does not require the inclusion of design features, the NRC assumes that applicants would nonetheless include the subject design features into their plant designs based on the availability of guidance and the revised policy statement.

Table 11 Alternative 2c – Industry Implementation Inputs

Required Activity	Cost Category	Unit Cost	Units	No. of entities involved
Review and provide feedback and comments on revised NRC policy statement document	Executive	$160/hr	100 hrs	6
	Manager	$104/hr	150 hrs	6
	Staff	$84/hr	200 hrs	6
	Licensing	$53/hr	150 hrs	6
	Travel and miscellaneous expenses		($23,634)	
Review and provide feedback and comments on NRC guidance document	Executive	$160/hr	50 hrs	6
	Manager	$104/hr	100 hrs	6
	Staff	$84/hr	150 hrs	6
	Licensing	$53/hr	100 hrs	6
	Travel and miscellaneous expenses		($15,225)	
Select and document DCD design features	Executive	$160/hr	150 hrs	4
	Manager	$104/hr	300 hrs	4
	Staff	$84/hr	2,000 hrs	4
	Licensing	$53/hr	500 hrs	4
	Travel and miscellaneous expenses		($69,796)	

* Unit cost values are shown to the nearest dollar.

Table 12 Alternative 2c – Industry Implementation Costs

Fiscal Year	Activity	Cost (2015 dollars)		
		Undiscounted	3% Discount	7% Discount
2015	Review and provide feedback and comments on revised NRC policy statement document	$ (180,630)	$ (180,630)	$ (180,630)
2016		$ (126,441)	$ (122,758)	$ (118,169)
2017		$ (54,189)	$ (51,078)	$ (47,331)
2016	Review and provide feedback and comments on NRC guidance document	$ (151,275)	$ (146,869)	$ (141,379)
2017		$ (81,456)	$ (76,780)	$ (71,147)
2019	EPR perform and document design feature review	$ (160,033)	$ (142,187)	$ (122,088)
2020		$ (106,688)	$ (92,030)	$ (76,067)
2017	APWR perform and document design feature review	$ (160,033)	$ (150,846)	$ (139,779)
2018		$ (106,688)	$ (97,635)	$ (87,090)
2017	KHNP perform and document design feature review	$ (106,688)	$ (100,564)	$ (93,186)
2018		$ (106,688)	$ (97,635)	$ (87,090)
2019		$ (53,344)	$ (47,396)	$ (40,696)
2018	NuScale perform and document design feature review	$ (106,688)	$ (97,635)	$ (87,090)
2019		$ (106,688)	$ (94,791)	$ (81,392)
2020		$ (53,344)	$ (46,015)	$ (38,034)
Total		**$ (1,660,000)**	**$ (1,540,000)**	**$ (1,410,000)**

* Total values are rounded to three significant figures.

4.3.1.4 Alternative 2d: Include paragraph 50.155(d) in the proposed rule

In this alternative, the new 10 CFR 50.155 would require new reactor applicants to include design features that enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities during an ELAP concurrent with a LUHS. The NRC assumes that NEI, EPRI, reactor vendors, current applicants, and future applicants interested in referencing one of the new reactor designs would follow the development of this requirement, provide feedback during public meetings, and comment on the documents when issued for public comment.

In addition, the NRC staff would interact with the industry to develop and issue guidance for an acceptable approach to implement this portion of the requirements in 10 CFR 50.155 (currently developed as Appendix A to DG-1301). Development of this guidance would proceed in parallel with the rulemaking—the draft guidance document would be issued with the proposed rule for public comment and the final guidance document would be published with the final rule. There would also be implementation costs for the NRC's review and documentation of applicant's submittals. The NRC staff estimates that industry will incur an incremental one-time cost of approximately $1.09 million using a 3 percent discount factor or $1.02 million using a 7 percent discount factor.

Table 13 Alternative 2d – Industry Implementation Inputs for each Entity

Required Activity	Cost Category	Unit Cost	Units	No. of entities involved
Review and provide feedback and comments on rule provision	Executive	$160/hr	40 hrs	6
	Manager	$104/hr	80 hrs	6
	Staff	$84/hr	200 hrs	6
	Licensing	$53/hr	40 hrs	6
	Travel and miscellaneous expenses		($14,113)	
Review and provide feedback and comments on NRC guidance document	Executive	$160/hr	50 hrs	6
	Manager	$104/hr	100 hrs	6
	Staff	$84/hr	150 hrs	6
	Licensing	$53/hr	100 hrs	6
	Travel and miscellaneous expenses		($15,225)	
Select and document DCD design features	Executive	$160/hr	150 hrs	4
	Manager	$104/hr	300 hrs	4
	Staff	$84/hr	1,000 hrs	4
	Licensing	$53/hr	500 hrs	4
	Travel and miscellaneous expenses		($46,315)	

