



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001**

May 18, 2016

Mr. Victor M. McCree  
Executive Director for Operations  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

**SUBJECT:** DRAFT INTERIM STAFF GUIDANCE JLD-ISG-2016-01, "GUIDANCE FOR ACTIVITIES RELATED TO NEAR-TERM TASK FORCE RECOMMENDATION 2.1, FLOODING HAZARD REEVALUATION; FOCUSED EVALUATION AND INTEGRATED ASSESSMENT"

Dear Mr. McCree:

During the 634th meeting of the Advisory Committee on Reactor Safeguards (ACRS), May 5-6, 2016, we reviewed draft Interim Staff Guidance JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment." Our Fukushima Subcommittee reviewed this matter on April 22, 2016. During these meetings, we had the benefit of discussions with representatives of the NRC staff and the Nuclear Energy Institute. We also had the benefit of the referenced documents.

**CONCLUSIONS AND RECOMMENDATIONS**

1. Except for the treatment of flooding from local intense precipitation, the graded approach that is endorsed in JLD-ISG-2016-01 provides an appropriate framework to evaluate the plant-specific effects from reevaluated flooding hazards.
2. If mitigation strategies are needed to maintain or restore key safety functions during a flood caused by local intense precipitation, the staff should review those evaluations in the same manner as the integrated assessments that are performed for other flooding mechanisms.
3. The staff should better specify expectations for assurance of reliable personnel performance in the integrated assessments that are performed according to the guidance for the higher frequency scenarios in Path 5 and all scenarios in Path 4.
4. The staff should develop guidance to ensure that the evaluations examine external flooding scenarios that result from seismic events which also cause damage at the plant site.

5. It would be challenging to conduct comprehensive and timely independent peer reviews of these flooding assessments according to the guidance and expectations.

## **BACKGROUND**

In March 2012, the Commission issued a letter to all U.S. nuclear power plant licensees requesting updated information about their site-specific seismic and external flooding hazards. If the reevaluated hazard from any flooding mechanism<sup>1</sup> exceeds the current design basis flood, licensees were requested to perform an integrated assessment to identify plant-specific vulnerabilities and actions to address them. The scope of the integrated assessment is intended to include all operating modes during which the plant is susceptible to flooding, account for flooding effects on the ultimate heat sink, and address the expected flood duration. The letter also outlined a two-phase approach to address the need for possible regulatory actions. In that approach, Phase 1 involves development of the updated hazard information and performance of any needed assessments of plant-specific vulnerabilities. Phase 2 involves staff review of the results from Phase 1 to determine whether additional regulatory actions are warranted.

In COMSECY-14-0037, the staff requested Commission affirmation that licensees' mitigating strategies for beyond-design-basis external events should address the reevaluated flooding hazard, that licensees may develop targeted strategies to address specific flooding scenarios, and that the Phase 2 regulatory decision making process should be integrated with the staff's evaluations of the Phase 1 assessments. Our December 10, 2014 letter report provides our conclusions and recommendations on those issues. In the Staff Requirements Memorandum (SRM) for COMSECY-14-0037, the Commission disapproved integration of the Phase 2 and Phase 1 activities. The Commission also directed the staff to revise the guidance for performing the Phase 1 integrated assessments to include a risk-informed, performance-based graded approach that focuses more efficiently on the specific sites, flooding mechanisms, and flood scenarios where there is greatest opportunity for additional safety enhancements.

In response to the SRM for COMSECY-14-0037, the staff developed COMSECY-15-0019, which contains details of an action plan to close Phase 1 of the flooding hazard evaluations. The major elements of that plan are:

- (1) A revised integrated assessment of the effects from local intense precipitation is not required. That flooding mechanism will be addressed by implementation of flood protection barriers, drainage, or other plant-specific modifications, and will not be subject to further regulatory actions in Phase 2 of the staff reviews.
- (2) Focused evaluations can be performed to confirm that key safety functions are protected against each reevaluated flooding mechanism by existing barriers and equipment, or by plant modifications to be implemented through a formal commitment.

