

DRAFT WHITE PAPER
INTEGRATION OF MITIGATING STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL
EVENTS AND THE REEVALUATION OF FLOODING HAZARDS

This draft “white paper” has been prepared and is being released to support ongoing public discussions on several activities associated with imposing requirements and collecting information related to lessons learned from the March 2011 accident at Japan’s Fukushima Daiichi facility. Specifically, the Nuclear Regulatory Commission (NRC) staff is exploring possible approaches to ensure timely decisions related to the ability of post-Fukushima mitigating strategies to address beyond-design-basis flooding scenarios that are being identified by licensees for operating nuclear power reactors in response to the NRC’s request for information issued in March 2012. Following the public discussions, - including with the Advisory Committee on Reactor Safeguards - the NRC hopes to clarify the relationships between activities and develop both short-term and long-term plans on how re-evaluation of flooding hazards will be considered in developing and implementing mitigating strategies and other regulatory actions.

This white paper is being provided to support public discussions and its contents should not be interpreted as official agency positions. The paper has not been subject to management and legal reviews and approvals. The NRC staff expects that this topic will be addressed in a future memorandum from the staff to the Commission.

Introduction

In response to the March 2011 accident at Fukushima Daiichi, the U. S. Nuclear Regulatory Commission (NRC) issued Order EA-12-049, which directed power reactor licensees to develop, implement, and maintain guidance and strategies (“mitigating strategies”) to maintain or restore core cooling, containment and SFP cooling capabilities following a beyond-design-basis external event. In addition, the NRC issued letters to power reactor licensees pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.54(f), which requested the licensees to reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. This information was requested to support NRC decisions regarding possible regulatory actions to protect the plants from these reevaluated external hazards.

The mitigation strategies and external hazard reevaluations are not independent activities, in that the staff has previously stated that the reevaluated external hazards would inform licensee development of the mitigating strategies, which the staff proposes to reflect in the follow-on rulemaking to Order EA-12-049. Changing the focus of the flooding-related response to the 10 CFR § 50.54(f) letters in NRC’s post-Fukushima activities and integrating the decision-making criteria with the development and implementation of mitigating strategies will improve the efficiency of the regulatory process. The NRC staff plans to ask the Commission to affirm that licensees for operating nuclear power plants need to address the reevaluated flooding hazards within their mitigating strategies, which may include developing targeted or scenario-specific mitigating strategies for some beyond-design-basis events. The staff also plans to request the Commission approve changing the focus of the flooding-related response to the

10 CFR § 50.54(f) letters and integrating activities into the development and implementation of mitigating strategies.

BACKGROUND:

The accident at the Fukushima Daiichi nuclear plant in Japan highlighted the possibility that certain external events may simultaneously challenge the prevention, mitigation, and emergency preparedness measures that provide defense in depth protections for nuclear power plants. NRC's assessment of the lessons learned from the experiences at Fukushima Daiichi led to the conclusion that additional requirements were needed to increase the capability of nuclear power plants to address certain beyond-design-basis external events. As a result, the NRC undertook actions that imposed new requirements to enhance safety, while simultaneously asking that licensees reevaluate seismic and flooding hazards using present day standards and guidance and provide that information to the NRC.

The 10 CFR 50.54(f) letters describe a two phase approach to support NRC decisions on whether to pursue regulatory actions to increase nuclear power plant capabilities to address flooding events. During the first phase, the NRC staff is gathering information related to the reevaluation of flooding hazards, as well as assessing each licensee's proposed response(s) to those hazards. The NRC staff recognized that updated standards, models, and data might result in hazard levels for various flooding mechanisms that exceed those considered during the siting and licensing of some nuclear power plants.¹ As discussed in SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," the staff identified that certain flooding scenarios are of special concern because of a potential "cliff edge" effect, in that safety consequences of a flooding event may increase sharply with small increases in the flooding level. With this in mind, the NRC issued 10 CFR 50.54(f) letters to all licensees to reevaluate the flooding hazards at their sites against present-day regulatory guidance and methodologies used for early site permit and combined license reviews under 10 CFR Part 52. Licensees for operating nuclear reactors are currently submitting their reevaluated flooding hazards. Under existing plans and guidance, licensees would be expected to complete and submit integrated assessments describing the total plant response to the reevaluated hazard. The integrated assessments would include the potential impact of such events on their facilities and describe how a plant's flood protection and mitigation would maintain key safety functions for the various flooding scenarios. Under Phase 2, the staff would determine whether additional regulatory actions are necessary (e.g., update the design basis for structures, systems, and components (SSCs) important to safety) to protect against the updated hazards. This paper is responsive to the staff requirements memorandum related to SECY-11-0124, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," in which the staff was directed to provide the Commission with information about the technical bases and acceptance criteria for implementing Recommendation 2.1.

¹ During previous actions by the NRC staff to look back at external hazards after siting and licensing of a plant, the new methods sometimes identified hazard levels and associated effects (for the same or similar flooding events or for newly considered flooding mechanisms) in excess of the design or licensing basis. Examples of such activities discussed in Enclosure 1 include the Systematic Evaluation Program and the Individual Plant Examinations of External Events.

Simultaneously with the reevaluation of flooding hazards, licensees were required to develop and implement improved mitigating strategies in accordance with NRC Order EA-12-049, "Requirements for Mitigation Strategies for Beyond-Design-Basis External Events." Licensees are developing responsive mitigating strategies using guidance prepared by the nuclear industry and endorsed by the NRC. The primary guidance document is Nuclear Energy Institute (NEI) 12-06, "Diverse and Flexible Coping (FLEX) Implementation Guide." The focus of these efforts is to define capabilities to protect against a variety of beyond-design-basis external hazards. The additional capabilities address plant conditions involving an extended loss of all alternating current (ac) power and challenges to the ability to remove heat from the reactor cores and spent fuel pools. As licensees have developed and implemented their mitigating strategies, the NRC has recognized that other Fukushima-related recommendations are being or could be addressed within this activity.²

NRC Order EA-12-049 requires nuclear power plant licensees to put in place mitigating strategies for a variety of beyond-design-basis external events, including flooding. The NRC staff plans to incorporate these requirements into NRC regulations through the mitigation of beyond-design-basis events (MBDBE) rulemaking. This approach ensures that capabilities for dealing with the reevaluated flooding hazards identified from Recommendation 2.1 activities are, at a minimum, addressed by the requirements for improved mitigating strategies. However, integrating the results of the Recommendation 2.1 activities could lead to some licensees needing to modify their mitigating strategies in response to the reevaluated flooding hazards after they have implemented plant changes and procedures to comply with Order EA-12-049. There is also a possibility that circumstances at some nuclear power plants may warrant consideration of additional measures to protect against or mitigate postulated flooding scenarios. These additional measures (beyond those imposed by Order EA-12-049 and the related MBDBE rulemaking) could be pursued voluntarily by licensees or imposed by the NRC through the process defined in 10 CFR 50.109, "Backfitting."

