DRAFT-WHITE PAPER
JAPAN LESSONS-LEARNED DIVISION
GUIDANCE FOR CLOSURE OF ACTIVITIES RELATED TO NEAR-TERM TASK FORCE RECOMMENDATION 2.1, FLOODING HAZARD REEVALUATION, THROUGH THE FOCUSED EVALUATION PROCESS

PURPOSE

This document is being issued to describe to stakeholders methods acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) for satisfying the requested integrated assessment for external flooding described in the NRC's March 12, 2012, request for information (Reference 1), issued pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54, "Conditions of licenses," (hereafter referred to as the 50.54(f) letter) regarding Recommendation 2.1 of the enclosure to SECY-11-0093, "Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident" (Reference 2), as modified by COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," (Reference 3), its related Staff Requirements Memorandum (SRM) (Reference 4), COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards For Operating Nuclear Power Plants," (Reference 5) and its associated SRM (Reference 5). Among other actions, the March 12, 2012, letter requested that respondents reevaluate flood hazards at each site and compare the reevaluated hazard to the design-basis at the site for each flood mechanism. Addressees were requested to perform an integrated assessment if the design-basis flood hazard does not bound the reevaluated flood hazard for all mechanisms.

This document will assist operating power reactor respondents and holders of construction permits under 10 CFR Part 50 with performance of the focused evaluations and revised integrated assessments. This document is not intended for use in design-basis applications or in regulatory activities beyond the scope of performing the integrated assessment.

BACKGROUND

Following the events at the Fukushima Dai-ichi nuclear power plant, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF conducted a systematic and methodical review of the NRC regulations and processes and determined if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in the enclosure to SECY-11-0093 (Reference 2). These recommendations were enhanced by the NRC staff following interactions with stakeholders. Documentation of the NRC staff's efforts is contained in SECY-11-0124, "Recommended Actions to be Taken without Delay from the Near-Term Task Force Report," dated September 9, 2011 (Reference 7), and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011 (Reference 8).

As directed by the SRM for the enclosure to SECY-11-0093 (Reference 9), the NRC staff reviewed the NTTF recommendations within the context of the NRC's existing regulatory framework and considered the various regulatory vehicles available to the NRC to

implement the recommendations. SECY-11-0124 and SECY-11-0137 established the staff's prioritization of the recommendations based upon the potential safety enhancements.

As part of the SRM for SECY-11-0124, dated October 18, 2011 (Reference 10), the Commission approved the staff's proposed actions, including the development of three information requests under 10 CFR 50.54(f). The information collected would be used to support the NRC staff's evaluation of whether available or planned measure provide effective protection and mitigation or if further regulatory action should be pursued in the areas of seismic and flooding design, and emergency preparedness.

In addition to Commission direction, the Consolidated Appropriations Act, Public Law 112-074, was signed into law on December 23, 2011, which contains the Energy and Water Development Appropriations Act, 2012. Section 402 of the law requires a reevaluation of licensees' design-basis for external hazards.

In response to the aforementioned Commission and Congressional direction, the NRC issued a request for information to all power reactor licensees and holders of construction permits under 10 CFR Part 50 on March 12, 2012 (Reference 1).

In SRM-COMSECY-14-0037 and SRM COMSECY-15-0019, the Commission approved the staff's plans to modify the approach for integrated assessments to implement a graded approach for determining the need for, and prioritization and scope of, plant-specific integrated assessments so that the integrated assessments are focused on those plants where there is the greatest opportunity for additional safety enhancements. . As discussed in COMSECY-15-0019, the majority of sites with flooding hazards exceeding the design-basis flood will screen out from the integrated assessments and licensees will instead provide focused evaluations to ensure appropriate actions are taken and that these actions are effective and reasonable.

On March 9, 2016, the Nuclear Energy Institute (NEI) submitted the document NEI 16-05, Revision A, "External Flooding Assessment Guidelines," (Reference 11) in support of this effort.

RATIONALE

On March 12, 2012, the NRC issued a request for information to all power reactor licensees and holders of construction permits under 10 CFR Part 50. The request was issued in accordance with the provisions of Sections 161.c, 103.b, and 182.a of the Atomic Energy Act of 1954, as amended (the Act), and NRC regulation in 10 CFR , Part 50, Paragraph 50.54(f). Pursuant to these provisions of the Act or this regulation, respondents were required to provide information to enable the staff to determine whether a nuclear plant license should be modified, suspended, or revoked. The request for information I includes a request that respondents reevaluate flooding hazards at nuclear power plant sites using updated flooding hazard information and present-day regulatory guidance and methodologies. The 50.54(f) letter also requests the comparison of the reevaluated hazard to the design-basis at the site for each potential flood mechanism. If the reevaluated flood hazard at a site is not bounded by the current design-basis, respondents were requested to perform an integrated assessment to evaluate the total plant response to the flood hazard, considering multiple and diverse capabilities such as physical barriers, temporary protective

measures, and operational procedures. As described in COMSECY-15-0019, a focused evaluation process will be used by the NRC staff to screen out licensees from need for an integrated assessment based on a graded, risk-informed, and performance-based approach. COMSECY-15-0019 and the related SRM informed the guidance in NEI 16-05 and the screening process for improving realism in the flooding hazards and addressing focused evaluations for plants with available physical margin and plants affected by local intense precipitation (LIP). As described in COMSECY-15-0019, Phase 2 decision making will only be applicable to plants performing a revised integrated assessment because licensees for "screened-out" sites will address the reevaluated flooding hazards through existing capabilities or regulatory commitments associated with enhanced capabilities. Inherent in the COMSECY-15-0019 graded approach is that Paths 1, 2, and 3 described in NEI 16-05 involve licensees providing sufficient information to show that available or planned measures provide effective protection and mitigation against reevaluated flooding hazards and therefore no further regulatory actions are needed. This logic is described more fully below in terms of NRC's backfit regulation.

Directive and Handbook (DH) 8.4, "Management of Facility-Specific Backfitting and Information Collection," (Reference 12), provides that:

> Throughout a facility's lifetime, many individuals on the NRC staff would have an opportunity to review the requirements and commitments incumbent upon a licensee. There will be occasions when a reviewer concludes that the licensee's program in a specific area does not satisfy a regulation, license condition, or the written licensee commitment. If the staff has previously accepted the licensee's program as being adequate, then any new or revised staff-specified changes in the program would be classified as a backfit.