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<sup>1</sup> In this letter, we use the term "flooding mechanism" as it is used in the references. In that context, a flooding mechanism is equivalent to a particular source of site flooding, such as local intense precipitation, failure of an upstream dam, storm-caused regional flooding, hurricane-caused storm surge, tsunami, etc.

- (3) For flooding mechanisms that may damage key safety functions, graded risk-informed integrated assessments will evaluate the plant-specific protection and mitigation strategies.

Only plants that need to perform an integrated assessment under element (3) of the plan would be subject to staff review during Phase 2 of the regulatory decision making process. In the SRM for COMSECY-15-0019, the Commission approved the staff's closure plan. We have not previously reviewed the specific proposals described in COMSECY-15-0019.

In parallel with these staff activities, the industry developed guidance in Appendix G to NEI 12-06 for assessing the capabilities of FLEX strategies to mitigate damage that may be caused by the reevaluated flooding hazard. The industry also developed NEI 16-05, which contains guidance for the performance of focused evaluations and integrated assessments of plant response to the reevaluated flooding hazard, in accordance with the principles outlined in COMSECY-15-0019. The guidance in Appendix G to NEI 12-06 and NEI 16-05 overlap to some extent. The mitigating strategies assessments described in NEI 12-06 are intended to confirm that the FLEX equipment and personnel actions can effectively cope with the reevaluated flood conditions. If the FLEX strategies are not fully effective for all flooding mechanisms, a licensee may consider an alternate or targeted mitigating strategy to compensate for those limitations. The integrated assessments described in NEI 16-05 may account for the FLEX mitigation strategies in the context of overall plant response, or they may confirm that flood protection strategies and installed plant equipment can effectively cope with the reevaluated flood, without benefit from the FLEX equipment.

Interim Staff Guidance JLD-ISG-2016-01 endorses, with some clarifications, the graded evaluation process and guidance in NEI 16-05, Revision 0.

## **DISCUSSION**

Each site-specific flooding mechanism is examined through an evaluation framework that consists of five possible "paths." Path 1, Path 2, and Path 3 are characterized as "focused evaluations." The intent of those evaluations is to demonstrate that the flooding mechanism is bounded by the current design basis flood or that plant barriers, structures, and equipment provide adequate protection of key safety functions. In this context, protection may include installation of temporary barriers, provided that adequate warning time, materials, and personnel are available to complete the installation, and effectiveness of the barriers has been demonstrated. If existing plant protection features must be modified to provide assurance that adequate physical margin is available for the reevaluated flood, those modifications are to be documented in a formal commitment that is subject to NRC inspection.

Path 4 and Path 5 evaluations are characterized as "integrated assessments." These paths apply if the focused evaluations cannot demonstrate that adequate protection is available to preclude flooding damage to plant equipment needed to maintain key safety functions. The integrated assessments then examine strategies to mitigate the effects from the flooding damage. Those strategies may involve combinations of plant equipment and FLEX equipment, and they may be tailored for a specific flooding mechanism. The integrated assessments provide input to the staff reviews in Phase 2 of the decision making process to determine whether additional regulatory action is needed for assurance of plant safety.

The graded approach that is endorsed in JLD-ISG-2016-01 provides an appropriate framework to evaluate the plant-specific effects from reevaluated flooding hazards. The focused evaluations provide assurance that key safety functions are protected against flooding damage, without the need to implement mitigation strategies. Those evaluations do not alter the baseline decisions for location, protection, and mobilization of FLEX equipment, as described in NEI 12-06 and pending regulatory guidance. If existing plant features and practices cannot be modified to provide assurance that key safety functions are protected from damage, the staff will examine the relevant flooding mechanisms and proposed site-specific mitigation strategies to determine whether additional regulatory action is warranted. The focus on protection before mitigation supports a defense-in-depth approach to plant safety.

The following sections summarize our comments and recommendations on specific elements of the evaluation framework and draft guidance.

### **Treatment of Local Intense Precipitation**

The evaluations in Path 3 apply only to flooding that may be caused by local intense precipitation. The guidance for those evaluations accounts for either protection against flood damage or mitigation of the effects from damage. In particular, the guidance in NEI 16-05 refers specifically to the FLEX mitigation strategies as an element of the Path 3 evaluations.

