

## RECOMMENDATION 2.3: FLOODING

### PURPOSE

The U.S. Nuclear Regulatory Commission (NRC or Commission) is issuing this information request for the following purposes:

- To gather information with respect to Near-Term Task Force (NTTF) Recommendation 2.3, as amended by staff requirements memorandum (SRM) associated with SECY-11-0124 and SECY-11-0137,
- To request licensees to develop a methodology and acceptance criteria for flooding walkdowns to be endorsed by the NRC staff,
- To request licensees to perform flooding walkdowns using an NRC-endorsed walkdown methodology, as defined herein
- To identify and address degraded, nonconforming, or unanalyzed conditions through the corrective action program
- To identify and address cliff-edge effects through the corrective action program
- To verify the adequacy of licensee monitoring and maintenance procedures.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), addressees are required to submit a written response to this information request.

### BACKGROUND

Structures, systems, and components (SSCs) important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of, Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 2. GDC 2 states that SSCs important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunami, and seiches without loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to reflect sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

In response to the accident at the Fukushima Dai-ichi nuclear power plant caused by the March 11, 2011, Tohoku earthquake and subsequent tsunami, the Commission established the NTTF to conduct a systematic review of NRC processes and regulations, and to make recommendations to the Commission for its policy direction. The NTTF developed a set of recommendations that are intended to clarify and strengthen the regulatory framework for protection against natural phenomena. The purpose of this letter is to gather information related to NTTF Recommendation 2.3 for flooding hazards. Recommendations 2.3, and the SRMs associated with SECY-11-0124 and SECY-11-0137, instructs the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f). This information request is for licensees to develop a methodology and acceptance criteria for flooding walkdowns to be endorsed by the NRC staff following interaction with external stakeholders. Licensees are requested to perform flood protection walkdowns to identify and address plant-specific

degraded, nonconforming, or unanalyzed conditions and cliff-edge effects (through the corrective action program) and verify the adequacy of monitoring and maintenance procedures.

In developing Recommendation 2.3, the NTTF observed that, "some plants have an overreliance on operator actions and temporary flood mitigation measures such as sandbagging, temporary flood walls and barriers, and portable equipment to perform safety functions." The NTTF report also states that, "the Task Force has concluded that flooding risks are of concern due to a 'cliff-edge' effect, in that the safety consequences of a flooding event may increase sharply with a small increase in the flooding level. Therefore, it would be very beneficial to safety for all licensees to confirm that SSCs important to safety are adequately protected from floods."

The NRC, in the past, has developed regulatory programs aimed at identifying plant-specific vulnerabilities to external flooding hazards. In June of 1991, the NRC issued Supplement 4 to Generic Letter (GL) 88-20, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, 10 CFR 50.54(f)." This GL requested that "each licensee perform an individual plant examination of external events to identify vulnerabilities, if any, to severe accidents and report the results together with any licensee determined improvements and corrective actions to the Commission." Flood-related hazards were considered in the IPEEE program as one of the high winds, floods, and other (HFO) external initiating-event hazards. Of the 70 IPEEE submittals, most indicated some type of walkdown was performed for the HFO events. However, NUREG-1742 states, "the [HFO walkdown] submittals usually did not provide detailed descriptions of the walkdown procedures and results." NUREG-1742 also states that, "A few licensees proposed flood-related countermeasures that may be optimistic. For example, one licensee took credit for sandbagging up to a level of 9 feet. In several other submittals, flood barriers made of various construction materials, such as logs or concrete berms, were credited with being effective for preventing flooding, but the submittals did not discuss whether the licensees performed confirmatory testing to verify the effectiveness of certain of these mitigating actions."

