Transactions, SMiRT-24
BEXCO, Busan, Korea - August 20-25, 2017
Division VII

PLAN TO ENSURE ONGOING ASSESSMENT OF NATURAL HAZARD INFORMATION AT U.S. NUCLEAR POWER PLANTS

Michelle T. Bensi[1], Nilesh Chokshi[1], Christopher Cook[1], Joseph Kanney[2], Cliff Munson[1], and Michael Willingham[1]

[1] Office of New Reactors, US Nuclear Regulatory Commission
[2] Office of Nuclear Regulatory Research, US Nuclear Regulatory Commission

ABSTRACT

Shortly after the Fukushima Dai-ichi accident, the United States Nuclear Regulatory Commission (NRC) established a Near-Term Task Force (NTTF) that was directed to conduct a methodical and systematic review of NRC processes and regulations for reactor safety. The NTTF was also directed to provide recommendations to the Commission on whether the agency should make changes to its regulatory programs in response to the accident. The NTTF's Recommendation 2.2 (R2.2) suggested that the NRC initiate rulemaking to require reactor licensees to: (1) confirm seismic and flooding hazards every 10 years and (2) address any new and significant information including, if necessary, updating the design basis for structures, systems, and components important to safety to protect against the updated hazards. The staff's subsequent assessment concluded that the NRC can meet the intent of R2.2 using an approach other than rulemaking. Instead, staff have developed a plan to enhance existing processes to ensure that the staff proactively and routinely aggregates and assesses new natural hazards information. This paper describes the approach NRC staff will use to ensure ongoing assessment of natural hazards at U.S. nuclear power plant sites, consistent with the intent of NTTF R2.2 and as described in SECY-16-0144 (USNRC, 2017).

INTRODUCTION AND 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 for reactor safety and assessed whether 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 (USNRC, 2011). With regard to seismic and flooding hazards, the NTTF made the following recommendations:

> *Recommendation 2, The Task Force recommends that the NRC require licensees to reevaluate and upgrade as necessary the design-basis seismic and flooding protection of SSCs* (structures, systems, and components) *for each operating reactor. The Task Force recommends that the Commission direct the following actions to ensure adequate protection from natural phenomena, consistent with the current state of knowledge and analytical methods. These should be undertaken to prevent fuel damage and to ensure containment and spent fuel pool integrity:*

- *2.1 Order licensees to reevaluate the seismic and flooding hazards at their sites against current NRC requirements and guidance, and if necessary, update the design basis and SSCs important to safety to protect against the updated hazards.*

- *2.2 Initiate rulemaking to require licensees to confirm seismic hazards and flooding hazards every 10 years and address any new and significant information. If necessary, update the design basis for SSCs important to safety to protect against the updated hazards.*

- *2.3 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 watertight barriers and seals in the interim period until longer-term actions are completed to update the design basis for external events.*

Of relevance to this paper is Recommendation 2.2 (R2.2), which recommended that the NRC initiate a rulemaking to require that reactor licensees confirm seismic and flooding hazards every 10 years. While R2.2 focused on seismic and flooding hazards, the NRC staff identified the need to perform evaluations of natural hazards other than seismic and flooding. In SECY-12-0095, the staff discussed that other hazards (e.g., hazards caused by meteorological effects) should be included as part of the NRC's response to R2.2 (USNRC, 2012a).

In addition to the NTTF's recommendations, other studies conducted after the Fukushima Dai-ichi accident also include recommendations that emphasized the importance of assessing new information. For example, Finding 3.1 of the National Academies of Science report, "Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants" states: "[t]he overarching lesson learned from the Fukushima Dai-ichi accident is that nuclear plant licensees and their regulators must actively seek out and act on new information about hazards that have the potential to affect the safety of nuclear plants" (NASEM, 2014).

The NRC staff assessed possible options for responding to NTTF R2.2 (and similar recommendations from external stakeholders). Based on its assessments, the NRC staff concluded that the NRC can meet the intent of R2.2 using an approach other than rulemaking. In SECY-15-0137, the staff found that current NRC practices to assess new external hazard information are generally effective, but identified a number of ways to enhance existing processes (USNRC, 2015). In addition, the staff recognized that there is no dedicated NRC process that systematically identifies new hazard information and assesses its risk significance. The staff identified the following opportunities to enhance existing practices:

- Ensure more timely identification and evaluation of new information (e.g., data, models, and methods).
- Facilitate a methodical evaluation of the cumulative effect of new data, models, and methods over time.
- Update existing hazard models with new information found to be significant so they are readily available for use by staff.