The staff confirmed that the Path 3 evaluations are intended to address both protection and mitigation of flooding caused by local intense precipitation, without the need for further regulatory examination in Phase 2 of the decision making process. This approach does not seem consistent with the discussion of local intense precipitation in COMSECY-15-0019. It is noted in COMSECY-15-0019 that a revised integrated assessment is not required for this flooding mechanism. However, the supporting discussion seems to clearly imply an intent that licensees will provide protection against flooding damage by accounting for more realistic estimates of precipitation rates, site topography, fixed and portable barriers, availability of engineered drains, etc.

During our briefings, the staff noted that separate treatment of local intense precipitation is justified by the low occurrence frequency of floods that may be severe enough to overwhelm existing plant protection features. That a *priori* generic conclusion about the frequency and consequences from this particular hazard is contrary to the structured evaluation framework that is applied for all other flooding mechanisms. For example, some flooding mechanisms subject to integrated assessments in Path 4 or Path 5 of the evaluation process may occur less frequently than severe local precipitation. It is incongruous that those flooding mechanisms and their corresponding mitigation strategies will be subject to staff review in Phase 2, while strategies to mitigate damage from local intense precipitation are not subject to a similar review.

If mitigation strategies are needed to compensate for the effects from flooding damage caused by local intense precipitation, an analysis similar to an integrated assessment should be performed. If the final evaluation framework retains separate treatment of local intense precipitation, and a Path 3 evaluation includes credit for mitigation of that flooding damage, the staff should review that evaluation in the same manner as a Path 4 or Path 5 assessment and consider possible regulatory actions accordingly.

### **Reliability of Mitigation Strategies**

The integrated assessments in Path 4 and Path 5 of the framework account broadly for risk information to structure the scope and details of those evaluations. According to the guidance in NEI 16-05, Path 4 assessments address only flood severity, without regard to occurrence frequency.<sup>2</sup> Path 5 assessments, when needed, address both flood severity and frequency.

The guidance indicates that effective mitigation should be demonstrated for the most potentially risk-important scenarios. These include all flooding mechanisms that are subject to a Path 4 assessment, because no estimate of frequency has been performed and the associated risk cannot be assessed. They also include the higher frequency scenarios<sup>3</sup> in a Path 5 assessment, i.e., the most risk important scenarios. In practice, effective mitigation means that the proposed strategies are both feasible and reliable. The quality of the guidance for determining if equipment is reliable and available is very good. The guidance for personnel performance is weak, by comparison.

The guidance in NEI 16-05 provides a series of tables that contain explicit considerations for assurance that the equipment used in these mitigating strategies is reliable and available, based on relevant hardware performance data and plant-specific operating, maintenance, and testing practices. With regard to personnel performance, the guidance in NEI 16-05 relies primarily on the task validation process described in Appendix E to NEI 12-06, Revision 2. That validation takes note of factors that could affect the ability of personnel to perform each task reliably. However, the validations are explicitly intended to only provide assurance that the actions are feasible, with some available time margin. More thorough qualitative and quantitative guidance on the factors that most strongly affect human performance is needed – guidance akin to that provided for equipment. The staff should better specify expectations for assurance of reliable personnel performance in the integrated assessments that are performed according to the guidance for Path 4 or for the higher frequency scenarios in Path 5.

### **Evaluation of Seismically-Caused Floods**

We were informed that the guidance in Appendix G to NEI 12-06, Revision 2, and NEI 16-05, Revision 0, does not apply for scenarios that may involve correlated external flooding and seismic damage. The guidance in NEI 12-06 indicates that mitigating strategies should account for failure of a downstream dam that is “not seismically robust.” The guidance in NEI 16-05 indicates that seismic failure of an upstream dam may contribute to a site flooding mechanism. However, consideration of consequential external flooding that is caused by a seismic event which also affects the plant site is deemed to be outside the scope of these assessments.

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<sup>2</sup> A staff position in JLD-ISG-2016-01 indicates that the occurrence frequency should also be estimated for a flooding mechanism that is evaluated through Path 4, but it is not apparent why that frequency is needed for the staff's review of those assessments.