In late December 1999, a severe storm induced flooding at Le Blayais nuclear power plant site in France. Lessons learned from this flooding event are documented in World Association of Nuclear Operators Significant Event Report (SER) 2000-3, "Severe Storm Results in Scram of Three Units and Loss of Safety System Functions due to Partial Plant Flooding," and in Institute of Nuclear Power Operations (INPO) SER 1-01, with the same title. Both reports list significant aspects and important lessons learned from the flooding event. On March 11, 2010, Électricité de France presented lessons learned from the 1999 Blayais flood at the NRC's Regulatory Information Conference (<http://www.nrc.gov/public-involve/conference-symposia/ric/past/2010/slides/th35defraquierepv.pdf>). Lessons learned discussed in this presentation were: (1) cable openings and trenches were an unrecognized common-mode vulnerability requiring review of existing protective measures, (2) difficulty in detecting water in affected rooms and an inadequate warning system, and (3) the flood's effects on support functions and surrounding areas were not adequately accounted for or were inappropriate for the weather conditions.

## **APPLICABLE REGULATORY REQUIREMENTS**

- 10 CFR 50.34(a)(1), (a)(3), (a)(4), (b)(1), (b)(2), and (b)(4)
- 10 CFR 50.54, "Conditions of Licenses"
- Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, GDC 2, "Design Bases for Protection against Natural Phenomena"
- Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100

The flooding design bases for currently operating nuclear power plants were either developed in accordance with, or meet the intent of, GDC 2 and 10 CFR Part 100, Appendix A (seismically induced floods and water waves). GDC 2 states that SSCs important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to reflect sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

## **DISCUSSION**

The NTTF recommended that the Commission direct several actions to ensure adequate protection from natural phenomena. These actions should be taken to prevent fuel damage and to ensure containment and spent fuel pool integrity. In particular, Recommendation 2.3 states that the Commission should "Order licensees to perform seismic and flood protection walkdowns to identify and address plant-specific vulnerabilities and verify the adequacy of monitoring and maintenance for protection features such as water tight barriers and seals in the interim period until longer term actions are completed to update the design basis for external events." However, in the context of this letter, the NRC staff is focusing on degraded, nonconforming, or unanalyzed conditions and cliff-edge effects.

The NRC staff's assessment of NTTF Recommendation 2.3 is discussed in SECY-11-0124. The NRC staff agreed with the NTTF Recommendation 2.3 findings and noted that some plants rely on operator actions and temporary flood mitigation measures such as sandbagging, temporary flood walls and barriers, and portable equipment to perform safety functions. Results of staff's inspections at nuclear power sites in accordance with Temporary Instruction (TI) 2515/183 identified potential issues and observations regarding mitigation measures. Recent flooding at the Fort Calhoun site showed the importance of temporary flood mitigation measures. The NRC staff also noted that guidance should be developed for flooding walkdowns with external stakeholder involvement to ensure consistency.

In its SRM to SECY-11-0124, the Commission approved the NRC staff's proposed actions to implement without delay the NTTF recommendations as described in the SECY. With regards to Recommendation 2.3, NRC staff's approved actions are to develop and issue a request for information to licensees pursuant to 10 CFR 50.54(f) to develop a methodology and acceptance criteria for flooding walkdowns to be endorsed by the NRC staff following interaction with external stakeholders, perform flood protection walkdowns to identify and address plant-specific degraded, nonconforming, or unanalyzed conditions and cliff-edge effects (through the corrective action program) and verify the adequacy of monitoring and maintenance for protection features, and inform the NRC of the results of the walkdowns and corrective actions taken or planned.

The TI 2515/183 was issued by the NRC on March 23, 2011. Inspection activities were completed by April 29, 2011, and NRC inspection reports were issued by May 13, 2011. The NRC developed a Summary of Observations report to document the performance of TI 2515/183 (see <http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/follow-up-rpts.html>). The summary report states that while individually, none of the observations posed a significant safety issue, they indicate a potential industry trend of failure to maintain equipment and strategies required to mitigate some design basis events. Regarding the licensee's capability to mitigate design bases flooding events, the report notes that some equipment (mainly pumps) would not operate when tested, or lacked test acceptance criteria, and that some discrepancies were identified with barrier and penetration seals.