The NRC has previously accepted the flooding protection programs for all power reactor licensees that received the 50.54(f) information request, typically through the licensing process for the granting of the Operating Licenses. Therefore, the potential modification, suspension or revocation of the licenses with respect to the flooding protection programs would be classified as a backfit and the NRC staff must follow the guidance for implementation of the backfitting rules in DH 8.4.

DH 8.4 provides the following discussion of backfit types:

(a) Cost-Justified Substantial Increase in Protection

(i) The NRC staff can impose a backfit if the staff prepares an analysis under the provisions of NRC's backfitting rules demonstrating that the backfit constitutes a substantial increase in protection to the public health and safety or common defense and security whose costs are justified in light of the increased protection.

…

(b) Exceptions to requirement to prepare a backfit analysis

(i) Three types of backfits are recognized in the NRC backfitting rules at 10 CFR 50.109, 70.76, and 76.76 as actions that do not require the NRC staff to prepare a backfit analysis:

- Action necessary to bring a facility into compliance with the facility license, rules or orders of the Commission, or written commitments by the licensee,
- Action necessary to ensure that the facility provides adequate protection of public health and safety or common defense and security, and
- Action that involves defining or redefining the level of adequate protection.

The first exception, listed in 10 CFR 50.109(a)(4)(i) is for modifications necessary to bring a facility into compliance with a license or the rules or order of the Commission, or into conformance with written commitments by the license. This exception "is intended to address situations in which the licensee has failed to meet known and established standards of the Commission because of omission or mistake of fact," as explained in the statement of considerations for the 1985 version of the Backfit Rule. (50 *Federal Register (FR)* 38097, 381023, September 20, 1985). "[N]ew or modified interpretations of what constitutes compliance would not fall within the exception and would require a backfit analysis and application of the standard." (*Id.*) As described in the 50.54(f) letter, the information request was justified based on the evolution of the regulatory framework over time as new information regarding site hazards and the potential consequences has become available; this would make modification, suspension, or revocation of a license inappropriate under this exception unless there were an omission or mistake of fact with regard to known and established standards of the Commission in the original licensing of the facility, which would be outside of the scope of this document.

The second exception, listed in 10 CFR 50.109(a)(4)(ii) is for regulatory actions necessary to ensure that the facility provides adequate protection to the health and safety of the public and is in accord with the common defense and security. "[T]he regulations, though they do not define 'adequate protection,' are presumed to ensure it and in the absence of a redefinition of 'adequate protection,' that presumption can be overcome only by significant new Information or some showing that the regulations do not address some significant safety issue." (50 FR 20603, 20608, June 6, 1988; internal citation omitted.)

The third exception, listed in 10 CFR 50.109(a)(4)(iii) is for regulatory actions that define or redefine the level of protection that is considered adequate. The use of this exception is expected to be rare and would need to be supported by "a reasoned analysis indicating the prior policies are being changed, not casually ignored." (50 FR 20603, 20609, June 6, 1988.)

If any of the three exceptions are relied upon to impose a backfit, the NRC staff will perform a documented evaluation of the type discussed in 10 CFR 50.109(a)(6). Absent the existence of one of these three exceptions to the Backfit Rule, the NRC staff must perform a backfit analysis and may be required to prepare a regulatory analysis to show that certain improvements in safety or security are justified on the basis of the associated costs. Directive DH 8.4 provides that the regulatory analysis must conform to the guidance and policies, including scope and format, as set forth in NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," Rev. 4 (Reference 13) and NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook" (Reference 14).

Directive DH 8.4 also allows that, to avoid duplication of effort and for regulatory efficiency purposes, the backfit analysis can be included in the regulatory analysis and that the regulatory analysis should only be terminated with a final recommendation that no action be taken. Finally, DH 8.4 provides that an action proposed by a licensee is not a backfit, even though the action may result from normal discussions between the staff and the licensee concerning an issue.

Guidance document NEI 16-05 includes 3 focused evaluation approaches that will result in screening out of individual flooding mechanisms for consideration of further regulatory actions based on the information provided in response to the 50.54(f) information request. These approaches are analyzed below using the guidelines of NUREG/BR-0058. This analysis includes the use of the safety goal evaluation of NUREG/BR-0058, Section 3 because it is a generic analysis rather than a plant-specific backfit analysis.

1. Statement of the problem and NRC objectives for the proposed regulatory action:

The licensees relying on the 3 focused evaluation approaches described in NEI 16-05 as Paths 1, 2, and 3, are licensees for which the reevaluated flooding hazards determined under the 50.54(f) information request include flooding mechanisms that are not bounded by the design-basis flood to which they are licensed. The NRC objective is to determine whether a positive showing that a generic safety problem exists relative to the difference between the licensed design-basis flooding hazards for these facilities and the reevaluated flooding hazards and that a backfit to impose requirements to provide additional protection against the reevaluated flooding hazard would both address the problem effectively and provide a substantial safety improvement in a cost-beneficial manner.

2. Identification and preliminary analysis of alternative approaches to the problem:

The reevaluated flooding hazard information was developed by licensees using present day regulatory guidance and methodologies used to establish site characteristics for structures, systems and components (SSCs) important to safety in the course of initial licensing under 10 CFR 50, Appendix A, General Design Criterion (GDC) 2. These regulatory guidance and methodologies are typically used by the NRC staff to support a conclusion listed in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Section 2.4.2, “Floods,” Rev. 4 (Reference 15) as follows (emphasis added):

> The staff finds that the applicant has considered the appropriate site phenomena for establishing the site characteristics for SSCs important to safety. The staff has generally accepted the methodologies used to determine the local intense precipitation, flooding causal mechanisms, and controlling flooding mechanism reflected in these site characteristics, as documented in safety evaluation reports for previous licensing actions. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified design bases meet the requirement(s) of [10 CFR Part 50, Appendix A, General Design Criterion 2 or 10 CFR 52.79,

as applicable] and 10 CFR 100.10(c) [or 10 CFR 100.20(c)], with respect to establishing the design basis for SSCs important to safety

The Commission direction in SRM-COMSECY-14-0037 and SRM-COMSECY-15-0019 that the staff reduce unnecessary conservatisms addresses the inclusion of conservatisms in the present day methodologies for hazard determination to achieve the margin required by GDC 2 and discussed in the boilerplate conclusion above.