Table 14 Alternative 2d – Industry Implementation Costs

Fiscal Year	Activity	Cost (2015 dollars)		
		Undiscounted	3% Discount	7% Discount
2015	Review and provide feedback and comments on draft rule provision	$ (183,368)	$ (183,368)	$ (183,368)
2016		$ (32,359)	$ (31,417)	$ (30,242)
2015	Review and provide feedback and comments on NRC guidance document	$ (116,366)	$ (116,366)	$ (116,366)
2016		$ (81,456)	$ (79,083)	$ (76,127)
2017		$ (34,910)	$ (32,906)	$ (30,491)
2017	EPR perform and document design feature review	$ (106,195)	$ (100,099)	$ (92,754)
2018		$ (70,796)	$ (64,789)	$ (57,791)
2017	APWR perform and document design feature review	$ (106,195)	$ (100,099)	$ (92,754)
2018		$ (70,796)	$ (64,789)	$ (57,791)
2017	KHNP perform and document design feature review	$ (70,796)	$ (66,732)	$ (61,836)
2018		$ (70,796)	$ (64,789)	$ (57,791)
2019		$ (35,398)	$ (31,451)	$ (27,005)
2018	NuScale perform and document design feature review	$ (70,796)	$ (64,789)	$ (57,791)
2019		$ (70,796)	$ (62,902)	$ (54,010)
2020		$ (35,398)	$ (30,535)	$ (25,238)
	Total	**$ (1,160,000)**	**$ (1,090,000)**	**$ (1,020,000)**

* Total values are rounded to three significant figures.

4.3.2 NRC Implementation

4.3.2.1 Alternative 2a: Take no action unique to new reactors

This alternative baseline would amend 10 CFR Part 50 to make the requirements in Order EA-12-049, Order EA 12-051, and industry initiatives generically applicable, while also requiring SAMGs. The NRC staff would use existing tools, review criteria, and templates to review the licensing application without inclusion of the subject design features and document the NRC’s conclusions a safety evaluation. As such, there would be no additional costs beyond that described for Option 2 in the regulatory analysis.

4.3.2.2 Alternative 2b: Issue guidance for new application and license reviews

This alternative would have the NRC staff develop and issue guidance for an acceptable approach for new reactors to include the subject design features, encouraging a focus on enhancing coping durations and minimizing reliance on human actions. The guidance would include a structured method by which NRC reviewers would evaluate these design features in concert with portable equipment and operator actions as part of the mitigation strategies. There would also be implementation costs for the NRC's review and documentation of applicant's submittals. The NRC staff estimates that the NRC will incur an incremental one-time cost of approximately $0.677 million using a 3 percent discount factor or $0.593 million using a 7 percent discount factor.

Table 15 Alternative 2b: NRC Implementation Costs

Fiscal Year	Activity	Cost (2015 dollars)		
		Undiscounted	3% Discount	7% Discount
2015	Prepare draft guide and supplemental RA and issue documents for public comment	$ (43,400)	$ (43,400)	$ (43,400)
2016		$ (26,040)	$ (25,282)	$ (24,336)
2017	Issue final regulatory guide and supplemental RA	$ (17,360)	$ (16,363)	$ (15,163)
2019	Perform preliminary review of EPR DCD design features and prepare RAIs	$ (49,600)	$ (44,069)	$ (37,840)
2020	Complete review of EPR DCD design features and issue SER	$ (116,560)	$ (100,546)	$ (83,106)
2017	Perform preliminary review of APWR DCD design features and prepare RAIs	$ (49,600)	$ (46,753)	$ (43,323)
2018	Complete review of APWR DCD design features and issue SER	$ (116,560)	$ (106,669)	$ (95,148)
2018	Perform preliminary review of KHNP DCD design features and prepare RAIs	$ (49,600)	$ (45,391)	$ (40,488)
2019	Complete review of KHNP DCD design features and issue SER	$ (116,560)	$ (103,562)	$ (88,923)
2019	Perform preliminary review of NuScale DCD design features and prepare RAIs	$ (49,600)	$ (44,069)	$ (37,840)
2020	Complete review of NuScale DCD design features and issue SER	$ (116,560)	$ (100,546)	$ (83,106)
Total		**$ (751,000)**	**$ (677,000)**	**$ (593,000)**

* Total values are rounded to three significant figures.

4.3.2.3 Alternative 2c: Revise the advanced reactor policy statement

This alternative would revise the policy statement on the Regulation of Advanced Reactors (Ref. 1) to describe the Commission's policy to resolve safety issues for events more severe than design basis accidents that challenge maintaining or restoring core cooling, containment, and SFP cooling capabilities. The staff would prepare and issue a draft policy statement for public comment followed by issuing the final policy statement. In addition, the NRC would need to develop and issue guidance for an acceptable approach for new reactors to include the subject design features. There would also be implementation costs for the NRC's review and documentation of applicant's submittals. The NRC staff estimates that the NRC will incur an incremental one-time cost of approximately $0.942 million using a 3 percent discount factor or $0.848 million using a 7 percent discount factor.