DISCUSSION:

The Commission determined that reasonable assurance of adequate protection of public health and safety requires that power reactor licensees and construction permit holders develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event. The agency is addressing this through Order EA-12-049 and the related MBDBE rulemaking, which impose additional regulatory requirements for licensees. As a result of the order and the expected rulemaking, licensees have been required to provide capabilities to mitigate extended losses of ac power and challenge to heat removal functions that might be caused by beyond-design-basis external events. Beyond-design-basis events have previously been incorporated into the NRC's regulations as additional risk insights became available from operating experience and analytical studies. Examples of previous instances include

² Previous examples of integrating and consolidating Fukushima activities are described in COMSECY-13-002, "Consolidation of Japan Lessons Learned Near-Term Task Force Recommendations 4 and 7 Regulatory Activities" and SECY-14-0046, "Fifth 6-Month Status Update on Response to Lessons Learned from Japan's March 11, 2011, Great Tōhoku Earthquake And Subsequent Tsunami (Enclosure 6 - Proposal to Consolidate Post-Fukushima Rulemaking Activities)," and the related staff requirements memoranda.

regulations for anticipated transients without scram (ATWS), station blackout (SBO), and loss of large areas of the plant due to explosions or fires. The NRC staff intends to use these examples and the associated regulatory processes for developing the requirements for mitigating strategies for beyond-design-basis external events. Enclosure 1 provides background information on how beyond-design-basis issues have been incorporated into the design basis for affected SSCs and treated within the licensing basis of operating nuclear power plants.

The results of the reevaluation of the flooding hazard are important to define the necessary attributes of the mitigating strategies equipment and actions to adequately protect against beyond-design-basis external events. The NRC staff plans to include this requirement in the pending MBDBE rulemaking. As such, the strategies required by the MBDBE rulemaking cannot be completed without information about the site-specific reevaluated flooding hazards. At the same time, establishing a regulatory requirement for mitigating strategies to address reevaluated flooding hazards affects the assessments and subsequent Phase 2 decision-making on possible regulatory actions that might result from the reevaluation of flooding hazards. Given the dependencies between the two activities, the staff reviewed ongoing efforts and determined that the most effective and efficient path forward is to integrate the Phase 2 regulatory decision making process regarding flooding reevaluations into the development and implementation of mitigating strategies (Order EA-12-049 and pending MBDBE rule). The integration of the activities increases confidence that the NRC will have a regulatory requirement addressing the reevaluated flooding hazards.

Focusing the Phase 2 decision-making on mitigating strategies means that the integrated (total plant) assessment in Phase 1 is no longer needed in its current form. Instead, the mitigating strategies equipment and actions will be confirmed to protect against the reevaluated flooding scenarios. The NRC staff and licensees would be able to take advantage of lessons learned from Order EA-12-049 in developing and implementing changes needed to address reevaluated flooding scenarios. It is worth noting that changing the focus of the Phase 1 assessment and Phase 2 decisions for the flooding reevaluation has some practical impacts. The planned approach reduces the level of information to be submitted by licensees, and the assessments will focus on mitigating strategies instead of more varied enhancements to protect against a range of flooding conditions. A broader assessment could, for example, identify protective measures for equipment important to safety against some flooding scenarios and thereby reduce the reliance on mitigating strategies to address such events. However, the NRC staff finds that the integration of the activities will provide the desired outcome in terms of meaningful and assured safety improvements. The recommended approach also provides benefits in terms of establishing regulatory clarity and stability, reducing demands on schedules and resources, and ensuring timely actions to address reevaluated flooding hazards. The NRC staff provides additional discussion of the integration of activities related to flooding reevaluations and mitigating strategies in Enclosure 2.

This white paper has been prepared to support efforts to clarify the NRC staff's plans to complete activities currently underway to address lessons learned from the Fukushima accident and describe how the mitigation strategies order, rulemaking, and reevaluated hazards relate to each other now that sufficient information exists to describe a more integrated process. Primarily, the NRC staff intends to require that licensees' mitigating strategies address the reevaluated flooding hazards as part of the MBDBE rulemaking. The reevaluation of the flooding hazard will help define the functional requirements and reference bounds of design for

the equipment and actions used for the mitigating strategies for beyond-design-basis external events. Focusing the flooding reevaluations on the SSCs serving key safety functions within the mitigating strategies requirements will reduce the need for a broader assessment of the plant response as described in the 50.54(f) letter and related guidance documents. The NRC staff will also evaluate the implications of the approach for flooding described in this memorandum on seismic and other hazard reevaluations, generic issues, and other ongoing NRC activities.

The NRC staff may investigate the need for flooding protection or mitigation beyond that provided by mitigating strategies based on insights from the flooding reevaluations, previous plant inspections, overall integrated plans for mitigating strategies, and other available information as part of a systematic assessment of each plant's capabilities to address reevaluated flooding hazards. These assessments will consider information about revised flooding conditions, estimated event frequencies, available response times for identified scenarios, plant-specific configurations and licensing histories, and other factors relevant to the staff's evaluation of potential regulatory actions. Established processes such as those defined in Management Directive (MD) 8.4, "Management of Facility-specific Backfitting and Information Collection" describe how to initiate, review, and disposition these types of safety concerns. The staff will document the disposition of the flooding reevaluations and inform licensees and other stakeholders about the results, including the possible need for more information or consideration of plant-specific actions.

The current efforts to coordinate activities related to mitigating strategies and flooding reevaluations improve the efficiency of implementing ongoing safety improvements. The NRC staff plans to request that the Commission approve the changes to the Recommendation 2.1 flooding assessments and integration of the Phase 2 decision-making into the development and implementation of mitigating strategies in accordance with Order EA-12-049 and the related MBDBE rulemaking.

The NRC staff has had several public meetings with the nuclear industry regarding the need to consider the reevaluated flooding hazard and possibly revise equipment or strategies to address conditions different than those considered in the implementation of Order EA-12-049. The NRC staff and the industry recognized that the coincident performance of the flooding reevaluations and the implementation of the order would subsequently require assessing the mitigating strategies developed to address a variety of external hazards to ensure they provide capabilities sufficient to address the reevaluated flooding hazards from Recommendation 2.1. These discussions helped identify an approach to integrate mitigating strategies and the flooding reevaluations. Licensees will assess the mitigating strategies developed to address Order EA-12-049 against the flooding scenarios from the Recommendation 2.1 reevaluations. The mitigating strategies and related equipment will be confirmed to adequately address the postulated scenarios, or the licensee will revise the mitigating strategies. Changes to the mitigating strategies could involve modifications to the existing equipment and plans developed for multiple hazards or could involve developing a targeted strategy for a specific flooding scenario. The NRC staff plans to ask the Commission to support the planned approach by affirming that the MBDBE rulemaking needs to require mitigating strategies that are able to address the reevaluated flooding hazards developed in response to the 50.54(f) letters in order to ensure reasonable assurance of adequate protection of the public health and safety.