3. Estimation and evaluation of the values and impacts of selected alternatives, including consideration of the uncertainties affecting the estimates:

Under NEI 16-05, Path 1, described in NEI 16-05, Section 7.1, a licensee would propose and justify reductions in the conservatisms inherent in a deterministic flooding hazard determination using present day regulatory guidance and methodologies. For licensees with individual flooding mechanisms in this category, the result would be a demonstration that the parameters of the flooding mechanism under consideration are bounded by the design taking into account the reductions in conservatism that are appropriately justified. Actions proposed by the licensee in order to justify the reductions in conservatism would not be considered backfits, even though the action resulted from normal discussions between the staff and the licensee concerning this issue.

Under NEI 16-05, Path 2, described in NEI 16-05, Section 7.2, a licensee could propose and justify reductions in the conservatisms inherent in a deterministic flooding hazard determination using present day regulatory guidance and methodologies similar to the NEI 16-05, Path 1 discussion above. For licensees with individual flooding mechanisms in this category, the result would be a demonstration that existing or planned flood protection strategies would prevent the entry or control accumulation of water in areas containing SSCs that support core cooling, containment and spent fuel pool cooling in the event of flooding at the parameters of the flooding mechanism under consideration, including reductions in conservatism that are appropriately justified, if applicable. Actions proposed by the licensee in order to justify the reductions in conservatism or to implement the flooding protection would not be considered backfits, even though the action resulted from normal discussions between the staff and the licensee concerning this issue.

Under NEI 16-05, Path 3, described in NEI 16-05, section 7.3, a license with a LIP hazard that exceeds the licensed design-basis flooding hazard for the facility would evaluate the impact of the hazard and implement any necessary programmatic, procedural or plant modifications to address the hazard taking into account available warning time. For licensees with LIP hazards exceeding the licensed design-basis flooding hazard, the result would be demonstration of a feasible methodology to address the hazard. Actions proposed by the licensee in order to justify the reductions in conservatism or to implement the flooding protection would not be considered backfits, even though the action resulted from normal discussions between the staff and the licensee concerning this issue.

4. Conclusions of the evaluation of values and impacts and the results of the safety goal evaluation:

For flooding mechanisms, a licensee proposes to resolve under NEI 16-05, Path 1, the NRC staff review of the information will focus on the licensees' arguments that the revised hazard

estimates involved removing “over-conservatisms” and that available or planned measures provide effective protection and mitigation against the more credible flooding hazards. If possible, the revised flooding hazard can be used to show that the change in core damage frequency achieved by further regulatory action would not exceed the NUREG/BR-0058 subsidiary safety goal quantitatively or the conclusion can use engineering judgment where the available information does not support quantification of the risk. Values and impacts of licensee proposed actions to justify the reduction in conservatism are outside the scope of this evaluation because they are not associated with a backfit.

For flooding mechanisms a licensee proposes to resolve under NEI 16-05, Path 2, the NRC acceptance of the reduction in conservatism in the flooding hazard reevaluation, if applicable, and the NRC acceptance of the available physical margin for flooding protection capability reflects that available or planned measures provide effective protection and mitigation against the flooding hazards. If possible, the evaluation can describe how the change in core damage frequency achieved by further regulatory action would not exceed the NUREG/BR-0058 subsidiary safety goal quantitatively or, more likely, the closeout of Recommendation 2.1 will reflect engineering judgment where the available information does not support quantification of the risk. Values and impacts of licensee proposed actions to justify the reduction in conservatism are outside the scope of this evaluation because they are not associated with a backfit.

For flooding mechanisms, a licensee proposes to resolve under NEI 16-05, Path 3, the NRC acceptance of the demonstration of a feasible methodology to address the revised hazard following the removal of unnecessary conservatisms (see Path 1) would implement the resolution of this issue approved in SRM-COMSECY-15-0019. Values and impacts of licensee proposed actions to justify the reduction in conservatism are outside the scope of this regulatory evaluation because they are not associated with a backfit.

5. Decision rationale for selection of the proposed regulatory action:

For flooding mechanisms under NEI 16-05, Path 1, the outcome of the reduction of conservatisms in the flooding hazard reevaluations would be a determination that the flooding mechanism under consideration is bounded by the design-basis flooding hazard the site is licensed to. As a result, there would be no reason to modify the licensed flood protection measures at the facility to address the flooding mechanism under consideration. At this point, the NRC staff would conclude that sufficient information has been provided by the licensee to demonstrate that the available or planned measures provide effective protection and mitigation against flooding and no regulatory actions are warranted.

For flooding mechanisms under NEI 16-05, Path 2, the outcome of this approach would be a determination that the licensee’s existing and proposed flooding protection would prevent the entry of or control the accumulation of water in areas containing SSCs that support core cooling, containment and spent fuel pool cooling in the event of flooding at the parameters of the flooding mechanism under consideration. As a result, there would be no reason to modify the licensed flood protection measures at the facility to address the flooding mechanism under consideration. At this point, the NRC staff would conclude that available or planned measures provide effective protection and mitigation against flooding and no regulatory actions are warranted.

For flooding mechanisms under NEI 16-05, Path 3, the outcome of this approach would be a determination that the licensee has demonstrated a feasible response strategy to address a LIP hazard. In the absence of a technically acceptable frequency of recurrence of the LIP at the level of the reevaluated LIP hazard as an initiating event, the staff would conclude that available or planned measures provide effective protection and mitigation against flooding and no regulatory actions are warranted.

6. Tentative implementation instrument and schedule for the proposed regulatory action:

The information request directed respondents to submit an approach for developing an integrated assessment report including criteria for identifying vulnerabilities. This document describes an approach for developing focused evaluations acceptable to the staff to close out regulatory action for the 50.54(f) information request for the described flooding mechanisms.

APPLICABILITY

This document shall be implemented on the day following its approval. It shall remain in effect until it has been superseded or withdrawn.