Table 16 Alternative 2c: NRC Implementation Costs

Fiscal Year	Activity	Cost (2015 dollars)		
		Undiscounted	3% Discount	7% Discount
2015	Prepare and issue draft policy statement	$ (91,512)	$ (91,512)	$ (91,512)
2016		$ (61,008)	$ (59,231)	$ (57,017)
2017	Issue final policy statement	$ (74,400)	$ (70,129)	$ (64,984)
2015	Prepare draft guide and supplemental RA and issue documents for public comment	$ (52,080)	$ (52,080)	$ (52,080)
2016		$ (34,720)	$ (33,709)	$ (32,449)
2017	Issue final regulatory guide and supplemental RA	$ (45,880)	$ (43,246)	$ (40,073)
2019	Perform preliminary review of EPR DCD design features and prepare RAIs	$ (49,600)	$ (44,069)	$ (37,840)
2020	Complete review of EPR DCD design features and issue SER	$ (116,560)	$ (100,546)	$ (83,106)
2017	Perform preliminary review of APWR DCD design features and prepare RAIs	$ (49,600)	$ (46,753)	$ (43,323)
2018	Complete review of APWR DCD design features and issue SER	$ (116,560)	$ (106,669)	$ (95,148)
2018	Perform preliminary review of KHNP DCD design features and prepare RAIs	$ (49,600)	$ (45,391)	$ (40,488)
2019	Complete review of KHNP DCD design features and issue SER	$ (116,560)	$ (103,562)	$ (88,923)
2019	Perform preliminary review of NuScale DCD design features and prepare RAIs	$ (49,600)	$ (44,069)	$ (37,840)
2020	Complete review of NuScale DCD design features and issue SER	$ (116,560)	$ (100,546)	$ (83,106)
Total		**$ (1,020,000)**	**$ (942,000)**	**$ (848,000)**

* Total values are rounded to three significant figures.

4.3.2.4 Alternative 2d: Include paragraph 50.155(d) in the proposed rule

In this alternative, the new 10 CFR 50.155 would include requirements for new reactor applicants to include design features in the plant design sufficient to enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities during an ELAP concurrent with a LUHS.

In addition, the NRC would need to develop and issue guidance for an acceptable approach to implement this portion of the requirements in 10 CFR 50.155 (currently developed as Appendix A to DG-1301). Development of this guidance would proceed in parallel with the rulemaking—the draft guidance document would be issued with the proposed rule for public comment and the final guidance document would be published with the final rule. The NRC staff estimates that the NRC will incur an incremental one-time cost of approximately $0.738 million using a 3 percent discount factor or $0.676 million using a 7 percent discount factor.

Table 17 Alternative 2d – NRC Implementation Costs

Fiscal Year	Activity	Cost (2015 dollars)		
		Undiscounted	3% Discount	7% Discount
2015	Draft rule provision and issue for public comment	$ (91,512)	$ (91,512)	$ (91,512)
2016		$ (61,008)	$ (59,231)	$ (57,017)
2017	Finalize rule provision	$ (74,400)	$ (70,129)	$ (64,984)
2015	Prepare draft guide and supplemental RA and issue documents for public comment	$ (52,080)	$ (52,080)	$ (52,080)
2016		$ (34,720)	$ (33,709)	$ (32,449)
2017	Issue final regulatory guide and supplemental RA	$ (45,880)	$ (43,246)	$ (40,073)
2019	Perform preliminary review of EPR DCD design features and prepare RAIs	$ (24,800)	$ (22,034)	$ (18,920)
2020	Complete review of EPR DCD design features and issue SER	$ (83,080)	$ (76,030)	$ (67,818)
2017	Perform preliminary review of APWR DCD design features and prepare RAIs	$ (24,800)	$ (23,376)	$ (21,661)
2018	Complete review of APWR DCD design features and issue SER	$ (83,080)	$ (76,030)	$ (67,818)
2018	Perform preliminary review of KHNP DCD design features and prepare RAIs	$ (24,800)	$ (22,696)	$ (20,244)
2019	Complete review of KHNP DCD design features and issue SER	$ (83,080)	$ (73,816)	$ (63,381)
2019	Perform preliminary review of NuScale DCD design features and prepare RAIs	$ (24,800)	$ (22,034)	$ (18,920)
2020	Complete review of NuScale DCD design features and issue SER	$ (83,080)	$ (71,666)	$ (59,235)
Total		**$ (791,000)**	**$ (738,000)**	**$ (676,000)**

* Total values are rounded to three significant figures.

4.3.3 Qualitative Benefits and Costs

The following discussion provides a discussion of the tradeoffs for pursuing any of the sub-alternatives identified in this analysis. The costs of industry implementation, industry operation, and NRC implementation are described in quantitative terms in the previous section and are not discussed further in qualitative terms.