As a result, in SECY-15-0137, the staff proposed to enhance existing processes and develop associated staff procedures to ensure that the staff proactively and routinely identifies, aggregates, and assesses new natural hazard information. The staff proposed that the enhanced internal process would leverage and augment existing programs and agreements with domestic and international organizations.

In SECY-16-0144 (USNRC, 2016a), NRC staff developed a more detailed framework that expands upon the concepts described in SECY-15-0137. The framework outlined in SECY-16-0144 provides a graded approach that allows NRC to proactively, routinely, and systematically seek, evaluate, and respond to new information on natural hazards.[1] Under the framework, the NRC staff will collect, aggregate, review, and assess information related to natural hazards on an ongoing basis. The framework enables the NRC staff to achieve the underlying intent of R2.2 in a manner that is timely, integrates well with NRC's existing regulatory framework, and is less burdensome on the agency and licensees than imposing a new rule.

This paper is based on, and draws heavily from, the framework outlined in SECY-16-0144 (USNRC, 2016a). The Commission approved the staff's framework for ongoing assessment of natural hazards information in the staff requirements memorandum SRM-SECY-16-0144 (USNRC, 2017). Staff are in the process of implementing the framework, including development of staff guidance and requisite infrastructure.

PROCESS OVERVIEW

The framework for ensuring ongoing assessment of natural hazard information consists of three primary components:

1. Knowledge base activities
2. Active technical engagement and coordination
3. Assessment activities

Additional details regarding each of the above components is provided below.

Knowledge Base Activities

The knowledge base activities provide the foundation for the framework for ongoing assessment of natural hazards. Development of the knowledge base will require a series of near-term activities to gather and preserve relevant existing information related to natural hazards so that the staff can readily retrieve and apply it. Sources of relevant information include:

[1] R2.2 focused on seismic and flooding hazards. However, the framework for ongoing assessment of natural hazards will include within its scope all relevant natural hazards (e.g., seismic, flooding, and extreme weather such as high winds). Man-made hazards are not included in the framework due to fundamental differences in the types of changes that arise due to natural and man-made hazards (USNRC, 2016a).

- post-Fukushima activities associated with re-evaluation of seismic and flooding hazards[2] as well as other hazards[3]
- new reactor reviews, and
- other regulatory activities (e.g., Generic Issues and Individual Plant Examination of External Events).

Relevant information will include diverse data, models, and methods associated with natural hazards. For example, in the case of flooding hazards, relevant data may include (but is certainly not limited to) precipitation, stream flow, and other event observations. Models may include hydrological and hydraulic models. Relevant methods are similarly diverse and may range from flood frequency analysis to complex numerical simulations. Other sources of information may include insights resulting from global, regional, or local climatologic and meteorological assessments. Examples of available seismic hazard resources include data, models, and methods used to estimate site-specific hazards (e.g., seismic source, ground motion, and site response characterizations). Similarly diverse information is available for other natural hazards (e.g., wind hazards).

In addition to information related to site hazards, the staff will identify appropriate information and analyses that provide insights on plant margins that are relevant to assessing the impact of natural hazards on plant safety. The staff will also identify and compile relevant information regarding mitigating strategies for beyond design basis external events (e.g., FLEX strategies and alternate and targeted hazard mitigating strategies). This information related to plant response will support the staff's ability to conduct efficient evaluations of the significance of new hazard information.

The concept of information aggregation is central to the framework for ongoing assessment of information related to natural hazards. Specifically, the NRC staff recognize that consideration of discrete pieces of information in isolation may lead to erroneous conclusions regarding potential

[2] In response to NTTF Recommendations 2.1 and 2.3, NRC staff issued a request for information pursuant to Title 10 of the Code of Federal Regulations, Part 50, Section 54(f) that requested licensees undertake a series of actions related to seismic and flooding hazards (50.54(f) letter) (USNRC, 2012b). The 50.54(f) letter requested that licensees and holders of construction permits: (1) perform walkdowns to verify that plant features that are credited in the current licensing basis for protection and mitigation of seismic and flooding events are available, functional, and properly maintained, (2) reevaluate the seismic and flooding hazard(s) at their sites using present-day regulatory guidance and methodologies, and, if the reevaluated hazard exceeds the site's design basis, (3) perform assessment of plant response in light of the reevaluated hazard. Thus, the R2.1 and R2.3 activities provide information regarding plant hazards and response that may be relevant to future assessments performed in conjunction with the process for ongoing assessment of natural hazards developed in response to NTTF R2.2. As a result, staff plans to preserve related information in the knowledge base.