PROPOSED GUIDANCE

This document is applicable to holders of operating power reactor licenses and construction permits under 10 CFR Part 50 from whom an integrated assessment is requested (i.e., sites for which the current design-basis flood hazard does not bound the reevaluated hazard for all potential flood mechanisms).

IMPLEMENTATION

Except in those cases in which a licensee or construction permit holder under 10 CFR Part 50 proposes an acceptable alternative method for performing the integrated assessment, the NRC staff will use the methods described in this document to evaluate the results of the integrated assessment.

BACKFITTING DISCUSSION

This document does not constitute backfitting as defined in 10 CFR 50.109 (the Backfit Rule) and is not otherwise inconsistent with the issue finality provision in Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” of 10 CFR. This document provides guidance on an acceptable method for responding to a portion of an information request issued pursuant to 10 CFR 50.54(f). Neither the information request nor the document require the modification or addition to systems, structures, or components, or design of a facility. Applicants and licensees may voluntarily use the guidance in this document to comply with the request for information. The information received by this request may, at a later date, be used in the basis for a backfit at a later date. In this case, the appropriate backfit review process would be followed at that time.

FINAL RESOLUTION

The contents of this document, or a portion thereof, may subsequently be incorporated into other guidance documents, as appropriate.

ENCLOSURES

1. Guidance for Closure of Activities Related To Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation, through the Focused Evaluation Process

2. Probabilistic Flood Hazard Assessment for Phase 2 Decision-making

REFERENCES

1. U.S. Nuclear Regulatory Commission, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, March 12, 2012, Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340.

2. U.S. Nuclear Regulatory Commission, "Recommendations for Enhancing Reactor Safety in the 21st Century, The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," Enclosure to SECY-11-0093, July 12, 2011, ADAMS Accession No. ML111861807.

3. U.S. Nuclear Regulatory Commission, “Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards,” COMSECY-14-0037, November 21, 2014, ADAMS Accession No. ML14238A616.

4. U.S. Nuclear Regulatory Commission, “Staff Requirements – COMSECY-14-0037 - Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards,” SRM-COMSECY-14-0037, ADAMS Accession No. ML15089A236.

5. U.S. Nuclear Regulatory Commission, “Closure Plan for the Reevaluation of Flooding Hazards For Operating Nuclear Power Plants,” COMSECY-15-0019, ADAMS Accession No. ML15153A105.

6. U.S. Nuclear Regulatory Commission, Staff Requirements – COMSECY 15-0019 - Closure Plan for the Reevaluation of Flooding Hazards For Operating Nuclear Power Plants,” SRM-COMSECY-15-0019, ADAMS Accession No. ML15209A682.

7. U.S. Nuclear Regulatory Commission, "Recommended Actions to be Taken without Delay from the Near Term Task Force Report," SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

8. U.S. Nuclear Regulatory Commission. "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11272A111.

9. U.S. Nuclear Regulatory Commission. “SRM - SECY-11-0093 - Near-Term Report and Recommendations for Agency Actions Following the Events in Japan,” August 19, 2011, ADAMS Accession No. ML112310021.

10. U.S. Nuclear Regulatory Commission. SRM - SECY-11-0124 - Recommended Actions to be Taken without Delay From the Near-Term Task Force Report, October 18, 2011, ADAMS Accession No. ML112911571.

11. Nuclear Energy Institute. NEI 16-05, Revision A, “External Flooding Assessment Guidelines,” June 2016, ADAMS Accession No. ML16074A263.

12. U.S. Nuclear Regulatory Commission. Directive and Handbook 8.4, “Management of Facility-Specific Backfitting and Information Collection,” DH 8.4, October 9, 2013, ADAMS Accession No. ML12059A460.

13. U.S. Nuclear Regulatory Commission. “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” NUREG/BR-0058, Rev. 4, September 2004.

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

15. U.S. Nuclear Regulatory Commission. “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Section 2.4.2, “Floods,” Rev. 4, March 2007.

GUIDANCE FOR CLOSURE OF ACTIVITIES RELATED TO NEAR-TERM TASK FORCE RECOMMENDATION 2.1, FLOODING HAZARD REEVALUATION, THROUGH THE FOCUSED EVALUATION PROCESS

1. Introduction

This document provides guidance for the Nuclear Regulatory Commission (NRC) staff review of focused evaluations submitted in response to the NRC's March 12, 2012, request for information regarding flooding hazards. The request was issued pursuant to Title 10 of the *Code of Federal Regul*ations (10 CFR), Section 50.54(f) hereafter referred to as the 50.54(f) letter). This document endorses, with clarifications and exceptions, the approach proposed by the Nuclear Energy Institute (NEI) in the document NEI 16-05, Revision A, "External Flooding Assessment Guidelines," Agencywide Documents Access and Management System (ADAMS) Accession No. ML16074A263.

Staff Position: NEI 16-05 provides an acceptable methodology for licensees to perform focused evaluations and integrated assessments of flood mechanisms that exceed the design basis flood parameters for a facility subject to the clarifications in the sections of this document discussing specific sections of NEI 16-05. Licensees may use the endorsed processes of NEI 16-05 as clarified upon receipt of the NRC letter providing the flood hazard parameters for use in the Mitigating Strategies Assessments of NEI 12-06, Appendix G.

2. Initial Evaluation Process – Improvement of Realism

Section 6.1 of NEI 16-05 discusses concepts a licensee may use in order to reduce conservatisms inherent in the reevaluation of flooding hazards. Appendix A of NEI 16-05 provides a catalog of select assumptions, inputs, and methods that are found in the evaluation methodologies for flooding hazards that may introduce conservatisms in the results.

Staff Position: NEI 16-05, Section 6.1 and Appendix A do not provide a specific methodology for reducing the conservatisms in the estimated flooding hazards. As such, the staff did not review this material and it is not within the scope of this document. However, the identification and resolution of over-conservatisms in defining the flooding hazards is important and the staff offers the following discussion for the benefit of licensees and the NRC staff.

Licensees seeking to remove conservatisms in the evaluation of flooding hazards may do so by refinement of the estimation of their site-specific hazard using the hierarchical hazard assessment (HHA) process of NUREG/CR-7046, as described in the 50.54(f) letter. The output of this process would be a more plausible, yet still bounding flood hazard.