For advanced reactor technologies, it is important to note that the characteristics of advanced reactors have evolved over past decades, and the NRC expects that this evolution will continue. The advanced reactor policy statement includes the following:

> Regarding advanced reactors, the Commission expects, as a minimum, at least the same degree of protection of the environment and public health and safety and the common defense and security that is required for current generation light-water reactors [i.e., those licensed before 1997]. Furthermore, the Commission expects that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions.

This policy was carried forward to the Generation III+ reactor designs (i.e., light water reactor designs such as the AP1000 and the Economic Simplified Boiling-Water Reactor) and is communicated to all potential licensing applicants and stakeholders. Subsequent Commission decisions in staff requirements memoranda and NRC staff positions in guidance documents have provided detailed expectations on specific topics.

If NRC staff guidance were developed (Alternative 2b) to describe an approach acceptable for new reactors, the inclusion of additional regulatory emphasis through revising the policy statement (Alternative 2c) or adding new rule provision for new applicants (Alternative 2d) may have diminishing returns in increased plant safety for the costs to achieve this increase. Therefore, to varying degrees, the NRC expects the following qualitative benefits of incorporating these design features at the design stage.

- **Reduction in the probability and consequences of accidents that could cause radiation exposure (occupational or public health effects) and property damage (onsite or offsite effects)**. Historically, the station blackout initiating event (loss of ac power) is a significant contributor to the overall risk of most active nuclear power plant designs. In addition, operator actions are generally significant contributors to overall plant risk, as well as sources of uncertainty in the analysis. A design-focused approach that enhances the capability of the plant to respond to a station blackout and reduces reliance on operator action would be expected to reduce the relative risk of these contributors. Any design features added to the design are likely to support the mitigation of a variety of accident scenarios, not just the ELAP event.

- **Increase in design efficiency and flexibility**. Including these design features early in the design and review process provides for more flexibility for designers to choose an approach, versus selecting one that fits with a fixed design or potentially needing to redesign systems at a late phase, even after construction. It also affords the opportunity for interaction between applicants and the NRC staff before the design process is concluded, such that designers can select an optimal approach that meets the relevant regulations or guidance. Finally, the overall plant design itself is expected to be more flexible, as design features will limit the need for rapid operator action in an ELAP event and should benefit the plant in other scenarios, as described above.

- **Increase in regulatory efficiency**. As described in the standardization policy statement, efficiency would be gained through the inclusion of design features in a standardized design subject to a single review rather than through individual licensing actions for COL applicants or licensees. In the 10-year timeframe assumed in the current analysis, only two affected COL applications (Calvert Cliffs and Bell Bend) are referencing the same design. Therefore, the standardization benefit within this timeframe is not significant. In the longer term, however, including design features in certified designs supports the NRC's standardization objective and is expected to contribute to overall regulatory efficiency and attendant safety enhancement of future reactors. In addition, this approach may provide for greater transparency and public confidence as the design is described by the applicant and reviewed in detail by the staff in the design certification review process.

- **Reduction in COL implementation and operation costs**. As described above in quantitative terms, COL applicants could have a reduced burden in developing and implementing the strategies required of all COL licensees by 50.155(b), since the initial phases of mitigation may have been addressed by the designer. From an operational perspective, COL licensees would rely on more installed SSCs (and have minimized human actions related to those design features. They would have smaller lifecycle costs and reduced operational complexity associated with using portable and offsite equipment to implement their mitigating strategies.

In the absence of any guidance, policy, or regulation (Alternative 2a), new reactor designs would generally be simpler and safer than the earlier generation of reactors, but it is unlikely that designers would interpret the high-level statements in the policy statement to necessitate specific design features similar to those described in this document.

4.3.4 Totals

Table 18 summarizes the integrated evaluation of benefits and costs of the proposed regulatory alternatives considered for addressing the design features for new reactors as compared to the zero-cost baseline (Alternative 2a).

Table 18 Summary of Overall Benefits and Costs (Quantitative and Qualitative)

Alternatives	Benefits –Qualitative Factors	Costs (2015 Dollars)
Alternative 2a: No action alternative	<u>**Consideration of qualitative benefits**</u> **Regulatory Efficiency –**The quantitative benefit of the no-action alternative related to regulatory efficiency is reflected in the lack of additional costs to the NRC and the industry.	**No additional costs beyond the overall Option 2.** Under alternative 2a, no unique action would be taken to impose requirements or provide additional guidance for new reactor applicants related to design features sufficient to enhance coping durations and minimize reliance on human actions to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities during an ELAP concurrent with a LUHS. That is, new reactors would be subject to the same requirements, expectations, and guidance as operating reactors. This alternative has the same costs as the Option 2 described in the regulatory

