



TEN YEAR REVIEWS OF NATURAL PHENOMENA HAZARD (NPH) ASSESSMENTS

Stephen McDuffie¹ and Quazi Hossain²

¹ Seismic Engineer, U.S. Department of Energy, Richland, WA (stephen.mcduffie@rl.doe.gov)

² Project Manager, Lawrence Livermore National Laboratory, Livermore, CA (hossain1@llnl.gov)

ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) report, *Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident* (NRC, 2011), also known as the NTF report, recommends that NRC initiate rulemaking requiring licensees to confirm seismic and flooding hazard analyses every ten years. U.S. Department of Energy (DOE) requirements for its nuclear facilities may provide useful insights for the NRC rulemaking effort. Operators of DOE-owned facilities are required to review NPH assessments every ten years and, if significant changes to data or assessment methods have occurred, make recommendations to DOE on updating the assessments. DOE-STD-1020-2012 provides guidance on performing 10-year NPH assessment reviews and deciding whether to update an assessment.

If a new NPH assessment results in a hazard increase, DOE-STD-1020 provides steps for assessing a facility's condition in light of the higher hazard. The first step is to determine whether the facility structures, systems, and components (SSCs) meet current design criteria when subjected to loads from the higher hazard. If some SSCs are found to be under-designed, then the facility operator must quantify the shortfall as compared to current design requirements. The operator must then develop an NPH mitigation plan for the under-designed SSCs. The plan shall describe how the design inadequacies will be corrected, it should consider cost versus risk-reduction of potential upgrades, and it should provide a prioritized schedule for upgrades. As DOE is the ultimate provider of facility funding, the upgrade plan is submitted to DOE for review and approval.

INTRODUCTION

Both the DOE and NRC require that nuclear facilities under their respective regulatory authorities be designed to withstand NPH such as earthquakes, floods, and high winds. NRC regulates nuclear power plants and other facilities operated by NRC license holders, whereas DOE self-regulates myriad nuclear facilities that are largely operated by private contractors for DOE. NRC's high-level NPH design requirements for power plants are contained in criterion 2, "Design bases for protection against natural phenomena," in Appendix A of 10 CFR Part 50. DOE's high-level NPH design requirements are contained in Chapter IV, "Natural Phenomena Hazards Mitigation," in Attachment 2 of DOE Order 420.1C, *Facility Safety* (DOE, 2012a).

Designing facilities to withstand NPH requires that all relevant hazards be properly analyzed. Since the 1970s NRC has issued and updated numerous regulations and guidance documents on assessing NPH. DOE has issued its own requirements, most recently in the 2012 revision of DOE-STD-1020, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities* (DOE, 2012b). Once hazards are assessed, consensus codes and agency-specific requirements dictate design of facility SSCs based on the consequences of an SSC failing to perform its safety function.

As NPH assessment techniques have improved and available data have increased over the last 40 years, NRC has periodically issued new guidance and regulations on NPH assessment, particularly seismic hazard assessment. However, NRC does not require existing power plant licensees to re-evaluate site hazards on a regular basis. In 1991, NRC did require licensees to review seismic and several other

external hazards that could impact operating reactors. This evaluation, known as the *Individual Plant Evaluation of External Events* (IPEEE) (NRC, 1991), required licensees to examine external events and identify any vulnerabilities, and report to NRC the evaluation results and any licensee-determined corrective actions. NRC did not mandate any corrective actions resulting from the IPEEE effort. NRC launched another activity in 2005, Generic Issue 199, titled *Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants* (NRC, 2005). This effort began when NRC staff discovered seismic hazards at some plants in the CEUS may have increased as a result of new geologic and seismologic information. GI-199 was still in an evaluation phase, pending new seismic hazard estimates from the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities Project, when the Great Tohoku earthquake of March 2011 occurred. Any potential GI-199 regulatory actions were superseded by actions requested by NRC (2011), specifically action 2.1 to require power reactor licensees to re-evaluate seismic and flooding hazards against current requirements, and update SSCs to protect against higher hazards, if necessary. NRC staff fulfilled NTF recommendation 2.1 by issuing the March 12, 2012 letter (NRC, 2012) to licensees requiring these and other evaluations.