The NRC staff's review of a licensee's proposed reduction of conservatism should take into account the existence of regulatory commitments on the part of the licensee to implement or maintain procedures or programs to justify the refinements.

3. Initial Evaluation of Flood Impacts and Protection

Section 6.3.1 of NEI 16-05 provides a method for evaluating the potential impact of flooding under the reevaluated flood parameters on plant conditions. This method includes the

identification of Key SSCs, the identification of flood protection features, and the identification of critical flood elevations that could impact the Key SSCs (i.e., the consequential flood). The term "Key SSCs" is defined in Section 4 of NEI 16-05 as "[t]he site-specific SSCs where a failure could lead to a loss of any of the [key safety functions] KSFs. This does not include the flood protection features that protect the SSCs from adverse flood conditions."

Staff Positions:

1. With respect to the consideration of flood protection as described in Regulatory Guide (RG) 1.102, Key SSCs do not include FLEX equipment provided under Order EA-12-049 that is relied upon to maintain or restore the KSFs in the event that flooding disables the Key SSCs.

2. Identification of the critical flood elevations that could impact Key SSCs should include all flood conditions under which flood protection is no longer effective, including overtopping of flood protection as well as those conditions for which the loads exerted by the flood exceed the capacity of the flood protection features.

3. Those licensees performing revised integrated assessments should identify the frequency of exceedance of the critical flood elevations determined under staff position 2, using a methodology that conforms to Enclosure 2 of this document.

3.**1 Determination of Available Physical Margin**

Section 6.3.2 and Appendix B of NEI 16-05 provide a method for determining available physical margin (APM) for passive (including temporary) or active flood protection features. Appendix C of NEI 16-05 and Appendix E of NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, (ADAMS Accession No. ML16005A625) provide a method for assessing the manual actions necessary for reliance on the flood protection features where appropriate.

Staff Positions:

1. Section 6.3.2 and Appendix B of NEI 16-05 and Appendix E of NEI 12-06, Revision 2, provide an acceptable method for the determining APM subject to the following clarifications:

    a. The validation method documented in Appendix E to NEI 12-06, Revision 2, is endorsed as a method to (1) assess whether it is feasible, considering design-basis or reevaluated hazard conditions determined under the 50.54 (f) request , (as applicable), to execute tasks, manual actions, and decisions (i.e., human actions) necessary for flood protection; and (2) support a conclusion that the strategies mitigate, to the extent practical, the adverse effects of the reevaluated hazard conditions on the ability of personnel to perform the required human actions. However, NEI 12-06, Revision 2, Appendix E, neither proposes nor is endorsed as a method to assess whether required human actions are reliable.

    b. Time-sensitive actions (TSAs) include tasks, manual actions, or decisions that are associated with time constraints. As discussed in Appendix C, Section C.3 to NEI

16-05, TSAs are actions on critical path where a failure would lead to the failure of the overall strategy. The TSAs performed greater than 24 hours after the initiation of the event that have time constraints may be validated using a Level A or Level B method from NEI 12-06, Appendix E, that results in an estimate of the time required to complete the task or manual action or to make and communicate the decision in order to confirm that the time constraint can reasonably be met.

2. Appendix C to NEI 16-05 provides a method for a qualitative evaluation of the site response, relying on the determination of feasibility under NEI 12-06, Appendix E. NRC staff reviewing the determination of APM using Appendix C to NEI 16-05 should exercise engineering and operational judgment of this qualitative evaluation in assessing the qualitative evaluation of site response.

3. Guidance Document NEI 16-05, Section B.1 provides methods for establishing adequate APM. It is unclear how these methods would be employed. Licensees should demonstrate that flood protection barriers are able to withstand the reevaluated flood parameters and estimate APM by comparing the failure parameters with the reevaluated flood parameters. Adequacy of APM should be demonstrated and justified using a site-specific assessment.

4. Section B.2.1.5 to NEI 16-05 relies on the guidance of NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," for the evaluation of adequacy of plugs and penetration seals. This guidance is generally limited to visual inspection of the seals. In addition to the visual inspections, licensees should identify operational requirements (e.g., surveillance, inspection, design control, procurement, maintenance, and testing) to provide confidence in the reliability of seals. If licensees do not know the capability of existing seals, licensees should enter the condition into the corrective action program (CAP) and provide the CAP program reference as well as a timeline for resolution as part of focused evaluation documentation submitted to NRC.

4. Focused Evaluation Process (Paths 1-3)

Section 7 of NEI 16-05 provides the process for licensees to use in conducting focused evaluations of the various flooding mechanisms.

4.1 Path 1: Demonstrate Flood Mechanism is Bounded (Box 2a-2b-2c)

Section 7.1 of NEI 16-05 provides a process for licensees to disposition flood mechanisms for which the flooding parameters are bounded by those of the design basis flooding parameters of the facility.

Staff Position: Section 7.1 of NEI 16-05 provides an acceptable method for dispositioning flood mechanisms with flooding parameters bounded by the design basis flooding parameters of the facility subject to the following clarifications:

1. The second paragraph of Section 7.1 includes the statement that "a bounding set of reevaluated flood parameters, instead of parameters for individual flood-causing mechanisms, can be used in making the flood comparison." Licensees may group sets

of flood mechanisms to disposition under path 1, leaving the remaining flood mechanisms or groups of flood mechanisms to be dispositioned under the other paths of NEI 16-05.

2. Staff may anticipate that all flood mechanisms dispositioned under path 1 will include modifications to the assumptions, inputs, and methods for the evaluation of the flood hazard to achieve the state of being bounded by the design basis for all flood parameters. This is due to the fact that flood mechanisms that are so bounded without modifications would not be subject to the focused evaluation process. Refinement under the HHA process discussed in Section 2 of this document results in a demonstration that the flood mechanism's parameters reevaluated under present day methodologies and therefore no regulatory action is warranted for the flood mechanism under consideration.

4.2 Path 2: Demonstrate Effective Flood Protection (Box 5-6)

Section 7.2 and Appendix B of NEI 16-05 provide a process for licensees to disposition flood mechanisms for which the facility's flood protection is effective. The process of Section 7.2 builds upon that of Section 6.3.2, but may also include modifications to the assumptions, inputs, and methods for the evaluation of the flood hazard in order to achieve a state where the flood parameters yield an adequate available physical margin.