Alternatives	Benefits –Qualitative Factors	Costs (2015 Dollars)
		analysis, as all licensees and applicants would be treated uniformly regardless of the time of licensing or certification. Therefore, it serves as a baseline to measure the costs and benefits against the other identified sub-alternatives. **<u>Consideration of qualitative costs</u>** In the 10-year timeframe analyzed, there are no affected COL applications. Furthermore, there are only two affected COL applications (i.e., Calvert Cliffs and Bell Bend, which reference the same reactor design. Therefore, the standardization benefit within this timeframe is not significant.
Alternative 2b: Issue guidance for new application and license reviews	**<u>Consideration of qualitative benefits</u>** **Simplifies operator actions.** Reduces and simplifies operator actions, and increases time for those actions, providing a risk and safety benefit consistent with the advanced reactor policy statement. **Simplifies severe accident mitigation strategies.** Simplifies the strategies required by license applicants and may potentially reduce the cost of implementing the overall strategy given reduced need for portable and offsite equipment.	**Industry Implementation costs:** ($ 1,190,000) using a 3% discount rate ($ 1,070,000) using a 7% discount rate **NRC Implementation costs:** ($ 677,000) using a 3% discount rate ($ 593,000) using a 7% discount rate **Total quantified costs:** ($ 1,867,000) using a 3% discount rate ($ 1,663,000) using a 7% discount rate **<u>Consideration of qualitative costs</u>** **Regulation through guidance.** This alternative could be viewed as regulating through guidance (i.e., encouraging industry to implement a chosen approach without a regulatory requirement), which may not achieve the desired outcome given the ability of applicants and licensees to justify alternative approaches. **Reduces the benefits of standardization.** Reduces the benefit of enhanced standardization for applicants choosing an approach different from the staff position, as more site-specific strategies would be needed in the absence of design features.
Alternative 2c: Revise the advanced reactor policy statement	**<u>Consideration of qualitative benefits</u>** **Simplifies operator actions.** Reduces and simplifies operator actions, and increases time for those actions, providing a risk and safety benefit consistent with the overall philosophy of the advanced reactor policy statement. **Simplifies severe accident mitigation strategies.** Simplifies the strategies	**Industry Implementation costs:** ($ 1,540,000) using a 3% discount rate ($1,410,000) using a 7% discount rate **NRC Implementation costs:** ($ 942,000) using a 3% discount rate ($ 848,000) using a 7% discount rate **Total quantified costs:** ($ 2,480,000) using a 3% discount rate

Alternatives	Benefits –Qualitative Factors	Costs (2015 Dollars)
	required by license applicants and should reduce the cost of implementing the overall strategy given reduced need for portable and offsite equipment. **Increased regulatory predictability and transparency.** Provides a greater level of regulatory stability and predictability beyond Alternative 2b through clear Commission policy	($ 2,260,000) using a 7% discount rate **<u>Consideration of qualitative costs</u>** **Regulates through Commission expectation**. This alternative encourages industry to implement a chosen approach described in the policy statement without a regulatory requirement. **Reduces the benefits of standardization.** Reduces the benefit of enhanced standardization for applicants choosing an approach different from the Commission policy and guidance, as more site-specific strategies would be needed in the absence of design features.
Alternative 2d: Include paragraph 50.155(d) in the proposed rule	**<u>Consideration of qualitative benefits</u>** **Simplifies operator actions**. Reduces and simplifies operator actions, and increases time for those actions, providing a risk and safety benefit consistent with the advanced reactor policy statement. **Ensures design-focused approach based on regulation.** Ensures that applicants will pursue this design-focused approach. **Simplifies severe accident mitigation strategies.** Simplifies the strategies required by license applicants and reduces the cost of implementing the overall strategy given reduced need for portable and offsite equipment. **Increased regulatory predictability and transparency.** Provides regulatory stability and predictability through clear regulatory requirements and associated NRC guidance.	**Industry Implementation costs:** ($ 1,090,000) using a 3% discount rate ($ 1,020,000) using a 7% discount rate **NRC Implementation costs:** ($ 738,000) using a 3% discount rate ($ 676,000) using a 7% discount rate **Total quantified costs:** ($ 1,830,000) using a 3% discount rate ($ 1,700,000) using a 7% discount rate **<u>Consideration of qualitative costs</u>**

4.3.5 Disaggregation

The NRC staff has evaluated the alternatives to determine whether specific requirements have to be considered separately, but has determined that the requirements are narrowly focused, meaning the benefits and costs can be reasonably and practically evaluated, and disaggregation would not result in the meaningful implications on the analysis results. Therefore, the analysis of disaggregated requirements is not appropriate.

4.3.6 Uncertainty Analysis

Because this analysis is based on estimates of values with unknown amounts of uncertainty, it is useful to run a sensitivity analysis of the variables in which there is the greatest amount of uncertainty. A Monte Carlo sensitivity analysis was completed with the assistance of @*Risk*, a software program specially designed for completing this type of analysis. The Monte Carlo approach provides an answer to the question: what distribution of net benefits results from multiple draws of the probability distribution assigned to key variables?

4.3.6.1 Uncertainty Analysis Assumptions

The Monte Carlo analysis requires the identification of the variables that are uncertain; in this analysis, those variables summarized in Attachment A to this supplemental regulatory analysis.