In some cases, the newly estimated elevated flooding hazards could result in significant damage to a nuclear power plant site and licensees may need to develop scenario-specific

strategies. However, even in such extreme cases, licensees will be required by the planned MBDBE regulation to have mitigating strategies that provide capabilities that can be deployed to prevent fuel damage in reactor cores or spent fuel pools and to minimize the resultant release of radioactive materials to the environment. These scenario-specific strategies may involve unconventional measures such as quickly entering refueling modes of operation, allowing flood waters into buildings, and pre-staging equipment and personnel to higher elevations. The NRC staff would review such proposals to ensure the licensee's analyses, assumptions, and planned actions appropriately address the risk from such flooding scenarios. In addition to satisfying the requirements of the NRC regarding radiological health and safety concerns, the above approach provides confidence that nuclear power plants will not significantly complicate the response to and recovery from extreme natural disasters. The NRC staff also plans to request Commission affirmation on this general approach for licensees developing mitigating strategies for floods that might result in significant damage to a nuclear power plant site.

Staff Recommendation

The staff currently plans to request that the Commission affirm the following:

1. Licensees for operating nuclear power plants need to address the reevaluated flooding hazards from Recommendation 2.1 within their mitigating strategies for beyond-design-basis external events (Order EA-12-049 and related MBDBE rulemaking),
2. Licensees for operating nuclear power plants may need to address some specific flooding scenarios that could significantly damage the power plant site by developing targeted or scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or spent fuel pools, and
3. The staff should revise the Recommendation 2.1 flooding assessments and integrate the Phase 2 decision-making into the development and implementation of mitigating strategies in accordance with Order EA-12-0049 and the related MBDBE rulemaking.

Enclosures:

1. Background - Design-basis Events, Design-basis Information, and External Events
2. Coordination and Clarification

Enclosure 1 – Background

Design-basis Events, Design-basis Information, and External Events

The terminology related to nuclear plant licensing and relationships between design-basis, design-basis events, beyond-design-basis accidents or events, and licensing basis can be difficult to follow. The complexity of the terminology has increased over the last several decades as new methodologies, such as probabilistic risk assessment (PRA), were introduced and as the U.S. Nuclear Regulatory Commission (NRC) and industry responded to specific issues or concerns (e.g., station blackout (SBO)). As explained in “A Short History of Nuclear Regulation, 1946–2009,” the initial design and licensing of nuclear power plants were approached as follows:

Regulators using a deterministic approach simply tried to imagine “credible” mishaps and their consequences at a nuclear facility and then required the defense-in-depth approach—layers of redundant safety features—to guard against them.

These “maximum credible accidents” were, in turn, used to define design-basis events, which were then used to determine design parameters for structures, systems and components (SSCs); the safety classification of SSCs; the contents of licensing-basis documents (such as final safety analysis reports (FSARs) and technical specifications); and needed supporting documents, such as plant procedures. The licensing efforts for early plants focused, therefore, on “design-basis events.” Regulator and licensee attention was centered on the mitigation of anticipated operational occurrences and design-basis accidents and on ensuring that plant structures and layouts addressed design-basis external hazards such that safety-related equipment was protected and plants could proceed from operations to a safe shutdown condition following a design-basis event.¹

The importance of “design-basis events” is, in part, because of its use within the definition of “safety-related” SSCs. The term “safety-related” is used to define requirements for the protection of SSCs from safe shutdown earthquakes (Title 10 of the *Code of Federal Regulations* (10 CFR) Part 100, “Reactor Site Criteria”) and is more widely used to distinguish those SSCs warranting special treatment in terms of quality assurance, environmental qualification, inclusion in FSAR safety analyses, and applicability of various industry codes and standards. The definition of “safety-related” SSCs provided in 10 CFR 50.2, “Definitions,” is as follows:

¹ Design-basis events are defined in 10 CFR 50.49, “Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants,” as follows:

Design-basis events are defined as conditions of normal operation, including anticipated operational occurrences, design-basis accidents, external events, and natural phenomena for which the plant must be designed to ensure functions (b)(1)(i) (A) through (C) of this section [see above items 1, 2 and 3 under definition of safety-related SSCs]

Safety-related structures, systems, and components means those structures, systems, and components that are relied upon to remain functional during and following design basis events to assure:

- (1) *the integrity of the reactor coolant pressure boundary;*
- (2) *the capability to shut down the reactor and maintain it in a safe shutdown condition; or*
- (3) *the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the applicable guideline exposures set forth in 10 CFR 50.34(a)(1) or 10 CFR 100.11 [“Determination of Exclusion Area, Low Population Zone, and Population Center Distance”] of this chapter, as applicable.*

This general approach was intended to address risks to the public health and safety by identifying potential internal and external design-basis events and ensuring that plant SSCs and personnel were able to respond and prevent or limit the release of radioactive materials. Lessons learned from subsequent studies of nuclear plant risks and operational experience led the NRC to introduce requirements for plant events and conditions beyond those included in the original licensing of nuclear power plants. An example is the requirements to better address anticipated transients without scram (ATWS) events. The NRC moved from the approach of focusing on design-basis events and adopted measures to control or reduce risks for the beyond-design-basis events added to the licensing basis for nuclear plants in the 1980s and later. The move to this approach reflects that, while the NRC is allowed under its backfit regulation to impose plant modifications to address safety concerns, if there are two or more ways to reach a level of protection that is adequate, then ordinarily the applicant or licensee is provided flexibility to choose the way that best suits its purposes. Given the ability to address safety concerns without re-defining design-basis events, the NRC has adopted more pragmatic approaches for NRC regulations and plant-specific issues since the 1980s. The NRC plans to continue this approach in addressing the reevaluation of external hazards that are underway or planned. That is; the NRC staff does not expect the reevaluated flooding hazards for most plants to affect the design-basis flood against which safety-related SSCs would need to be protected. The flooding reevaluations will, however, be used to define functional requirements and reference bounds for those specific SSCs used to support key safety functions within the mitigating strategies for beyond-design-basis external events. Exceptions to this approach might be taken on a plant-specific basis if justified by the NRC evaluations performed in accordance with 10 CFR 50.109, “Backfitting”. An example where this exception might be considered is a flooding scenario a relatively high estimated frequency and an associated high probability of the flooding event leading to core damage. In such a case, the NRC staff may find that reliance on mitigating strategies is not sufficient and flood protection or mitigation requirements beyond the MBDBE rulemaking may be warranted. The staff could propose to require the licensee address this issue by revising the design-basis flood and modifying the plant to protect safety-related SSCs..

In contrast to “design-basis events” that relate to the safety classification and special treatment requirements for plant SSCs, the term “design basis” is used in a more general manner as reflected in the following definition from 10 CFR 50.2:

Design basis means that information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted 'state of the art' practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals.