The NTF report also recommends, in action 2.2, that NRC initiate rulemaking to require licensees to confirm seismic and flooding hazards every 10 years and address any new and significant information. This would also require licensees to update the design basis for SSCs important to safety, if necessary, to protect against the updated hazards. DOE has a similar, existing requirement that could be helpful to NRC staff as they implement NTF recommendation 2.2. This requirement, in Chapter IV of Attachment 2 of DOE Order 420.1C, states, “Existing facility or site NPH assessments must be reviewed at least every 10 years for any significant changes in data, criteria, and assessment methods that would warrant updating the assessments.”

DOE NPH REVIEW REQUIREMENTS

DOE published facility design criteria and NPH evaluation guidelines in the late 1980s, and the first DOE Order devoted to NPH mitigation, Order 5480.28, was issued in January 1993. Order 5480.28 contained the following requirement for existing facilities: “A review of the state-of-the-art of natural phenomena hazard assessment methodology and of site-specific information shall be conducted at least every 10 years.” Order 5480.28 has been superseded, but this requirement, with minor re-wording, was carried into DOE Order 420.1 issued in 1995, as well as the successor documents through Order 420.1C, issued in December 2012. The original rationale behind the 1993 requirement is not documented, but it is reasonable. Our understanding of natural processes, hazard assessment techniques, and availability of data continue to evolve and expand, so a periodic review of natural hazard assessments is prudent.

Order 420.1C contains only high-level requirements for NPH mitigation. The Order mandates use of DOE-STD-1020-2012, which contains requirements for analyzing NPH and criteria for designing facilities commensurate with the hazards. DOE Technical Standards do not normally contain requirements, but Standard 1020 is considered a requirements document for DOE nuclear facilities, because its use is mandated by Order 420.1C. The Standard has sections devoted to the analysis and mitigative design for seismic, wind, flood, lightning, precipitation, and volcanic hazards. Particularly relevant to this discussion is Section 9, “Evaluation and Modification of SSCs in Existing Facilities.” This section provides requirements for periodic review and update of NPH assessments and evaluating potential facility upgrades due to changes in NPH assessments. However, the requirements of Section 9 apply only to the higher hazard DOE facilities, those with SSCs classified in design category 3 or higher, per the classification scheme of ANSI/ANS-2.26-2004, *Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design* (ANS, 2004). All nuclear power plants have SSCs that, if the ANSI/ANS-2.26-2004 scheme were applied today, would be classified in design category 3 or higher.

Section 9.2 of DOE-STD-1020-2012 provides detailed requirements and guidance for the periodic review and update of NPH assessments. At a frequency not to exceed ten years, the NPH data and data collection methods, modeling techniques, and assessment methods shall be reviewed for changes

that would warrant updating the assessments. The Order 420.1C requirement to review for “significant changes in data, criteria, and assessment methods” is somewhat subjective. Section 9.2 provides guidance to assist facility operators in deciding whether changes are significant. One criterion to consider is whether the changes to data, models, or methods would shift the estimates of major inputs to hazard calculations. Even if a preliminary estimate of hazard results suggests no significant change to the results, large changes to input parameters may warrant an updated assessment to ensure it continues to have a viable technical basis. In the case of seismic hazard assessments, Section 4.1 of ANSI/ANS-2.29-2008, *Probabilistic Seismic Hazards Analysis* (ANS, 2008), contains nine high-level requirements for assessments that can guide a decision on whether an existing probabilistic seismic hazard analysis (PSHA) is suitable for continued use. Examples of these nine high-level requirements are the quality of the database used as input to the PSHA, consideration of all credible seismic sources, characterization of the ground motion, quantification of uncertainties, and level of peer review. Additional factors such as the number of facilities impacted by an NPH assessment, facility design and life-cycle stages, and facility hazards posed to the public, should also be considered in decisions on whether to update an assessment. If the NPH assessment review indicates an update is warranted, then the recommendation shall be presented to the DOE field office for approval. An updated assessment must be performed in accord with the requirements provided in the section specific to that NPH elsewhere in the Standard. If no update is warranted, the facility operator shall document the review and the basis for the decision, and provide the report to the DOE field office.