Additional review of Section 03.03 of the responses to TI 2515/183 indicates that several sites were susceptible to water accumulation that submerged safety-related cables. Issues were noted with cracks in penetrations, evidence of water infiltration, and groundwater intrusion. Individual TI inspection reports noted that a few licensee-proposed flood-related countermeasures may not achieve the intended mitigative effect. Flood barriers made of various construction materials were credited with being effective for preventing flooding, but the confirmatory testing to verify the effectiveness of certain of these mitigating actions was not conclusive. It should be noted that these findings are consistent with findings documented in the "Perspectives Gained" section of the IPEEE program report (NUREG-1742).

The Advisory Committee on Reactor Safeguards (ACRS) in its letter dated October 13, 2011, requested that the Commission consider that "site-specific external hazards, vulnerabilities, and consequences need to be evaluated in an integrated context. For example, tornadoes and hurricanes may cause extended loss of offsite power with coincident physical damage to nonsafety structures or equipment at multiple units that has not been fully evaluated. Damage from severe storms or other site-specific hazards may also disable external essential cooling water supplies. Vulnerabilities to those hazards and subsequent damage may not be identified from assessments that focus only on design-basis seismic and flooding events." The ACRS further requested that "Near-term actions related to NTTF Recommendation 2.3 should be expanded to assure that the walkdowns address the integrated effects of severe storms as well as seismic and flooding events. The walkdowns and associated assessments should confirm that the identified hazards and vulnerabilities remain bounded by the current plant licensing basis."

The NRC staff will interact with industry and stakeholders to develop a methodology and acceptance criteria for flooding walkdowns. These walkdowns should integrate the External Flood results in NUREG-1742, common issues and findings discussed in Section 03.03 of the responses to TI 2515/183, and the Significant Aspect findings discussed INPO SER 1-01. It is anticipated that the walkdown procedure will be developed or modified using various existing NRC- and industry-developed procedures. As mentioned in SECY-11-0124, recent flood events such as those at Fort Calhoun should also provide valuable insights. Additional attributes of the walkdown procedure are described in the Requested Action section below. The technical approach used to develop the needed information should be holistic and integrated to account for the site-specific design, physical barriers, procedures, temporary measures, and planned or installed mitigation measures to deal with the potential flooding scenarios.

As stated earlier, the NRC staff will interact with industry and other stakeholders to develop an approach, which can be applied in a uniform and consistent manner across the different sites and plant conditions. An integrated approach will allow the NRC and industry to assess the significance of any new information related to flooding hazards in a systematic manner. During these interactions, the NRC staff will also work with industry and stakeholders to identify efficiencies and strategies to ensure that responses and reviews are timely and support the Commission guidance on the overall schedule.

As mentioned in the cover letter, other external events (e.g., extreme winds and its effects) will be covered as a separate action from this letter. It would be prudent for addressees to consider the inclusion of other external events in these walkdown procedures due to the potential efficient use of similar resources to perform these walkdowns.

## **REQUESTED ACTIONS**

The NRC requests that each addressee confirm that they will use the industry-developed, NRC-endorsed, flood walkdown procedures<sup>1</sup> or provide a description of plant-specific walkdown procedures. The requested actions include the following:

- (1) Perform flood protection walkdowns using an NRC-endorsed walkdown methodology,
- (2) Identify and address plant-specific degraded, nonconforming, or unanalyzed conditions, as well as, cliff-edge effects through the corrective action program, and consider these findings in the Recommendation 2.1 hazard evaluations, as appropriate,
- (3) Identify any other actions taken or planned to further enhance the site flood protection,
- (4) Verify the adequacy of programs, monitoring and maintenance for protection features, and,
- (5) Report to the NRC the results of the walkdowns and corrective actions taken or planned.

A final report should be submitted to the NRC addressing items identified in the Requested Information section.

---

<sup>1</sup> NRC staff are currently engaged with industry and other external stakeholders to develop NRC-endorsed procedures. The NRC staff anticipates completing this activity by May, 2012.