4.3.6.2 Uncertainty Analysis Results

Five thousand simulations were run. Figure 1 displays the plot diagram for alternatives 2b, 2c, and 2d total costs using a 7 percent discount rate.

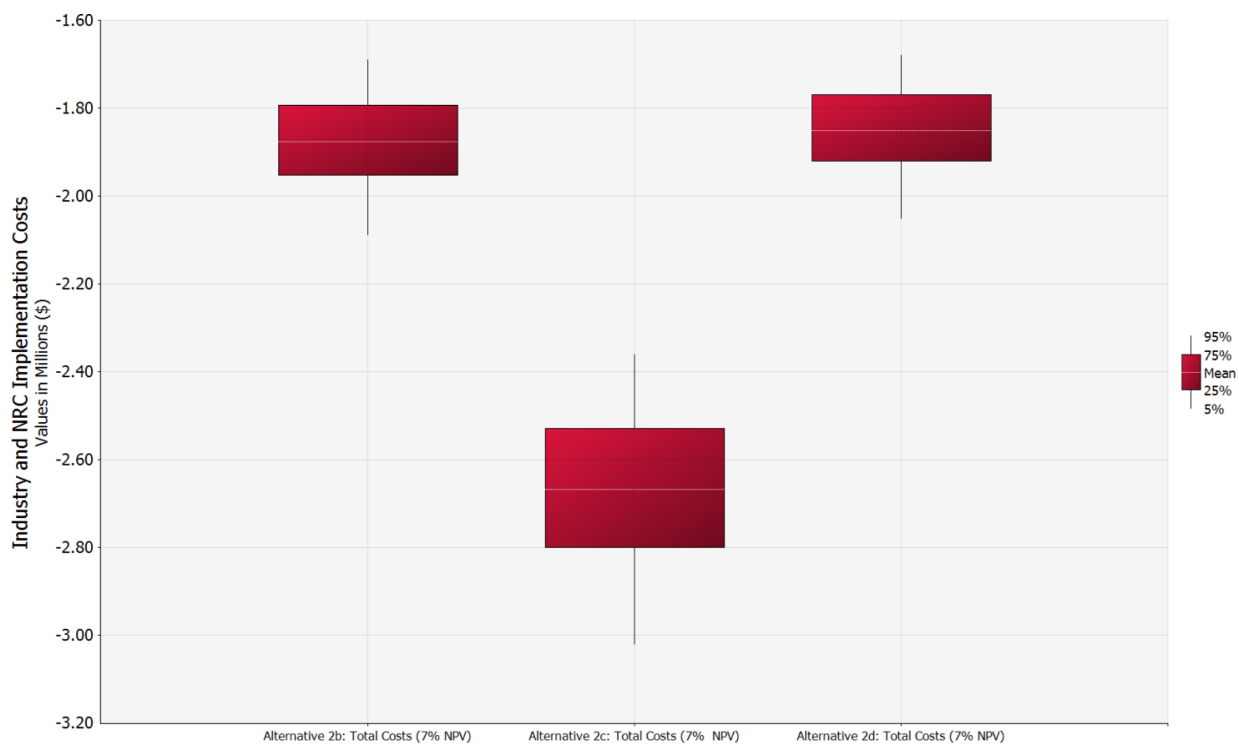

Figure 1 Uncertainty Analysis Plot Diagram

4.3.6.3 Uncertainty Analysis Results

A Monte Carlo analysis found that alternatives considered for addressing the mitigation of beyond-design-basis events design features for new reactors show that alternatives 2b and 2d have similar costs and uncertainties and that alternative 2c has greater costs and uncertainties than alternatives 2b and 2d.

5 Decision Rationale

All of the alternatives, with the exception of alternative 2a, would result in incremental costs, with the highest estimated cost being for alternative 2c, which involves developing both guidance and a revision to the advanced reactor policy statement. Alternatives 2b and 2d (guidance and requirement, respectively), have comparable costs within the bounds of the uncertainty analysis described above.

The potential benefits of pursuing a design-focused approach (which would be ensured under Alternative 2d) have not been quantified. Given the already low risk associated with new reactors, a large absolute safety benefit from an averted-dose perspective is unlikely. However, new reactor licensees would benefit from the operational advantages of a design-focused approach, as described further in Section 4.3.3 above. Such capability would maximize reliance on installed design features to maintain or restore the key safety functions. As a result, new reactor licensees would have a more flexible approach to such an event than operating reactor licensees, with a longer period of time until the plant would need to rely on portable equipment or offsite resources to maintain or restore the key safety functions. This approach provides an enhanced means of addressing the intent of Order EA-12-049, consistent with the advanced reactor policy statement. Design features included to address the concept described in this analysis might also benefit plant operation in other scenarios, with attendant safety and risk benefits.