Appendix C of NEI 16-05 and Appendix E of NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, (ADAMS Accession No. ML16005A625) provide a method for assessing the manual actions necessary for reliance on the flood protection features where appropriate.

Staff Positions:

1. Section 7.2 and Appendix B of NEI 16-05 and Appendix E of NEI 12-06, Revision 2, provide an acceptable method for the determining APM subject to the following clarifications:

    a. The validation method documented in Appendix E to NEI 12-06, Revision 2, is endorsed as a method to (1) assess whether it is feasible, considering design-basis or reevaluated hazard conditions determined under the 50.54(f) information request, (as applicable), to execute tasks, manual actions, and decisions (i.e., human actions) necessary for flood protection; and (2) support a conclusion that the strategies mitigate, to the extent practical, the adverse effects of the reevaluated hazard conditions on the ability of personnel to perform the required human actions. However, NEI 12-06, Revision 2, Appendix E, neither proposes nor is endorsed as a method to assess whether required human actions are reliable.

    b. Time-sensitive actions (TSAs) include tasks, manual actions, or decisions that are associated with time constraints. As discussed in Appendix C, Section C.3 to NEI 16-05, TSAs are actions on critical path where a failure would lead to the failure of the overall strategy. TSAs performed greater than 24 hours after the initiation of the event that have time constraints may be validated using a Level A or Level B method from NEI 12-06, Appendix E, that results in an estimate of the time required to

complete the task or manual action or to make and communicate the decision in order to confirm that the time constraint can reasonably be met.

2. Appendix C to NEI 16-05 provides a method for a qualitative evaluation of the site response, relying on the determination of feasibility under NEI 12-06, Appendix E. NRC staff reviewing the determination of APM using Appendix C to NEI 16-05 should exercise engineering and operational judgment of this qualitative evaluation in assessing the qualitative evaluation of site response.

3. Section B.2.1.5 to NEI 16-05 relies on the guidance of NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," for the evaluation of adequacy of plugs and penetration seals. This guidance is generally limited to visual inspection of the seals. In addition to the visual inspections, licensees should identify operational requirements (e.g., surveillance, inspection, design control, procurement, maintenance, and testing) to provide confidence in the reliability of seals. If licensees do not know the capability of existing seals, licensees should enter the condition into the corrective action program (CAP) and provide the CAP program reference as well as a timeline for resolution as part of focused evaluation documentation submitted to NRC.

4. For licensees that either used the reevaluated flood parameters for the flood mechanism under consideration or refined the evaluation using the HHA refinement process discussed in Section 2 of this document, supra, the result of path 2 is a demonstration that the facility flood protection for the flood mechanism parameters is feasible for a hazard reevaluated under present day methodologies and therefore no regulatory action is warranted for that flood mechanism.

4.3 Path 3: Demonstrate a Feasible Response to Local Intense Precipitation (Box 7-8)

Section 7.3 of NEI 16-05 provides a process for licensees to disposition instances where the LIP flood mechanism is not bounded by the design basis flooding parameters of the facility.

Staff Position: As discussed in COMSECY-15-0019, "licensees [with LIP hazards exceeding their current design-basis flood should] assess the impact of the LIP hazard on their sites and then evaluate and implement any necessary programmatic, procedural or plant modifications to address this hazard exceedance. This assessment includes evaluation and justification for: crediting systems that were assumed clogged during the hazard reevaluations; and considering available warning time and flood protection measures, both permanent and temporary, as well as associated manual actions." Licensees may use the process described in the NEI White Paper, "Warning Time for Maximum Precipitation Events," dated April 8, 2015 (ADAMS Accession No. ML15104A157), and the related NRC letter dated April 23, 2015 (ADAMS Accession No. ML15110A080), in order to take advantage of warning time for LIP.

Section 7.3 of NEI 16-05 provides an acceptable approach to implement the principles discussed in COMSECY-15-0019 for dispositioning LIP hazards that are not bound by the design basis flooding parameters of a facility.

5. Full Scope Integrated Assessment Process (Paths 4-5)

Section 8 of NEI 16-05 provides the process for licensees to use in conducting revised integrated assessments of the various flooding mechanisms.

5.1 Path 4: Demonstrate Effective Mitigation (Box 9-10)

Section 8.1 of NEI 16-05 provides a process for licensees to perform a revised integrated assessment of flood mechanisms that are not bounded by the design basis flood hazard of a facility.

Staff Position: Section 8.1 of NEI 16-05 provides an acceptable method to perform a revised integrated assessment subject to the following clarification:

1. In addition to the key elements listed in NEI 16-05, the licensee should provide corresponding information to address the critical flood elevations identified for the flood mechanism under consideration under NEI 16-05, Section 6.3.1 and this document, Section 3, infra.

5.2 Path 5: Scenario Based Approach (Box 11-12)

Section 8.2 of NEI 16-05 provides a process for licensees to perform a revised integrated assessment of flood mechanisms that are not bounded by the design basis flood hazard of a facility.

Staff Position: Section 8.2 of NEI 16-05 provides an acceptable method to perform a revised integrated assessment subject to the following clarifications:

1. Development and characterization of the scenarios under NEI 16-05, Section 8.2.2, should include scenarios for the flooding mechanism under consideration at the critical flood elevations identified under NEI 16-05, Section 6.3.

2. Identification of scenarios with effective flood protection under NEI 16-05, Section 8.2.3 should include the considerations of NEI 16-05, Section 7.2 and Section 4.2 of this document, infra.

3. Frequencies of exceedance for the scenarios should be developed under a methodology that conforms to Enclosure 2 of this document.