From this broader definition, it is possible to have beyond-design-basis events, such as ATWS and SBO contribute to the design-basis functions of specific SSCs. Explanations and guidance related to design-basis information are provided in Appendix B to Nuclear Energy Institute (NEI) 97-04, "Design Bases Program Guidelines," which is endorsed by the NRC in Regulatory Guide (RG) 1.186, "Guidance and Examples for Identifying 10 CFR 50.2 Design Basis." NEI 97-04 describes the information usually found in plant FSARs that makes up the functional requirements and the controlling parameters chosen as reference bounds for design that help define the design basis for plant SSCs. The guidance document also defines broader topics that need to be addressed within the design basis for plant SSCs. These topical design-basis issues include the following:

- fire protection
- flooding (internal and external)
- tornadoes and hurricanes
- seismic criteria
- missiles (internal and external)
- separation (Hazards)
- electrical separation and independence
- single failure criteria
- pipe break criteria
- environmental qualification (electrical and mechanical)
- SBO
- ATWS

The above topical design issues include several related to external events, including flooding, and also address design features for the beyond-design-basis events of SBO and ATWS. The topical design issues are derived from the following explanation from Appendix B to NEI 97-04:

Relationship of 10 CFR 50.2 Design Bases Functions to Licensing
Basis and Part 50 Requirements

10 CFR 50.2 design bases functional requirements are derived primarily from the principal design criteria for an individual facility (the minimum standards for which are set by 10 CFR Part 50 Appendix A) and NRC regulations such as the

Emergency Core Cooling System, SBO and ATWS rules that impose functional requirements or limits on plant design. 10 CFR 50.2 design bases are a subset of a plant's licensing basis. While a plant's licensing basis includes all applicable requirements of Part 50, not all Part 50 requirements have corresponding 10 CFR 50.2 design bases. For example, in Appendix A, several GDC [general design criteria] contain requirements for fabrication, construction, testing, inspection, and quality. These are process requirements on SSCs—not requirements for the performance of intended SSC functions—and are therefore not 10 CFR 50.2 design bases.

Order EA-12-049, "Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," and the mitigation of beyond-design-basis events (MBDBE) rulemaking will establish regulatory requirements for functional requirements (i.e., design basis) for SSCs in terms of responding to an extended loss of electrical power and separation from the ultimate heat sink resulting from beyond-design-basis external events. The use of existing requirements and guidance, including RG 1.186, provides for an effective and efficient path forward and can be used to address possible future issues regarding establishing and controlling licensing basis information.

Figure 1 provides a representation of the relationships between various elements of the licensing basis for a nuclear power plant. An example of how the elements fit together is offered below using a hypothetical plant and an auxiliary feedwater system consisting of one train using an alternating current (ac) driven pump and one train using a turbine driven pump. Both trains are used to address anticipated operational occurrences and other design-basis events involving the failure of plant equipment. Therefore, both trains are categorized as safety related equipment and are required to remain functional during the defined design-basis flood. A review of the established design basis for each train would therefore include pumping capacities and other functional requirements reflected in the final safety analysis report (FSAR) as well as needed protections against external flooding hazards up to the design-basis flood. The design basis for one or both trains may also include functional requirements to address a beyond-design-basis event such as SBO. For this example, the turbine-driven train is assumed to be used within the licensee's mitigating strategies. The licensee would add a design-basis requirement for the turbine-driven train to address the reevaluated flooding hazard. In accordance with existing guidance, the added measures to address the reevaluated flooding hazard would not need to be categorized as safety related. The auxiliary feedwater system is likely to have testing or inspection-related features defined within the licensing basis for the plant, but these features are not considered to be within the design basis for the system. The licensee may also establish controls or capabilities for the auxiliary feedwater system that go beyond regulatory requirements and which would be captured in their own "engineering design basis."

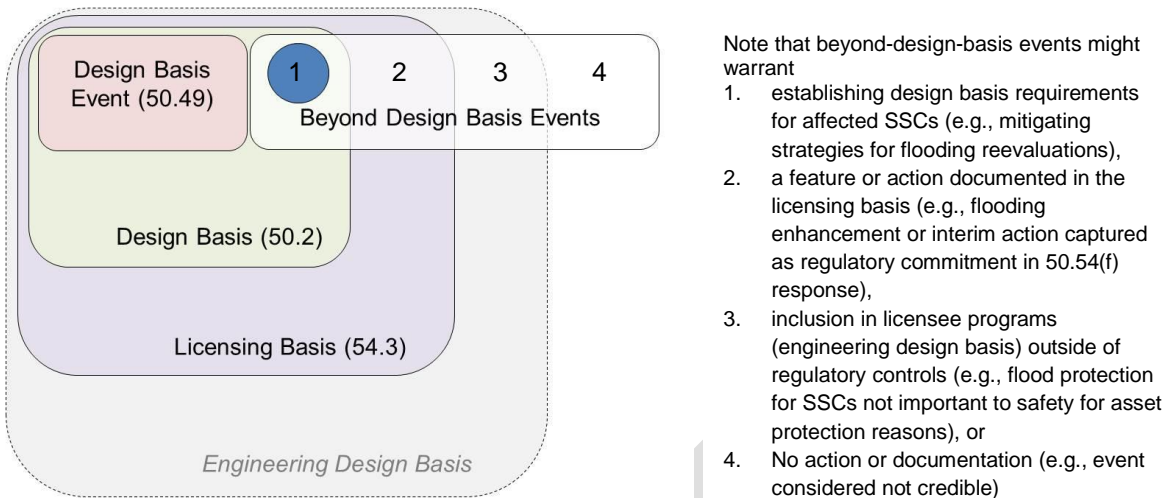


Figure 1

Scheduler constraints may require some licensees to implement changes to comply with Order EA-12-049 before flooding reevaluations for the affected plants are complete. However, the NRC staff interprets Commission direction to be that the appropriate installed and/or portable equipment and related mitigating strategies ultimately need to address the reevaluated hazards to ensure reasonable assurance of adequate protection of public health and safety. This could result in licensees needing to review and possibly modify SSCs or strategies if the flooding reevaluations result in changes to the functional requirements or reference bounds for design from those previously used to develop and implement plans for Order EA-12-049. The MBDBE rulemaking will codify these expectations consistent with the Commission's intended outcome for the regulatory requirements imposed by the order and related rulemaking.

The NRC staff has had several public meetings with the nuclear industry regarding the need to consider the reevaluated flooding hazard and possibly revise equipment or strategies to address conditions different than those considered in implementing Order EA-12-049. The industry also recognized that the coincident performance of the flooding reevaluations and implementation of the order would require assessing the flexible strategies developed to address multiple hazards to ensure they provide capabilities sufficient to address the Recommendation 2.1 reevaluated flooding hazards. These discussions have helped to clarify the relationships between the Fukushima-related activities and to support revising guidance documents for addressing the order and flooding reevaluations. As a general matter, the nuclear industry acknowledges that licensees will need to assess the mitigating strategies required by Order EA-12-049 against the flooding scenarios from the Recommendation 2.1 reevaluations. Changes to the mitigating strategies after initial implementation of Order EA-12-049 could involve modifications to the existing equipment and plans developed for multiple hazards or could involve developing a targeted strategy for specific flooding scenarios. The nuclear industry and NRC staff are revising appropriate guidance documents to incorporate the clarifications and assessments of mitigating strategies in light of the flooding reevaluations. The mitigating strategies and related equipment will be confirmed to adequately address the reevaluated flooding scenarios as part of the activities associated with the MBDBE rulemaking.