It is requested that the walkdown procedure verify that flood protection systems for the plant are available, functional, and implementable under a variety of site conditions. In particular, the walkdowns should confirm that: (1) cable and piping trenches and other penetrations to SSCs important to safety, including underground rooms, are not pathways for external ingress of water, (2) adequate water detection and warning systems are available, if credited in the current licensing basis, (3) the effects of elevated water levels and severe weather conditions would not impair support functions or would not impede performing necessary actions given the weather conditions, and (4) other factors at multi-unit sites (e.g., equipment availability and staffing) would not prevent implementation of flood protection measures.

If any condition identified during the walkdown activities represents a degraded, nonconforming, or unanalyzed condition (i.e., noncompliance with the current licensing basis) for an SSC, describe actions that were taken or are planned to address the condition using the guidance in Regulatory Issues Summary 2005-20, Revisions 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the corrective action program. Reporting requirements pursuant to 10 CFR 50.72 should also be considered. In addition, if any condition noted during the walkdown represents a cliff-edge effect, describe any measures taken or planned to address the condition(s) while the corrective action is being implemented.

Along with an assessment of reactor integrity, the NTTF recommended an evaluation of spent fuel pools to assess the effectiveness of the flood protection. The approach should account for the site-specific design, physical barriers, procedures, temporary measures, and planned or existing mitigation measures.

## **REQUESTED INFORMATION**

1. The NRC requests that each addressee confirm that it will use the industry-developed, NRC-endorsed, flooding walkdown procedures or provide a description of plant-specific walkdown procedures that include the following characteristics:
  - a. Address the NTTF Report's observations regarding "overreliance on operator actions and temporary flood mitigation measures" and the 'cliff-edge' effect regarding a sharp increase in flooding risks with a small increase in flooding level.
  - b. Integrate issues discussed in the External Flood Qualitative Results (Section 4.3.3) in NUREG-1742, common issues and findings discussed in Section 03.03 of the responses to TI 2515/183, and the Significant Aspect findings discussed in INPO SER 1-01.
  - c. Integrate insights from any new and relevant flood hazard information, as well as recent flood-related walkdowns such as the events at the Fort Calhoun site, as mentioned in SECY-11-0124. Additionally, relevant NRC inspection findings could provide additional insights.
  - d. Integrate the combined effects of flooding along with other adverse conditions, such as high winds, hail, lightning, etc., that could reasonably be expected to simultaneously occur. For example, steps in a flooding procedure that require manipulation of systems and components in outside areas of the plant site that could not be safely assessed because of storm conditions.

- e. Identify pre-walkdown actions, such as the collection of current site topography including any changes since the original licensing (e.g., security improvements and temporary structures), sets of as-built drawings, review of the existing design basis flood level(s), review of any flood protection and pertinent flood mitigation features, such as exterior barriers, incorporated barriers, and temporary flood barriers.
  - f. Identify a list of pertinent elevations of Regulatory Guide 1.29<sup>2</sup> structures, systems, and components that should be designed to withstand the design basis hazard (similar to Table 1, i.e., 3.1.3 of American National Standards Institute/American Nuclear Society (ANSI/ANS)-2.8-1992)
  - g. Identify the team composition and qualifications.
  - h. Verify that flood protection systems are available, functional, and implementable under a variety of site conditions by reviewing the following:
    - i. Operator availability, operator training, timeliness of response, equipment maintenance and operability, back-up availability, operator access under adverse site conditions<sup>3</sup>
    - ii. Methods and acceptance criteria to evaluate exterior barriers<sup>4</sup>
    - iii. Methods and acceptance criteria to evaluate incorporated barriers
    - iv. Methods and acceptance criteria to evaluate temporary flood barriers
    - v. Preparations in advance of adverse weather conditions
  - i. Identify programs in place that periodically verify the status and adequacy of flood mitigation strategies and equipment.
  - j. Develop a documentation template, including peer-review requirements, so that walkdown results can be efficiently and uniformly reviewed and evaluated. The template should also consider the reporting requirement discussed below.
2. Following NRC's endorsement of the walkdown procedure, conduct the walkdown and submit a final report which includes the following:
- a. Describe the design basis flood hazard level(s) for all flood-causing mechanisms, including groundwater ingress.
  - b. Describe protection and mitigation features that are considered in the licensing basis evaluation to protect against external ingress of water into SSCs important to safety.
  - c. Describe any warning systems to detect the presence of water in rooms important to safety.
  - d. Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers were evaluated using the acceptance criteria developed as part of Requested Information item 1.h.