6. Documentation

Licensees should submit the results of the focused evaluations and integrated assessments for staff review and closure of the 50.54(f) request. The level of detail generally considered adequate is consistent with the level of detailed contained in the Licensee's Final Safety Analysis Report (FSAR). Information submitted should address the following:

- Characterization of flood parameters

- Evaluation and description of flood impacts and site/plant conditions
- Explanation of approach used for integrated assessment

- Evaluation of flood protection for reevaluated flooding hazard, including criteria used to justify reliability, if applicable
- Identification of characteristics of consequential flooding
- Information Recommendation 2.1 closeout or Phase 2 decision making (e.g., commitments)

In addition to the items above, sites performing an IA should also address the following information:

- Detailed description of the approach used for mitigation
- Description of scenarios considered (multiple scenario or bounding scenario)
- Documentation of the evaluation of the availability and reliability of credited SSCs
- Strategy timeline showing all manual actions
- Description of evaluation of manual actions and strategies
- Logic structures (or sufficient information to allow staff development of logic structures)
- Documentation of conclusions regarding effectiveness of mitigation approach(es)
- [optional] Identification of redundancy and diversity in approach(es), available margins (e.g., time margins), and discussion of defense-in-depth considerations that are maintained under each set of flood scenario parameters

Probabilistic Flood Hazard Assessment for Phase 2 Decision-making

1. Introduction

This document supports development of probabilistic flood hazard assessments (PFHAs) needed for Phase 2 decision-making. For the purposes of Phase 2 decision-making, the primary focus is on estimating hazards associated with annual frequencies of exceedance in the range 10-4 and 10-3/year. The attributes defined in this document are developed with cognizance of the current state of practice and limitations arising from the timelines associated with the Post-Fukushima activities. Future guidance related to PFHA may differ.

2. Overview of Probabilistic Flood Hazard Assessment

The PFHA is a systematic assessment of the likelihood that a specified parameter or set of parameters representing flood severity (e.g., flood elevation, flood event duration, and parameters related to associated effects) will be exceeded at a site or in a region based on a site-specific evaluation. The PFHA is typically used to develop a hazard curve, which provides the annual frequency of exceedance for various levels of flood severity. Generally, the key components of a PFHA are:

1. Assembly of the PFHA team
2. Identification of relevant flood-causing mechanisms and plausible combinations
3. Identification, characterization, and use of technically defensible data, models, and methods
4. Characterization and quantification of aleatory and epistemic uncertainties
5. Quantification of hazard, including propagation of uncertainties
6. Documentation of PFHA activities

A peer review provides additional confidence in the results of the evaluation.

3. High-level attributes

3.1 Identification of relevant flood-causing mechanisms (including combinations of mechanisms)

In developing the PFHA, it is necessary to capture the contributions to the exceedance frequency of a specified parameter (or sets of parameters) representing flood severity from all relevant flood hazard mechanisms affecting the site, including combinations of phenomena. Capturing the contributions from multiple mechanisms may involve development of a composite or multiple flood hazard curves corresponding to multiple mechanisms and scenarios. Under Recommendation 2.1 activities, the PFHA may focus on a smaller subset of the hazard mechanisms (i.e., those not bounded by the design basis), which differs from a full external flooding PRA that would include all relevant mechanisms.

3.2 Selection and use of appropriate models and methods

The PFHA should be performed using models and methods consistent with the existing state of practice for the annual exceedance frequency range of relevance. This will involve use of statistical or probabilistic methods augmented by a realistic mechanistic treatment of hazards. The models and methods selected and associated level of detail should be justified.

3.3 Use of up-to-date and comprehensive information

To support development of the PFHA, it is necessary to compile and use up-to-date information for the relevant phenomena consistent with the models and methods selected. Relevant information may include:

- Site-specific data augmented by regional, historical, and paleoflood data (as available or applicable) that reflect the current state of knowledge

- Recent site hydrologic surveys or survey/walkdowns of the site to establish site topography and identify features that would affect site flow, including site drainage

- Regional information and surveys to develop topography and bathymetry (at appropriate spatial scales) and to characterize land use and land cover for use in mechanistic models or for use by experts (as applicable to the mechanism considered)

- Information needed to define or represent the uncertainty in data, models and methods (e.g., information needed to develop probabilistic distributions for relevant model parameters and information regarding potential errors in recorded data)

- Information regarding river operations (e.g., operating rules, curves, procedures and known future operational plans) and operating history for regulated river systems (if available).

- Site procedures and features (e.g., exposed SSCs, diversion features, drainage features, or a combination thereof) that may affect the flow or accumulation of water on site

Some of the above information may be available from the FHRR and supporting documents. Otherwise information may be need to be collected from alternate sources. It is important to understand the quality and limitations of available data.

3.4 Characterization of flood hazard

The site flood hazard should be characterized using relevant parameter(s) representing flood severity such as flood height, parameters related to associated effects, and flood event

duration.[1] The parameters chosen for flood hazard characterization should be consistent with the parameter(s) needed for subsequent component or plant response analysis. As a simplifying assumption, it may be necessary to estimate the frequency of exceedance for one representative parameter (e.g., flood elevation or discharge) and implicitly treat other flood parameters (e.g., via deterministic approaches). It is also important to account for differences in the severity of flood hazard at different locations at the site.

3.5 Treatment of uncertainties and sensitivity studies

Important sources of aleatory and epistemic uncertainty should be identified and characterized for each flood mechanism. Aleatory variability is typically represented by probability distributions (e.g., distributions on storm or snowmelt parameters) and expressed as a hazard curve. Epistemic uncertainty is typically expressed by representing the center, body, and range of technically defensible interpretations of data, models, and methods as identified by the informed technical community. These various technical interpretations may be represented in a logic-tree (or other appropriate and transparent method) and are propagated through the analysis, resulting in a suite of hazard curves and associated weights from which the mean hazard curve can be derived. Identification of important sources of aleatory and epistemic uncertainty may be based on sensitivity studies (e.g., by identifying input parameters that have a significant effect on the output of numerical models).

The assessment of the impact of key sources of uncertainty of important factors may be evaluated qualitatively or quantitatively. Uncertainties should be propagated in the final quantification of the hazard. It is also reasonable to utilize simplifying and bounding assumptions to address some sources of uncertainties (e.g., fixing parameters at reasonably bounding values rather than accounting for their variability); however it is useful to understand how use of these simplifying and bounding assumptions affect key insights and conclusions related to Phase 2 decisions.