[3] In SECY-15-0137, the NRC staff outlined a four-step process for reviewing natural hazards other than seismic and flooding (USNRC, 2015). In SECY-16-0074, the staff concluded that the only natural hazards (other than seismic and flooding) that required further assessment and stakeholder interactions were associated with high winds and snow loads (USNRC, 2016b). In SECY-16-0144, staff ultimately concluded that regulatory action to provide additional protection against high winds and snow loads is not warranted (USNRC, 2016a). The assessments performed by the staff to support these conclusions may be relevant to future assessments performed in conjunction with the process for ongoing assessment of natural hazards developed in response to NTTF R2.2. As a result, staff plans to preserve related information in the knowledge base.

natural hazards and their effects on nuclear power plant sites. To ensure staff are able to assess information within the appropriate aggregated context, the staff will maintain the knowledge base to reflect the information collected, aggregated, and assessed as part of the framework for ongoing assessment of natural hazards as well as from other regulatory programs and operating experience. The maintenance of the knowledge base will include updating of site-specific information and hazard models as well as relevant plant-specific information, as needed. In addition, the staff will maintain cumulative information records that document the accumulation of new natural hazards information over time (e.g., occurrences of extreme natural phenomena; changes to the state of practice, including new data, models, and methods). The cumulative information records will facilitate the aggregation of information and allow the staff to identify when further assessments are warranted.

Active Technical Engagement and Coordination

The active technical engagement and coordination component of the framework involves periodic interactions between the NRC staff and external individuals and organizations involved in collecting or analysing, or applying natural hazard information (e.g., Federal agencies, industry, international counterparts, academics, as well as technical and scientific organizations). These activities will help facilitate identification of new data, models, and methods.

To ensure the staff maintains awareness of new developments to support implementation of the framework, the staff will periodically coordinate and document the outcomes of meetings during which NRC and the aforementioned groups will review and discuss the evolution in knowledge (e.g., changes in data, models, and methods). In addition, the staff will continue to remain engaged in the broader technical and scientific community, which will ensure the staff are aware of, and are contributors to, advances in data, models, and methods (including opportunities for leveraging more sophisticated models and refinements). This systematic technical engagement effort also ensures the staff has the appropriate knowledge and capabilities to assess the potential significance of new information

Ongoing Assessment Activities

When the NRC staff identifies new hazard information (e.g., through technical engagement activities of other NRC activities such as operating experience, licensing experience, and research activities), the staff will aggregate the information with previously collected information. Thus, the staff will assess new information for potential significance in the context of accumulated hazard information, rather than in isolation. This assessment will evaluate the change in the hazard represented by the aggregated information and consider available risk insights to determine whether the change in the hazard has a potentially significant effect on plant safety.

The assessment of hazard significance will involve a determination of whether the new information indicates that the hazard is more severe than that considered in previous evaluations as well as an assessment of its potential significance. To assess the potential significance of an increase in hazard severity, the staff will use available information and risk insights. For example, additional information may be available based on the outcomes of activities associated with response to the events at Fukushima Dai-ichi. Such additional information could include available seismic capacities, available physical margin for flooding, and cliff-edge effects. As another example, to inform the assessment of hazard significance, the staff can consider the characteristics of the increased hazard severity (e.g., screening criteria used in R2.1 seismic reevaluations). Depending on the nature of the new information, the assessment may be based on site-specific evaluations, consider groups of representative sites (e.g., based on geographic location), or use generic assessments.

The overall objective of the assessment of hazard significance is to determine if the new information could have a potentially significant effect on plant safety. If the staff finds that the new hazard information is of low safety significance (e.g., that it would be unlikely to lead to the need for a generic or plant-specific backfit or other regulatory action), the staff will document the results of the assessment in updates to the cumulative information records. These updates will include a short summary of the new hazard information and the staff's basis for concluding that the new hazard information is not significant at that point from a plant safety perspective. If the staff finds that the new hazard information has a potentially significant effect on plant safety, the NRC staff will refer the issue to appropriate regulatory programs for detailed assessment and further action. Regulatory programs for these referrals include:

- Transfer of an issue to the relevant program office for resolution (e.g., via plant-specific assessment and regulatory action),
- Transfer of the issue to the Generic Issues Program, if the new information could potentially affect safety at multiple plants and the issue meets other Generic Issues Program screening criteria, or
- Identification of the need for further research if a better understanding of the new information could improve the staff's understanding of the hazard and the resulting potential effects on plant safety.

The relevant program office will decide if the agency should issue requests for additional information, and whether to issue these generically or on a site-specific basis. The program office will also decide whether and how regulatory analysis and decisionmaking should proceed, consistent with existing regulatory processes (e.g., backfit, operability). In addition, the staff will document the results of the assessment in updates to the cumulative information records and a periodic (e.g., annual) report to be released publically. The staff will also use insights from the R2.2 activities to inform updates to regulatory guidance. Consistent with current NRC practices, the staff will engage external stakeholders at appropriate times in the process (e.g., via public meetings and public comment periods).