Regulatory Requirements Related to External Hazards

The NRC and its predecessor agency, the Atomic Energy Commission, established regulatory requirements for siting and designing nuclear power plants to ensure safety-related SSCs were protected against natural hazards such as earthquakes and floods. Failure to protect SSCs important to safety from natural phenomena with appropriate safety margins has the potential to result in common-cause failures with significant consequences. The accident at Fukushima demonstrated the importance of providing measures to protect and mitigate external events. However, the approaches to evaluating external hazards have evolved over time as new information regarding site hazards and the potential consequences have become available. As a result, the licensing basis, design, and level of protection from natural phenomena differ among the existing operating reactors in the United States. Much of this variation can be attributed to the time when the plant was constructed and licensed for operation, once the issue of site selection was settled. Except as imposed by the NRC through specific regulations, orders, or license conditions, licensees are not required to assess or modify plant designs to meet new or revised standards. Nor are licensees normally requested to periodically assess possible changes to plant designs or procedures to address external hazards beyond those used in the initial plant siting and licensing decisions.

The NRC recognized these differences between plants and the need to assess early plants against the evolving standards in the 1970s following the development of the standard review plan (SRP). The agency identified potential safety issues and reviewed the early plant designs against the then-newer SRP guidance under the systematic evaluation program (SEP). The SEP included several flooding issues and resulted in some plant-specific reviews and design or procedure changes implemented by impacted licensees to address potentially higher flooding hazards. Generic Letter 95-04, "Final Disposition of the Systematic Evaluation Program Lessons-Learned Issues," dated April 28, 1995, describes the SEP and the resolution of the issues. Many of the SEP issues were resolved by the subsequent requests for licensees to perform individual plant examinations. Supplement 4 to Generic Letter 88-20, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities – 10 CFR 50.54(f)," addressed some of the flooding issues. The actions taken by licensees to address potential vulnerabilities or other flooding concerns were not subsequently incorporated into regulations or operating licenses. In recognition that the NRC's regulations do not include requirements for licensees to periodically update plant designs to newer standards, revised estimates of external hazards, or other risk insights, Generic Letter 88-20 identified that the IPEEE might lead to the following assessment:

If NRC consideration indicates that plant design or operation could be enhanced by substantial additional protection beyond NRC regulations, appropriate enhancement will be recommended and supported with backfit analysis in accordance with 10 CFR 50.109.²

² Backfitting is permitted only after a formal, systematic review to ensure that changes are properly justified and suitably defined. The requirements of this process are intended to ensure order, discipline, and predictability and to optimize the use of NRC staff and licensee resources. With limited exceptions such as changes needed to ensure reasonable assurance of adequate protection of public health and safety, the NRC must determine that the proposed backfit will

In the 1990's, the NRC identified issues with the control of licensing basis information. The NRC staff recommended specific actions in SECY-97-036, "Millstone Lessons Learned Report, Part 2: Policy Issues," dated February 12, 1997, to improve the understanding and control of licensing basis information. In a staff requirements memorandum dated May 20, 1997, the Commission directed the staff, in part; to issue guidance for complying with requirements in 10 CFR 50.71(e) so that updated final safety analysis reports (UFSARs) reflect changes to the design bases and address the effects of other analyses performed since original licensing. In response, the NRC staff issued RG 1.181, "Content of the Updated Final Safety Analysis Report in Accordance with 10 CFR 50.71(e)." RG 1.181 endorsed industry guidance provided in the document NEI 98-03, "Guidelines for Updating Final Safety Analysis Reports." These guidance documents identified as "historical information" industry or other data obtained to support or develop the original plant design bases, including that relating to natural or manmade phenomena such as geography, meteorology, hydrology, geology, seismology, population density, and nearby facilities.³ The guidance defines historical information as that information that was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant. Even though the NRC anticipated that this information would not need to be updated during the licensed period, licensees remain obligated to inform the NRC of issues that they determine to have a significant implication for public health and safety (see 10 CFR 50.9, "Completeness and Accuracy of Information").

Two relatively recent events—the August 2011 earthquake near the North Anna Power Station nuclear plant in Virginia and the flooding of the Missouri River in June 2011 that impacted the Fort Calhoun Station nuclear plant—have led the NRC to review regulatory requirements related to external events. Both events challenged or slightly exceeded the design-basis events established for protection against natural phenomena for the two plants. Each event also involved the NRC assessing the regulatory requirements in support of decisions related to the restart of the plants. In keeping with the established agency positions, the NRC again agreed that the design-basis events used during the initial siting and licensing of these plants remain the basis for the protection of safety-related SSCs. As part of the process of gaining NRC approval for restart, the licensees for both stations did, however, improve capabilities to deal with the specific external event that had affected their facility. Licensees made changes to UFSARs or made regulatory commitments to capture the agreements within the appropriate licensing basis documents for the subject nuclear power plants.

Although licensees are not generally required to identify and address changes to external hazards to their nuclear power plants, the NRC has well-established programs to address potential safety issues identified from operating experience and hazard studies performed by other Federal agencies. Two examples related to external hazards are Generic Issue (GI)199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," and GI-204, "Flooding of Nuclear Power Plant Sites Following

substantially increase the overall protection of public health and safety or the common defense and security and that the direct and indirect costs for the facility are justified in view of the increased level of protection.

³ This information is typically found in Chapter 2 of the UFSAR.

Upstream Dam Failure.” The NRC’s programs include various steps to identify issues, assess the safety significance, determine needs for information collection, and evaluate possible regulatory actions. Both of these GIs were being pursued at the time of the Fukushima accident and the NRC staff subsequently incorporated them into the broader activities related to lessons learned from that event.

The accident at the Fukushima Daiichi nuclear plant in Japan initiated additional NRC assessments of the regulatory requirements associated with protecting nuclear power plants in the United States from natural phenomena, such as large earthquakes and floods. The NRC undertook a number of actions to address lessons learned from the accident in Japan, including imposing several new requirements to enhance safety, and requiring licensees to submit information on the reevaluation of seismic and flooding hazards using present-day standards and guidance. In addition to the actions initiated by the NRC, congressional direction was provided to the agency in Section 402 of the Consolidated Appropriations Act, 2012, (Public Law 112-074, dated December 23, 2011), which requires a reevaluation of licensees’ design basis for external hazards and expands the scope to include other external events, as described below:

The Nuclear Regulatory Commission shall require reactor licensees to reevaluate the seismic, tsunami, flooding, and other external hazards at their sites against current applicable Commission requirements and guidance for such licensees as expeditiously as possible, and thereafter when appropriate, as determined by the Commission, and require each licensee to respond to the Commission that the design basis for each reactor meets the requirements of its license, current applicable Commission requirements and guidance for such license. Based upon the evaluations conducted pursuant to this section and other information it deems relevant, the Commission shall require licensees to update the design basis for each reactor, if necessary.