Ideally, all technically defensible data, models, and methods should be considered, including alternative, composite, and new data, models, and methods (e.g., alternate data sources, options for filtering data, or alternate functional forms for probability distributions). However, given the timelines associated with post-Fukushima activities, complete treatment of epistemic uncertainty (and development of a mean hazard) may not be feasible. Nonetheless, to develop a reasonable estimate of the hazard using this approach, key epistemic uncertainties should be addressed, at minimum, through sensitivity studies involving key components of the analysis (e.g., alternate functional forms for distribution models). Reasonable variation in these key components and assumptions should be considered and the effects on estimated hazards quantified and documented as part of sensitivity studies. Justification should be provided that sensitivity studies give a reasonable representation of key sources of uncertainty.

[1] *Associated effects* may include factors such as wind waves and run-up effects; hydrodynamic loading, including debris; effects caused by sediment deposition and erosion; concurrent site conditions, including adverse weather conditions; and groundwater ingress.

3.6 Peer review

It is recognized that subjective judgements will be necessary in performing a PFHA. To increase the efficiency of NRC staff review, an independent peer review is recommended, preferably using an in-process review.2 The peer review should focus on the following key factors:

- The treatment of aleatory variability and epistemic uncertainty
- The treatment of combined events (e.g., storm surge and river flooding; river flooding concurrent with wind events) and the means by which the hazard contributions from the mechanisms are aggregated
- Key assumptions
- Validation and verification of data, models, and methods

The peer review team members should have expertise in the fields of relevance to the PFHA and the flood-causing mechanisms considered. The peer review team should be of sufficient size that the backgrounds of reviewers are appropriately diverse and complementary. For example, in the case of the assessment of storm surge hazard in estuarine environments, fields of relevance include meteorology, (river) hydrology and hydraulics, oceanography, numerical modeling, and probabilistic hazard assessment. The peer review team should generate a formal report that is available for NRC review and their findings should be appropriately dispositioned.

3.7 Consistency with state of practice to the extent appropriate

It is recognized that probabilistic methods for assessment of flooding hazards are widely used in applications outside of siting of nuclear power plants (e.g., to develop inundation maps for flood insurance, emergency evacuation plans, and coastal protection structures). However, due to the quality and characteristics of available data, as well as differing needs of these other applications, they typically do not consider the full range return periods of relevance for nuclear power plant sites. Therefore, it may be appropriate and necessary to address factors that are not considered in these other applications (e.g., to account for site-specific considerations or identified shortcomings in other assessments and to provide a more comprehensive and systematic treatment of uncertainty and larger ranges of parameters than needed for studies focused on shorter return periods). It is noted that use of conventional flood frequency analysis alone to estimate flooding hazards for long return periods is not supported by the current state of practice or the quality and characteristics of available data.

3.8 Mechanism-specific considerations

The following list identifies mechanism-specific considerations that may be relevant to the PFHA.

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[2] An independent peer reviewer has no conflicts of interest that may influence the outcome of the peer review.

3.8.1 Local intense precipitation

- Local and regional precipitation history and basis for selecting applicable regional data (e.g., for use in statistical assessments used in conjunction with mechanistic models)

- Aleatory variability resulting from variations in storm loading patterns (e.g., precipitation depth, area, and duration as well as spatial and temporal distribution) as well as associated epistemic uncertainties (e.g., data selection, statistical approaches used, and distributions assigned to parameters)

- Site building and barrier layouts and drainage and run-off capacity (including site and roof drainage)

- Approaches to address uncertainties and limitations of data collection instruments

- Selection of storm catalog if stochastic sampling or transposition used; selection of time intervals spatial resolutions; and seasonal/annual rainfall

- Potential impacts of onsite impoundments (e.g., levees and dams)

- Initial and boundary conditions as well as assumptions in losses and runoff condition in modeling

- Local watershed effects on run-off (e.g., run-on from adjacent parts of the watershed)

- Contributions from all relevant rainfall durations and temporal distributions to parameters of relevance for LIP (e.g., elevation of site ponding)

3.9 Riverine without upstream dams

- Flood history of the watershed including local and regional precipitation and river levels[3]

- Aleatory variations in storm loading patterns (e.g., precipitation depth, area, and duration as well as spatial and temporal distribution)

- Warm and cold season events (e.g., conditions associated with melting of winter snowpack)

- Approaches to address uncertainties and limitations of data collection instruments (e.g., site-specific techniques used to quality control data)

[3] It is noted that use of conventional flood frequency analysis alone to estimate flooding hazards for long return periods is not supported by the current state of practice or the quality, and characteristics of available data. However, information regarding history of the watershed may still be relevant to the PFHA.

- Engineered and natural features affecting site flood severity (e.g., permanent and temporary features and downstream impoundments)

- Basis for:

    - Site and watershed initial and boundary conditions

    - Site and watershed hydrologic and hydraulic models

    - Selection of parameters describing watershed characteristics (e.g. roughness, channel profiles, channel cross-sections, ineffective flow areas)

    - Storm characteristics and parameter combinations considered (e.g., duration; area; time intervals; monthly, seasonal, yearly rain patterns; distribution in time and space and associated uncertainties)

3.9.1 Riverine with upstream dams

- All elements applicable to riverine flooding
- Dam operating guidelines, operational history (if available) and future operational plans (if any) (e.g., releases and reservoir levels, flood control and release plans, and design and current reservoir capacities)
- Dam condition (e.g., condition reports, or other assessments), age, and refurbishments
- Type of dam (e.g., dam construction and relevant design characteristics)
- Seismic, hydrological, and other failures of onsite and offsite impoundments
- Treatment of non-consequential dams
- Treatment of downstream dam failure
- Uncertainties associated with dam breach parameter estimates and breach modeling
- All plausible dam failure scenarios with associated uncertainties for each scenario.

3.9.2 Storm Surge (tropical or extratropical cyclones) and seiche

- Clear basis for resonant frequency estimates, if used

- Contribution from tropical and extratropical events

- Historical data augmented, as appropriate, by reanalysis or synthetic data sources filtered for the geographic region, including identification of limitations of available data

- Numerical wind field and surge models

- Basis for:

    - Selection of methodology (e.g., Joint Probability Method or Empirical Simulation Technique)
    - Filtering of data
    - Storm recurrence rate
    - Relevant storm parameters and their distributions

- Application of wind and surge models
- Bathymetry and site topography