To support the assessment of the significance of new hazard information, the NRC staff will ensure a technical advisory committee is available. The committee will be composed of senior technical staff with expertise in relevant disciplines (e.g., seismology, hydrology, meteorology, plant operations) and will be expanded, as needed, to include other program offices and relevant personnel to address site-specific issues and ensure results are presented in a manner that supports an assessment of next steps to be considered by relevant program offices.

STATUS AND NEXT STEPS

The Commission approved the framework described in this paper in staff requirements memorandum SRM-SECY-16-0144 (USNRC, 2017). Staff is in the process of developing infrastructure to support implementation of the framework. To ensure the framework is durable and executed consistently, it will be institutionalized via NRC office instruction(s) along with any necessary additional supporting documents. The office instruction(s) will address activities associated with periodic technical engagement, information collection and management, risk-informed assessment of information, and documentation of program activities. As directed by the Commission (USNRC, 2017), staff will provide periodic updates to the Commission until all implementation activities are completed.

CONCLUSION

This paper describes a framework for ongoing assessment of natural hazards at U.S. nuclear power plants. The framework will enhance safety by ensuring NRC staff are able to (1) identify new information affecting individual sites or larger geographic regions that might otherwise go unrecognized and (2) evaluate whether the information has potential safety significance. The framework efficiently integrates with existing regulatory activities, leverages existing infrastructure and staff expertise, uses NRC's risk-informed regulatory framework, supports coordination between relevant regulatory offices, and facilitates transfer of issues to the appropriate regulatory programs. In addition, the framework provides stability and predictability by institutionalizing and clearly documenting the process in office instruction(s) and any necessary additional documents and includes an interoffice technical advisory committee.

The proposed framework relies primarily on internal NRC resources for implementation. By leveraging existing staff resources, requests for action and information from licensees will be limited to situations in which the staff has demonstrated the potential significance of new information through a deliberate and systematic assessment, including consideration of backfitting requirements and issue finality provisions. In addition, partnering with external organizations (including other Federal agencies) will increase consistency in the treatment of natural hazards and permit overall cost-savings. Deliberate engagement and periodic coordination with external organizations will allow the NRC staff to proactively seek information. In general, this deliberate external engagement enhances staff capabilities while minimizing burden on licensees. This is achieved by allowing the staff to gather and evaluate information on an ongoing basis and requiring licensees to provide information only when the responsible program office deems it necessary to make a decision on a regulatory action (e.g., a request for information under Title 10 of the Code of Federal Regulations, paragraph 50.54(f)). Thus, the proposed framework provides an alternative to requiring that licensees evaluate information at a predefined periodicity regardless of its potential significance to a site or group of sites. It is noted that licensees' regulatory responsibilities related to identifying and evaluating new information have not changed.

DISCLAIMER

Any opinions, findings and conclusions expressed in this paper are those of the authors and do not necessarily reflect the views of the United States Nuclear Regulatory Commission.

REFERENCES

NASEM. (2014). National Academies of Science, Engineering and Medicine, "Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants." Washington, DC.

USNRC. (2011). "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. ADAMS Accession No. ML111861807.

USNRC. (2012a). SECY-12-0095, "Tier 3 Program Plans And 6-Month Status Update in Response To Lessons Learned From Japan's March 11, 2011, Great Tohoku Earthquake And Subsequent Tsunami."

USNRC. (2012b). 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. ADAMS Accession No. ML12053A340.

USNRC. (2015). SECY-15-0137, "Proposed Plans for Resolving Open Fukushima Tier 2 and 3 Recommendations." ADAMS Accession No. ML15254A006.

USNRC. (2016). Staff Requirements Memorandum SECY-15-0137 – Proposed Plans for Resolving Open Fukushima Tier 2 & 3 Recommendations.

USNRC. (2016a). SECY-16-0144, "Proposed Resolution of Remaining Tier 2 And 3 Recommendations Resulting From the Fukushima Dai-Ichi Accident." ADAMS Accession No. ML16286A552.

USNRC. (2016b). SECY-16-0074, "Assessment of Fukushima Tier 2 Recommendation Related to Evaluation of Natural Hazards other than Seismic and Flooding." ADAMS Accession No. ML16102A301.

USNRC. (2017). SRM-SECY-16-0144, "Staff Requirements – Secy-16-0144 – Proposed Resolution of Remaining Tier 2 And 3 Recommendations Resulting From the Fukushima Dai-Ichi Accident."