The NRC is responding to the above Congressional direction through its activities related to seismic and flooding reevaluations under the Near-Term Task Force (NTTF) Recommendation 2 and the required implementation of mitigating strategies. Insights from the seismic and flooding reevaluations and the ongoing activities related to implementation of Order EA-12-049 will be used to develop plans to address other external hazards (e.g., wind-related events). As previously discussed, the reevaluations of flooding and other hazards will help to define the functional requirements and reference bounds for design (i.e., design-basis) that are applicable to specific SSCs used within licensees’ mitigating strategies for beyond-design-basis external events. The possible performance of periodic evaluations of the risks posed to nuclear power plants by external events is being considered under a separate activity (NTTF Recommendation 2.2). The NRC staff will assess possible approaches for such periodic evaluations and make recommendations to the Commission in a future paper (separate from the subject paper of this white paper). The staff will also assess the implications that implementing the approach described in the memorandum for flooding reevaluations has on other hazard reevaluations, generic issues, and related NRC activities.

Enclosure 2 – Coordination and Clarification

Licenses are currently evaluating flooding hazards using present-day standards and guidance and submitting reports to the U.S. Nuclear Regulatory Commission (NRC) in accordance with Phase 1 of the activities associated with the Near-Term Task Force's (NTTF's) Recommendation 2.1. In addition to the hazard reevaluation, licenses whose hazard exceeds the design-basis flood levels were requested to describe interim actions taken or planned that address the specific flooding issues identified by the reevaluation. The request for information and related guidance also call for affected licenses to perform an integrated assessment of the effects of higher flood levels on the nuclear power plant site. The integrated assessment was initially intended to evaluate the total plant response to the flood hazard and identify vulnerabilities and actions to address them. The integrated assessment could consider multiple and diverse capabilities such as physical barriers, temporary protective measures, and operational procedures. The capabilities being developed and implemented as part of the mitigating strategies required by Order EA-12-049, "Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," could also be considered as part of an integrated assessment.

As licenses were performing their reevaluations of seismic and flooding hazards, questions arose regarding the regulatory treatment of flood levels that were potentially higher than those established as design- or licensing-basis events for specific facilities. These questions translate to how the NRC staff would determine if regulatory actions are necessary under Phase 2 of the program and how those decisions are integrated with other Fukushima-related activities. A challenge in answering such questions is that the NRC response to the Fukushima accident involves the concurrent imposition and implementation of new requirements and the collection and assessment of information, such as the reevaluations of external hazards. The NRC staff has provided some guidance and plans regarding the decision-making process and integration of Fukushima-related activities to address specific questions during the reevaluation of external events and the implementation of mitigating strategies. The collection and assessment of information related to flooding hazards as part of the NRC's resolution of the NTTF's Recommendation 2.1 helps establish functional requirements and reference bounds for design to address external event scenarios in accordance with the generic mitigating strategies requirements. Focusing the flooding reevaluations on the SSCs serving key safety functions within the mitigating strategies requirements will, in many cases, improve the efficiency of the NRC's regulatory process by eliminating the need for a broader assessment of the plant response as described in current plans and staff guidance for integrated assessments.

In keeping with the established policies that reevaluated hazards are not automatically incorporated into the licensing basis for operating reactors, but instead would be assessed in accordance with the NRC's regulation for considering new regulatory requirements (i.e., 10 CFR 50.109, "Backfitting"), the Director of the NRC's Office of Nuclear Reactor Regulation provided supplemental information in letters dated March 1, 2013, regarding flooding reevaluations and February 20, 2014, for seismic reevaluations. The letter, dated March 1, 2013, stated:

The staff considers the flood hazard re-evaluations being performed pursuant to the 50.54(f) letter to be beyond the current design/licensing basis of operating plants. Consequently, the results of the analysis performed using present-day regulatory guidance, methodologies, and information would not generally be expected to call into question the operability or functionality of SSCs. Therefore, the results are not expected to be reportable pursuant to 10 CFR 50.72, "Immediate notification requirements for operating nuclear power reactors," and 10 CFR 50.73, "Licensee event report system." However, as with any new information that may arise at a plant, licensees are responsible for evaluating and making determinations related to operability and any associated reportability on a case-by-case basis.

and:

Notwithstanding the preceding discussion, and as noted in the 50.54(f) letter, based upon the results of the review of the responses and other available information, the staff may impose additional requirements to protect against the re-evaluated flood hazard. As always, the safety of the operating plants is of paramount importance. The NRC staff will follow established regulatory processes, including the backfit rule, in determining whether additional requirements are warranted. Further, as with any submittal to the NRC, licensees should evaluate the content to determine if it requires special treatment (e.g., security-related, proprietary, etc.) and request the information be withheld from public disclosure, as appropriate.

As licensees and the NRC staff were assessing the reevaluations of external hazards, they were also working on the order that required the development and implementation of mitigating strategies for beyond-design-basis external events. The initial plans for the mitigating strategies allowed the use of the most recent site flood analysis (e.g., the design-basis flood) because the licensees had not yet completed the Recommendation 2.1 hazard reevaluations. However, the need for the mitigating strategies to address external hazards (especially flooding) exceeding the original design-basis levels for some facilities had been recognized during discussions on implementation of Order EA-12-049 and this point was incorporated into staff and industry guidance documents. The incorporation of the beyond-design-basis external hazards into measures being taken to control risks via implementation of improved mitigating capabilities and strategies is reflected in the regulatory basis document published for the mitigation of beyond-design-basis events (MBDBE) rulemaking activity. The NRC staff described the linkage between the reevaluation of hazards and the planned requirements for mitigating strategies as follows in the published regulatory basis document:

Since the purpose of the SBOMS [Station Blackout Mitigating Strategies (SBOMS) now referred to as MBDBE] rulemaking would be to provide mitigation capability for extreme external events, information from NTTF Recommendation 2.1 regulatory activities or other re-evaluations of site-specific hazards would be relevant and need to be addressed and could result in changes to the facility. These changes could include changes to: installed equipment; portable

equipment; portable equipment connections; and/or guidance and strategies. Consistent with Order EA-12-049 and related regulatory guidance, it is expected that the SBOMS rule would contain requirements to maintain the SBOMS capabilities, including the protection afforded the equipment consistent with any updated hazard analyses. The supporting SOC and regulatory guide would indicate that the meaning and intent of this provision would be to ensure that new information or operating experience feedback (e.g., new information about a re-evaluated hazard) that impacts the SBOMS equipment and strategies would need to be addressed, and the SBOMS strategies and equipment protection would be updated accordingly.