DOE FACILITY ASSESSMENT REQUIREMENTS

Section 9.3 of DOE-STD-1020-2012 outlines a process for DOE facility operators to follow if a new NPH assessment indicates an increase in hazard to one or more existing facilities. If an updated assessment results in a hazard above that considered in a facility’s safety analysis, then the facility operator shall evaluate whether the facility SSCs meet current design criteria when subjected to the higher hazard. Subject matter experts should perform this SSC evaluation by reviewing the existing SSC design documents and the new hazard assessment, and their results should be peer reviewed. If this evaluation concludes that the higher hazard will not compromise the safety function of any SSCs, the evaluation shall be provided to the DOE field office for review. As the facility owner, DOE may choose to direct additional actions or evaluations.

If the facility SSC evaluation indicates the higher hazard may compromise the safety function of one or more SSCs, then the facility operator shall develop a plan to quantitatively evaluate the performance and failure consequences of all suspect SSCs. This plan shall provide a schedule for the evaluations, considering the consequences of the potential failure of the various SSCs. The operator shall next develop a mitigation plan for those SSCs with quantified design shortcomings. The mitigation plan shall prioritize the inadequacies to be rectified, address how this will be accomplished, and justify any decisions that leave SSCs in a deficient condition. The mitigation plan shall be provided to the DOE field office for review and approval. Section 9.3 of the Standard goes on to describe situations in which a decision to not upgrade a deficient SSC may be justified.

DOE Standards must be crafted to accommodate facilities with a wide range of designs, hazards, and physical conditions. As a result, some of the wording and requirements, especially in Section 9, are not as explicit as they could be. DOE has committed to solicit input from field offices and improve the clarity of Section 9. Furthermore, DOE is in the process of writing a Handbook to supplement the Standard to provide commentary, background material, and useful examples to help DOE field offices and facility operators implement the Standard. This will include additional guidance for performing NPH 10-year reviews and assessing existing facility conditions.

The NRC likely has no need for model requirements on evaluating existing facilities against new hazards. The NRC’s March 12, 2012 letter to power reactor licensees (NRC, 2012) includes a requirement to perform near-term facility walkdowns to detect any current, degraded facility conditions. The letter also provides clear direction on steps to take if, once the reevaluated seismic hazard is

available, it exceeds a plant's current design basis. Licensees must perform a seismic probabilistic risk assessment or a seismic margin assessment, as stipulated in the letter.

CONCLUSION

In 1993, DOE established a requirement that DOE facility operators review NPH assessments every ten years and update them if necessary. This requirement is prudent, as NPH data, models, and assessment methods continue to expand and evolve. The DOE requirements and guidance for 10-year NPH reviews, contained in Section 9.2 of DOE-STD-1020-2012, may be a useful starting point for the NRC staff as they embark on a rulemaking to address NNTF Recommendation 2.2. The criteria for evaluating the suitability of an existing NPH assessment may be quite helpful to the NRC. The DOE requirements for assessing current facility conditions in light of an increased hazard may be less applicable to NRC-licensed facilities because of the different designs, hazards, and conditions posed by DOE facilities. Requirements in Section 9.3 of DOE-STD-1020-2012 allow considerable room for management judgment on whether to upgrade facility components when a hazard increases, probably more than is appropriate for nuclear power plants. Moreover, requirements in Section 9 of the Standard can benefit from improved clarity and implementation examples. DOE is currently working to provide this in an NPH Handbook to supplement the Standard.

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