Based on this evaluation the staff concludes that Alternative 2d, which is currently included in Section 50.155(d) of the proposed rule language, is the preferred alternative. While there are clear costs associated with this alternative, they represent a small percentage of the total costs of Option 2 in the regulatory analysis. The unquantified benefits of the design-focused approach—enhanced safety, standardization, flexibility, and efficiency—provide a sufficient basis for the staff to recommend an action alternative over Alternative 2a. In weighing Alternatives 2b and 2d, which have similar estimated costs, the staff concludes that Alternative 2d, which provides for more clarity in expectation and uniformity in implementation, should be pursued.

The *Federal Register* notice associated with the proposed rule will include questions that will engender dialogue with stakeholders on the value of this proposed approach, as well as the costs that would be incurred in implementing it. Of particular importance would be the views of reactor designers, and whether they believe that safety enhancements can be achieved (i.e., is it possible to achieve the objective of the new reactor policy for this application), and if so, what approach should be taken. This information can be used in informing a Commission decision on the content of the final rule.

6 Implementation

The MBDBE final rule is expected to be issued in 2017. Several design certification applications are expected to be under review between now and 2017. To streamline the implementation of Alternatives 2b, 2c, or 2d, if approved by the Commission, the NRC intends to pursue a parallel path for design certification applications under current review (e.g., US-APWR and APR1400) and request that they provide information related to the subject design features, using the draft guidance developed in Appendix A to DG-1301 to support these interactions. In addition, to the extent that current COL applications reference these not-yet-certified designs, they will incorporate by reference the design features developed in connection with the standard designs. In contrast, for current COL applications that reference an existing certified or renewed design (e.g., South Texas Project), the staff would follow existing guidance, developed for operating reactors, recognizing that the addition of design features for designs that are already certified would be subject to the issue finality provisions of 10 CFR Part 52 as explained in Section 4.2.2. These COL applicants may nonetheless choose to credit design features from the certified design as part of their mitigating strategies, and the staff will evaluate such proposals as part of the application review. The staff would take steps to keep potential applicants aware of the development of this proposed rule and its associated implementation guidance through pre-application interactions with the applicants. Additionally, applicants will have the opportunity to review and comment on draft documents throughout the development process.

For applications filed after the effective date of the final rule, the design features would be required to be described in the application. However, if an application is expected to be submitted within 6 months of the effective date of the rule, the NRC could decide whether the applicant could describe the design features in a subsequent revision to its application. Normally, an incomplete application would not be accepted for docketing. If this circumstance is expected to occur, the staff believes it is reasonable to provide time for the applicant to perform the assessment and incorporate the design features in the application. This process would allow the staff to begin reviewing the application, while the applicant completes the design process for determining the appropriate design features.

7 References

1. NRC Policy Statement, “Regulation of Advanced Reactors” (73 FR 60612), dated October 14, 2008.

2. NRC Policy Statement, “Nuclear Power Plant Standardization” (52 FR 34884), dated September 15, 1987.

3. NRC Policy Statement, “Severe Reactor Accidents Regarding Future Designs and Existing Plants” (50 FR 32138), dated August 8, 1985.

4. U.S. Nuclear Regulatory Commission, “Regulatory Analysis Technical Evaluation Handbook,” NUREG/BR-0184, January 1997.

5. U.S. Nuclear Regulatory Commission, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” NUREG/BR-0058, Revision 4, September 2004, ADAMS Accession No. ML042820192.

6. U.S. Nuclear Regulatory Commission, “USNRC Regulations Handbook,” NUREG/BR-0053, Revision 6, 2005, ADAMS Accession No. ML052720461.

7. U.S. Nuclear Regulatory Commission, “Generic Cost Estimates,” NUREG/CR-4627, Revision 2, January 1992, ADAMS Accession No. ML13137A259.

Appendix A: Uncertainty Analysis Inputs

Data Element	Distribution	Low estimate	Best estimate	High Estimate
Affected Entities				
No. of construction permit applicants	Pert [3]	0	0	0
No. of operating license applicants that reference a new construction permit	Pert	0	0	0
No. of standard design certification applicants	Pert	3	4	4
No. of manufacturing license applicants that do not reference a standard design certification or standard design approval	Pert	0	0	0
No. of combined license applicants that reference either a standard design certification, standard design approval, or manufactured reactor	Pert	0	0	6
No. of combined license applicants that do not reference a standard design certification, standard design approval, or manufactured reactor	Pert	0	0	0
No. of technical and nuclear power member industry groups	Pert	2	2	2
No. of industry stakeholder groups	Pert	5	6	12
Design Certification Rule Issue Date (estimated)				
EPR	Pert	2019	2020	2022
USAPWR	Pert	2018	2018	2019
KHNP APR1400	Pert	2019	2019	2020
NuScale Power	Pert	2020	2020	2021
Labor Estimates by Task				
Implementation (one-time costs)				
NRC regulatory guide preparation and issue costs				
NRC staff hours to prepare draft guide and supplemental regulatory analysis and issue documents for public comment	Pert	600	700	1050
NRC staff resolve public comments and issue final guide and supplemental regulatory analysis	Pert	300	370	600

[3] A Program Evaluation and Review Technique (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 as 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 modelling purposes where it is desired to capture tail or extreme events.