The relevant hazard information would be taken into account in showing that adequate time for use of portable equipment can reasonably be met as described in [Nuclear Energy Institute] NEI 12-06, Section 3.2.1.7, Principle 6, and clarified in JLD-ISG-2012-01's Staff Position of Section 2.1.¹ The establishment of an appropriate hazard is, therefore, an important element of the strategies that requires maintenance of mitigation capability for changes in the facility that could impact the identified time constraints. As such, the staff expects that NTTF Recommendation 2.1 activities, for licensees having re-evaluated hazards that exceed their current design basis, could have a significant impact on their SBOMS equipment and strategies. For example, the industry and the NRC are currently considering an expedited approach for the treatment of seismic issues to address NTTF Recommendation 2.1, and the result of that effort could impact the SBOMS equipment and strategies related to this rulemaking. The SBOMS rule could serve to codify the requirement for establishing and addressing re-evaluated hazards and their impact on mitigation equipment and strategies.

The completion and submittal of flooding reevaluations and the development and implementation of mitigating strategies for beyond-design-basis external events are bringing to the forefront the issue of the regulatory treatment of hazards that exceed existing design-basis flood levels. Licensees have developed interim actions and are undertaking additional analyses and plant changes to address the potential effects of beyond-design-basis natural events on equipment important to safety, and in particular on equipment used as part of the mitigating strategies associated with Order EA-12-049 and the MBDBE rulemaking. The reevaluation of flooding hazards will likely raise questions from both internal and external stakeholders regarding the mitigation of risks from water levels significantly above the original design bases for individual facilities. The NRC staff has, therefore, engaged the nuclear industry and developed a general approach for Phase 2 of Recommendation 2.1 on flooding and the process by which the flooding reevaluations will be incorporated into the overall response to lessons learned from the Fukushima Daiichi accident. As discussed above, the flooding reevaluation

¹ NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," is the industry guidance document for implementing NRC Order EA-12-049 and was endorsed in NRC interim staff guidance (ISG) JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events."

activities are supporting (1) the establishment of design basis functions and reference bounds for design for mitigating strategies and, if warranted, (2) support for plant-specific evaluations of other possible regulatory actions (i.e., potential plant-specific backfits). The use of the flooding reevaluations from Recommendation 2.1 primarily to define functional requirements and reference bounds for mitigating strategies is a change from existing guidance and descriptions provided in briefings and reports to the Commission. This integration of activities is an appropriate way to provide reasonable confidence that key safety functions are maintained during flooding scenarios while improving the efficiency and effectiveness of addressing lessons learned from the Fukushima accident.

The NRC staff finds that the integration of the activities will provide the desired outcome in terms of meaningful and assured safety improvements. The recommended approach also provides benefits in terms of establishing regulatory clarity and stability, reducing demands on schedules and resources, and ensuring timely responses to the lessons learned from the Fukushima accident. Primarily, the NRC staff intends to require that licensees' mitigating strategies address the reevaluated flooding hazards as part of the MBDBE rulemaking. The reevaluation of the flooding hazard will help define important attributes of the equipment and actions used for the mitigating strategies for beyond-design-basis external events. Focusing the flooding reevaluations on the SSCs serving key safety functions within the mitigating strategies requirements will reduce the need for a broader assessment of the plant response as described in the current flooding-related guidance documents. There may be circumstances where the staff concludes that the flooding reevaluations warrant investigating the need for additional protection or mitigation beyond that provided by mitigating strategies. The current efforts to coordinate activities related to mitigating strategies and flooding reevaluations improve the efficiency of implementing ongoing safety improvements. The NRC staff plans to request that the Commission approve the revised focus of Phase 1 flooding assessments and integration of Phase 2 decision-making into the development and implementation of mitigating strategies in accordance with Order EA-12-049 and the related MBDBE rulemaking.

Establishing Design Basis Functions and Values for Mitigating Strategies SSCs

A major part of addressing the lessons learned from the Fukushima accident for nuclear power plants in the United States is the development and implementation of mitigating strategies for beyond-design-basis external events. Figure 2.1 provides a simplified representation of the issue and resultant mitigating strategies. The figure shows how a beyond-design-basis event, such as a flooding scenario exceeding the values used to protect safety-related SSCs, can initiate a plant upset (Point 1). Nuclear power plants are designed with multiple safety systems to ensure that important safety functions, such as core cooling, are provided and protected against design-basis events (Point 2). However, postulated beyond-design-basis events can not only initiate a plant upset but can also challenge the availability of equipment performing key safety functions (Point 3). The Fukushima accident is an example of such an event where a tsunami exceeded the established flood protection features, caused the loss of electrical power and other safety systems, and ultimately a loss of safety functions needed to maintain the integrity of the reactor core and containment structures. The mitigating strategies put in place to address such external events therefore include measures to protect some equipment from beyond-design-basis external events and thereby provide capabilities to prevent fuel damage in the reactor core or spent fuel pool and a significant release of

The industry and NRC staff were faced with challenges related to the schedules for implementing Order EA-12-049 and the re-evaluation of flooding hazards using present day standards and guidance. The need to develop and implement plans for mitigating strategies for beyond-design-basis external events prior to completing the reevaluation of seismic and flooding hazards led the NRC staff to accept for the purpose of Order EA-12-049 that the functional requirements for installed and portable equipment could, if other information was not available, be established at conditions associated with the most recent site flood analysis.² There is, however, a general consensus that the desired end state following completion of the hazard reevaluations and implementation of the MBDBE rulemaking is that licensees have mitigating strategies to address the scenarios identified from the Recommendation 2.1 assessments. Guidance documents and the regulatory basis for the MBDBE rulemaking have included statements that the mitigating strategies are expected to address beyond-design-basis events, including the flooding reevaluations resulting from the Recommendation 2.1 requests for information. However, incorporating the flooding reevaluations and integrated assessments into the process to define functional requirements for mitigating strategies equipment may require licensees to perform additional evaluations of installed equipment, structures, and the placement of portable equipment to reconcile the mitigating strategies plans and the results from the flooding assessments.

Although the focus for the reevaluated flooding hazards is related to assessing the capabilities for mitigating strategies, the activities related to the flooding reevaluations may result in the NRC staff identifying safety concerns and the need to consider regulatory actions beyond those being implemented in accordance with Order EA-12-049 and the related MBDBE rulemaking. The NRC staff will use established processes such as those defined in Management Directive (MD) 8.4, "Management of Facility-specific Backfitting and Information Collection" to initiate, review, and disposition any such safety concerns. MD 6.4, "Generic Issues Program," defines the process for raising and resolving generic safety concerns.