<sup>3</sup> The guidance partitions flooding scenarios into high and low frequency using a nominal flooding frequency of approximately  $1 \times 10^{-4}$  per year.

Licensees are currently examining plant structures and equipment to determine whether they are sufficiently robust to withstand the reevaluated site-specific seismic and flooding hazards. They are also performing similar evaluations of storage locations, equipment, and connections to be used in their proposed FLEX mitigating strategies. Guidance for performance of the seismic and flooding evaluations is evolving toward more focused assessments of integrated plant response to specific damage scenarios. In the context of those evaluations, licensees are proposing strategies that may protect a particular set of equipment from a specific hazard. For flooding scenarios with sufficient warning time, some licensees are also proposing to move equipment to a protected location. Effective implementation of strategies that are targeted to only one hazard could be compromised if a strong seismic event causes damage at the site and to nearby dams, resulting in a consequential flood. A seismically-caused tsunami is another example of this consequential relationship.

The staff should develop guidance to ensure that the evaluations examine external flooding scenarios that result from seismic events which also cause damage at the plant site.

### **Independent Peer Reviews**

Enclosure 2 to JLD-ISG-2016-01 recommends that an independent peer review be performed for integrated assessments that are submitted to support the Phase 2 regulatory decision making process. It is not anticipated that these submittals will involve a comprehensive probabilistic flooding hazard analysis with an integrated plant-specific risk assessment. However, probabilistic methods will be used to identify specific flooding mechanisms that are allocated to higher and lower frequency scenarios for Path 5 assessments. Probabilistic methods may also be used to provide assurance of reliable implementation of mitigating strategies for the higher frequency scenarios in Path 5 and scenarios in Path 4.

Experience has shown that assembly of an appropriately qualified independent peer review team, performance of the review, and resolution of the review findings can be very resource-intensive and time-consuming. This is especially true for complex issues such as probabilistic flooding hazard analysis, for which there is relatively limited domestic and international experience and a rather small pool of experts from which to assemble qualified review teams. For example, in practice, performance of a technically qualified peer review of a site-specific probabilistic flooding hazard analysis would be much more challenging than a peer review of a risk-informed fire analysis for licensing transition to NFPA-805. Therefore, it seems unrealistic to anticipate that comprehensive and timely independent peer reviews of these flooding assessments can be performed according to the guidance and expectations that typically apply for other analyses.

We look forward to continuing our interactions with the staff as they complete the guidance for the Phase 1 flooding assessments and develop guidance for the Phase 2 regulatory decision making process.

Sincerely,

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Dennis C. Bley  
Chairman

## REFERENCES

1. U.S. Nuclear Regulatory Commission, Draft Interim Staff Guidance JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," April 15, 2016 (ML16090A140).
2. 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 (ML12053A340).
3. U.S. Nuclear Regulatory Commission, COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," November 21, 2014 (ML14238A616).
4. Advisory Committee on Reactor Safeguards, "Commission Paper, Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," December 10, 2014 (ML14342A899).
5. U.S. Nuclear Regulatory Commission, SRM-COMSECY-14-0037, "Staff Requirements – COMSECY-14-0037 – Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," March 30, 2015 (ML15089A236).
6. U.S. Nuclear Regulatory Commission, COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," June 30, 2015 (ML15153A104).
7. U.S. Nuclear Regulatory Commission, SRM-COMSECY-15-0019, "Staff Requirements – COMSECY-15-0019 – Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," July 28, 2015 (ML15209A682).
8. Nuclear Energy Institute, NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, December 2015 (ML16005A625).
9. Nuclear Energy Institute, NEI 16-05, "External Flooding Integrated Assessment Guidelines," April 2016 (ML16105A327).

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**REFERENCES**

1. U.S. Nuclear Regulatory Commission, Draft Interim Staff Guidance JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," April 15, 2016 (ML16090A140).
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9. Nuclear Energy Institute, NEI 16-05, "External Flooding Integrated Assessment Guidelines," April 2016 (ML16105A327).

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