Data Element	Distribution	Low estimate	Best estimate	High Estimate
Industry costs per entity to review NRC draft guide				
Industry executive hours to review and comment on draft NRC guidance	Pert	40	50	80
Industry manager hours to review and comment on draft NRC guidance	Pert	80	100	160
Industry staff hours to review and comment on draft NRC guidance	Pert	120	150	240
Industry licensing staff hours to review and comment on draft NRC guidance	Pert	80	100	160
Travel and miscellaneous expenses	Pert	6.00%	7.00%	8.00%
Industry costs to develop NEI implementation guide				
Industry executive hours to review and comment on draft NRC guidance	Pert	60	128	160
Industry manager hours to review and comment on draft NRC guidance	Pert	150	320	480
Industry staff hours to review and comment on draft NRC guidance	Pert	480	600	1200
Industry licensing staff hours to review and comment on draft NRC guidance	Pert	480	600	1200
Travel and miscellaneous expenses	Pert	6.00%	7.00%	8.00%
NRC endorsement of Industry guide				
NRC staff hours to review and endorse industry guidance	Pert	380	480	720
NRC policy preparation and issue costs				
NRC staff hours to prepare revised policy statement and supplemental RA, and issue documents for public comment	Pert	980	1230	1850
NRC staff hours to resolve public comments and issue final policy statement and supplemental RA	Pert	480	600	900
Industry costs per entity to review policy statement				
Industry executive hours to review and comment on draft NRC policy statement	Pert	80	100	160
Industry manager hours to review and comment on draft NRC policy statement	Pert	120	150	240
Industry staff hours to review and comment on draft NRC policy statement	Pert	160	200	320
Industry licensing staff hours to review and comment on draft NRC policy statement	Pert	120	150	240

Data Element	Distribution	Low estimate	Best estimate	High Estimate
Travel and miscellaneous expenses	Pert	6.00%	7.00%	8.00%
NRC rule preparation and issue costs				
NRC staff hours to prepare the proposed 10 CFR 50.155(d) section, its statement of considerations, and the supplemental regulatory analysis and issue for public comment	Pert	980	1230	1850
NRC staff hours to resolve public comments and issue final 10 CFR 50.155(d) rule language, statement of considerations, and supplemental regulatory analysis	Pert	480	600	900
Industry costs per entity to select and document DCD design features				
Industry executive hours to review and comment on DCD design features	Pert	120	150	300
Industry manager hours to review and comment on DCD design features	Pert	240	300	600
Industry staff hours to select and document DCD design features	Pert	800	1000	2000
Industry licensing staff hours to select and document DCD design features	Pert	400	500	1000
Travel and miscellaneous expenses	Pert	6.00%	7.00%	8.00%
Industry hours to respond to NRC issued RAIs on DCD design features (applies to Alt. 2b and Alt. 2c)	Pert	800	1000	2000
Industry hours to respond to NRC issued RAIs on DCD design features (applies to Alt. 2d)	Pert	400	500	1000
NRC staff review of DCD design features				
NRC staff hours to perform preliminary review of new design features and prepare RAIs, if necessary (alt 2b and alt 2c)	Pert	350	400	700
NRC staff hours to complete review of design features and RAIs (alt 2b and alt 2c)	Pert	450	540	900
NRC staff hours to perform preliminary review of new design features and prepare RAIs, if necessary (alt 2d)	Pert	175	200	350
NRC staff hours to complete review of design features and RAI responses (alt 2d)	Pert	225	270	450
NRC staff hours to prepare and issue SER for design features	Pert	200	400	600
Revise SRP				
Prepare draft standard review plan for the review of design features and issue for public comment	Pert	360	450	720
Resolve public comments on draft SRP, finalize, and issue SRP	Pert	280	350	560

Data Element	Distribution	Low estimate	Best estimate	High Estimate
Industry costs per entity to perform and document COLA design features				
Industry executive hours to review and comment on COLA design features	Pert	30	40	60
Industry manager hours to review and document COLA design features	Pert	80	100	160
Industry staff hours to select and document COLA design features	Pert	160	240	320
Industry licensing staff hours to select and document COLA design features	Pert	80	100	160
Travel and miscellaneous expenses	Pert	6.00%	7.00%	8.00%
Averted COLA cost for design features review (Alt. 2b, Alt 2c)	Pert	-300	-200	-100
Averted COLA cost for design features review (Alt. 2d)	Pert	-500	-350	-190
Labor Rates				
Industry Executives	Pert	$152	159.64	$168
Industry Managers	Pert	$99	104.22	$109
Industry Staff	Pert	$80	83.86	$88
Industry Clerical Staff	Pert	$50	52.68	$55
Industry Licensing Staff	Pert	$122	128.72	$135
NRC	Pert	$120	$124	$125