The planned increased integration of the re-evaluation of flooding into the mitigating strategies activities will serve to enhance the plant improvements being implemented in response to the lessons learned from the Fukushima Daiichi accident. The NRC staff described in the 50.54(f) letter and related guidance an approach where Phase 1 of the flooding assessments (hazard re-evaluation, interim actions, and integrated assessment) would support a subsequent NRC decision on appropriate regulatory actions. Those regulatory actions could include requiring licensees to prevent flooding of safety-related SSCs by improving flooding protection (akin to redefining the design-basis flood), requiring mitigating capabilities for cases where the availability of safety-related SSCs are challenged by flood waters, or some combination of actions to prevent or mitigate the risks from the re-evaluated flooding hazards. As discussed above, the relationship between the external hazard re-evaluations and the development of mitigating strategies for such events has become clearer as both activities have been developed

² NEI 12-06 includes guidance for screening and considering external events, including flooding scenarios that states "The equipment should be stored in one or more of the following configurations: (a) Stored above the flood elevation from the most recent site flood analysis. The evaluation to determine the elevation for storage should be informed by flood analysis applicable to the site from early site permits, combined license applications, and/or contiguous licensed sites...."

over time, and the planned integration of the activities will support a more efficient and effective resolution of the issues. The NRC staff undertook improved coordination of the activities given that both centered on providing key safety functions during challenging external events. This paper is responsive to the staff requirements memorandum related to SECY-11-0124, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," in which the staff was directed to provide the Commission with information about the technical bases and acceptance criteria for implementing Recommendation 2.1.

The integrated assessments envisioned by the original guidance provided an opportunity for licensees and the NRC staff to gain insights into plant responses to flooding beyond testing capabilities to mitigate the event. Although the assessment of flooding hazards will now be focused primarily on the mitigating strategies capabilities (including necessary installed SSCs), the revised approach does not rule out the possibility that some licensees may perform the more detailed integrated flooding assessment as described in the current guidance documents (i.e., assessing plant impacts beyond maintaining mitigating strategy capabilities). These assessments could support licensees' consideration of asset protection measures (Figure 2.2; Point 5) or identify possible cost savings associated with traditional flood protection versus revised mitigating strategies. The staff may also undertake detailed assessments of flood protection and mitigation capabilities beyond Order EA-12-049 and the MBDDBE rulemaking if needed to support evaluating the possible pursuit of plant-specific requirements in accordance with NRC's backfit regulation. The NRC staff will, on a case-specific basis, consider information about the reevaluated hazards; available response times for identified scenarios; plant-specific configurations and licensing histories; and other factors when defining an appropriate assessment of flooding scenarios to support evaluating a potential plant-specific backfit.

The assessments of mitigating strategies equipment and actions would ensure protection against various flooding mechanisms and conditions identified from the flooding reevaluations. Mitigating strategies would therefore need to address scenarios that could range from slightly above the design-basis flood to significantly above the design-basis flood and depending on the site, scenarios involving different warning times, debris loads, and event durations. The NRC staff has had several public meetings with the nuclear industry regarding the need to consider the reevaluated flooding hazard and possibly modify equipment or strategies to address conditions different than those considered in the implementation of Order EA-12-049. The industry provided a framework generally consistent with that proposed by the NRC staff in terms of assessing new hazard information and evaluating mitigating strategies and related equipment to either confirm the various flooding scenarios are adequately addressed or to identify possible revisions to the strategy to address the reevaluated flooding hazard. Changes to the mitigating strategies could involve modifications to the existing equipment and plans developed for a variety of external hazards or could involve developing a targeted strategy for specific flooding scenarios.

An example of revising the existing equipment and plans developed for multiple external hazards would be to raise the elevation of a connection or storage location to accommodate higher flood levels that might be calculated when using present day standards and guidance. The assessment of new hazard information would consider not only the flooding conditions but also the timing of the event in terms of the ability of a licensee to be warned of an impending flood and ability to prepare. Licensees may be able to address some flooding scenarios by

taking advantage of the available warning time to shut down the plant and optimize the use of the mitigating strategies developed to address all external hazards.

It is clear that for some flooding scenarios, licensees may need to develop targeted or scenario-specific mitigating strategies to deal with events that far exceed their original design-basis flood and the approaches developed for other external hazards. For example, some low-probability, but conceivable flooding scenarios could challenge a licensee's access to many plant SSCs, including those used to mitigate most beyond-design-basis external events. A possible scenario that would require a targeted mitigating strategy is the failure of one or more major dams upstream of a nuclear plant. In addition to the expected damage to the nuclear power station, such a flooding scenario would – in and of itself - have major adverse impacts on public health and safety, regional economic activities, and other socio-economic conditions. However, measures would still be needed to ensure that the damages to the nuclear facility would not make the impact of the disaster materially worse by introducing the complexities of a large release of radioactive materials. In the event of such an unlikely, but very large flood, the goal of protecting public health and safety by providing additional capabilities to prevent damage to fuel assemblies in the reactor core and the spent fuel pool is considered acceptable.

Licensees may develop a scenario-specific plan for some postulated flooding events that would identify the necessary actions, including the orderly shutdown of the reactor, to support the unit(s) achieving and maintaining a manageable shutdown condition. The targeted strategy would address the time from initial notification throughout the period of degrading conditions, loss of access to important plant areas and equipment, and receding water levels. As appropriate, the scenario-specific mitigating strategy would include provisions to address the following:

- Facility structures (containments, reactor and fuel buildings, etc.) and key systems (e.g., reactor vessel and spent fuel pool). The targeted strategy should address possible actions to help maintain overall structural and system configurations and integrity to support achieving and maintaining a manageable shutdown condition. Configuration control can, as appropriate, rely on the ability of structures and systems to withstand the static and dynamic forces associated with an overwhelming flood or include administrative actions, such as opening flowpaths for the flood waters to travel through a building. If flood waters are expected to enter buildings, the targeted strategy should address the ability of key systems to maintain a configuration that supports a manageable shutdown condition (i.e., prevents loss of cooling to fuel assemblies in the core and spent fuel pool).
- Cooling functions. The mitigating strategies should address those measures (design characteristics, installed equipment, portable equipment, etc.) providing criticality control and cooling functions for the reactor core and spent fuel beginning with the notification of the initiating event (e.g., dam failure), throughout the plant shutdown, and ultimately achieving and maintaining a manageable shutdown condition.

- The targeted or scenario-specific mitigating strategy would identify key steps (including equipment and personnel) for the following:
 - o Preparing for the arrival of the flood waters (e.g., reaching cold shutdown or refueling mode).
 - o Providing cooling for the reactor core and spent fuel for the range of possible flooding levels—addressing the various potential stages of losing access to plant structures and equipment.
 - o Maintaining a manageable shutdown condition for the range of possible flooding levels—addressing equipment (including needed fuel supplies and supporting functions), access and movement to staging areas, and personnel support (including food and water). As with other aspects of mitigating strategies, the plan should address maintaining the manageable shutdown condition using onsite portable equipment until such time as support can reasonably be expected from offsite resources.

The NRC staff is implementing the above approach as part of its activities related to Recommendation 2.1 on flooding reevaluations and Recommendation 4 on improving plant capabilities to deal with SBO events and mitigating strategies for beyond-design-basis natural events. These approaches are consistent with longstanding policies on the treatment of design-basis events and safety enhancements to address beyond-design-basis events. The integration of the reevaluated flooding hazards with the ongoing mitigating strategies activities and the related rulemaking effort provide the most effective and efficient path for the timely resolution of Fukushima-related issues and implementation of safety enhancements at nuclear power plants.