---

<sup>2</sup> Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants", and Regulatory Guide 1.102, Flood Protection for Nuclear Power Plants," both recommend the use of Regulatory Guide 1.29, "Seismic Design Classification" for identifying structures, systems, and components, that should be designed to withstand the conditions resulting from the design basis flood and remain functional.

<sup>3</sup> This may not be an all-inclusive list.

<sup>4</sup> See Regulatory Position 1 of Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," for definitions acceptable to the NRC staff for exterior barriers, incorporated barriers, and temporary barriers.

- e. Present information related to the implementation of the walkdown process (e.g., details of selection of the walkdown team and procedures,) using the documentation template discussed in Requested Information item 1.j, including actions taken in response to the peer review.
- f. Results of the walkdown including key findings and identified degraded, nonconforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using the guidance in Regulatory Issues Summary 2005-20, Revision 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the corrective action program.
- g. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the corrective action program. Also include a detailed description of the actions taken or planned to address these effects.
- h. Describe any other planned or newly installed flood protection systems or flood mitigation measures including flood barriers that further enhance the flood protection. Identify results and any subsequent actions taken in response to the peer review.

## **REQUIRED RESPONSE**

In accordance with 10 CFR 50.54(f), an addressee must respond as described below. The submission of the requested information is in stages to allow adequate time for further interactions with the stakeholders to provide clarifications, to develop implementation procedures and processes, and to develop the associated guidance as needed.

- 1. Within 90 days of the date of this information request, the addressee will confirm that it intends to use the NRC-endorsed flooding walkdown procedures or provide the NRC a description of the process that will be used to conduct the walkdowns and to develop the needed information.
- 2. Within 180 days of NRC's endorsement of the walkdown procedure, each addressee will submit its final response for the requested information. This response should include a list of any areas that are unable to be inspected due to inaccessibility and a schedule for when the walkdown will be completed.

If an addressee cannot meet the requested response date, the addressee must provide a response within 90 days of the date of this information request and describe the alternative course of action that it proposes to take, including the basis of the acceptability of the proposed alternative course of action and estimated completion dates.

The required written response should be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, 11555 Rockville Pike, Rockville, MD 20852, under oath or affirmation under the provisions of Sections 161.c, 103.b, and 182.a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f). In addition, addressees should submit a copy of the response to the appropriate regional administrator.



#### **Enclosure 4 References**

SECY-11-0124, "Recommended Actions to be taken without Delay from the Near-Term Task Force Report," Agencywide Documents Access and Management System (ADAMS) Accession No. ML11245A158, dated September 9, 2011.

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

"Recommendations for Enhancing Reactor Safety in the 21<sup>st</sup> Century: The Near-term Task Force Review of Insights from the Fukushima Dai-ichi Accident," ADAMS Accession No. ML111861807, July 12, 2011.

10 CFR 50.54 – Conditions of Licenses

10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors"

Appendix A to 10 CFR Part 50, General Design Criteria for Nuclear Power Plants

Appendix A to 10 CFR Part 100, Seismic and Geologic Siting Criteria for Nuclear Power Plants

Temporary Instruction 2515/183, "Follow-up to the Fukushima Dai-ichi Fuel Damage Event," November 2011, ADAMS Accession No. ML113220407.

Energy and Water Development and Related Agencies Appropriations Act, 2012

NUREG-0800, SRP Section 2.4

NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," Final Report, ADAMS Accession No. ML063550238, June 1991.

ASME/ANS RA-Sa-2009, American Society of Mechanical Engineers/American Nuclear Society standard, RA-Sa-2009, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," 2009.

INPO version, SER 1-01, "WANO Significant Event Report (SER) 2000-3, 'Severe Storm Results in Scram of Three Units and Loss of Safety System Functions Due to Partial Plant Flooding,'" February 2001 (Proprietary)