Item A-41: Long-Term Seismic Program (Rev. 1)

DESCRIPTION

Historical Background

In a memorandum[1] dated June 7, 1976, NRR recommended that a study be initiated on the quantification of inherent seismic safety margins in NRR's seismic design requirements. This memo suggested the initiation of a long-term research program and outlined a long list of informational deficiencies to be addressed by this

program. This program was included in NUREG-0371.[2]

Subsequently, a User Need Request[3] was forwarded to RES detailing the NRR needs.[4] In response to this request,[5] RES established a contract with LLNL to conduct the Seismic Safety Margins Research Program (SSMRP) to start in 1978. The program plan[6] was intended to provide the methodology to determine safety margins in a nuclear power plant subjected to a large earthquake. The objectives of the SSMRP are to estimate the conservatisms (or lack of conservatisms) in the SRP[7] seismic safety requirements and to develop improved requirements. The approach to achieve these objectives is to develop probabilistic methodology that enables one to more realistically predict the behavior of nuclear power plants safety systems, components, and structures during an earthquake. The SSMRP project in its first phase was divided into two major task areas: (1) calculation of major structural and subsystem responses; and (2) development of a code to calculate accident sequence probabilities (SEISM) tied to specific radioactive release categories. The final report for the first phase is contained in NUREG/CR-2015,[8] Vol. 1. Subsequent to the completion of the first phase of the SSMRP, an NRR memo[9] was issued to RES in which a significant redirection of the SSMRP was suggested in order to more directly fit NRR needs. Recommendations[10] were developed in conjunction with a recent review of the SSMRP and the Long Range Research Plan[11] of RES, together with discussions between the RES staff and the NRR staff. In general, the recommendations were based on the view that, while NRR's user needs and

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[1] Memorandum for H. Kouts from B. Rusche, "Quantification of Inherent Safety Margins in Seismic Design (SAFER-76-5)," June 7, 1976. [8003100435]
[2] NUREG-0371, "Task Action Plans for Generic Activities (Category A)," U.S. Nuclear Regulatory Commission, November 1978.
[3] Memorandum for S. Levine from E. Case, "Quantification of Inherent Safety Margins in Seismic Design," June 16, 1977. [8103270937]
[4] Memorandum for H. Kouts from B. Rusche, "Quantification of Inherent Safety Margins in Seismic Design (SAFER-76-5)," June 7, 1976. [8003100435]
[5] Memorandum for H. Denton from S. Levine, "RES Response to NRR User Request on Quantification of Inherent Safety Margins to Seismic Design," November 1, 1978. [8003100425]
[6] Memorandum for S. Levine from H. Denton, "Seismic Safety Margins Research Program," February 23, 1979. [8003280774]
[7] NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (1st Ed.) November 1975, (2nd Ed.) March 1980, (3rd Ed.) July 1981.
[8] NUREG/CR-2015, "SSMRP Phase I Final Report," U.S. Nuclear Regulatory Commission, (Vol. 1) April 1981, (Vol. 2) July 1981, (Vol. 3) January 1983, (Vol 4) June 1982, (Vol. 5) August 1981, (Vol. 6) October 1981, (Vol. 8) September 1984, (Vol. 9) September 1981, (Vol. 10) July 1981.
[9] Memorandum for R. Minogue from H. Denton, "NRR Research Needs in Seismic Analyses Methodology," April 8, 1982. [8706040051]
[10] Memorandum for R. Minogue from H. Denton, "NRR Research Needs in Seismic Analyses Methodology," April 8, 1982. [8706040051]
[11] NUREG-0784, "Long Range Research Plan FY 1984– 1988," U.S. Nuclear Regulatory Commission, August 1982.

programmatic goals for additional and follow-on seismic analysis research were the same as for SSMRP, it was becoming clear that significant advancements in seismic analysis and confidence in estimates of seismic structural risk cannot be achieved without improved and definitive data in the following areas: seismic input, soil structure interactions, dynamic structural response, and structural fragility. These revised needs were cognizant of the potentially significant changes inherent in SECY-82-53[12] in which the magnitude of the controlling earthquake in the eastern U.S. could increase. This was based on the possible modification of the U.S. Geological Survey position on the association of the 1886 Charlestown, SC, earthquake with geologic structure and the recent earthquakes in New Brunswick, Canada. The SSMRP was scheduled to end at the close of FY 1984.

Safety Significance

Recent PRA studies[13] have indicated that the seismic risk may be a significant contributor to the total risk for nuclear power plants. Most PRAs prepared to date do not include an assessment of risk from earthquakes.

Thus, it is important that the NRC have methods to quantify and assess seismic risk to evaluate and enhance the credibility of PRAs. Also, there is a need to reexamine the traditional process of seismic analysis and design of nuclear power plants in an overall system context. This need comes principally from the widely held belief that a compounding of conservatisms occurs in the current process, i.e., at each stage of the current process,

conservatisms are introduced to account for uncertainties and these conservatisms compound from one stage to the next. However, in each stage only minimal compensations are made for the compounding of conservatisms because they are not quantified. For example, the earthquake used in the seismic design represents the maximum earthquake potential (SSE) considering the geology, seismology, and specific characteristics of the subsurface material. The earthquake motion is coupled to the bedrock and building foundation through the use of conservative soil properties to produce the highest responses (forces and stresses). Such responses are compared to conservative estimates of the strength or capacity of each structure or component.

On the other hand, there is concern that the current licensing criteria may produce seismic designs that are apparently conservative for some features, but can have adverse effects on the overall plant safety. For example, piping made stiff to resist seismic loads may cause higher thermal expansion stresses in nozzles during normal operation.

Thus, NRC has established regulations, guides, and licensing review procedures that define seismic safety criteria for nuclear power plant design. These criteria collectively constitute a seismic methodology chain (SMC). The seismic safety criteria for nuclear power plant design were developed to ensure structural integrity and functional safety of buildings, equipment, and components. They depart from the conventional earthquake engineering practice in detail and complexity. The overall SMC is considered sufficiently conservative to ensure safety. However, it is thought to be necessary to characterize the overall seismic safety and to improve it by establishing new criteria as may be required.

CONCLUSION

The NRC must be prepared to provide the basis for licensing decisions involving operating plants that are required to consider changing seismic loads and design criteria. By knowing and understanding the inherent conservatisms in the seismic design (i.e., being able to more accurately characterize the realistic behavior of structures and components under earthquake conditions), the NRC would be better able to judge the necessity and extent of modifying and requalifying structures and components in older operating plants to be reviewed for increased seismic loads or of improving design criteria for new standardized plants.

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[12] SECY-82-53, "Possible Relocation of Design Controlling Earthquakes in the Eastern U.S.," U.S. Nuclear Regulatory Commission, February 5, 1982. [8203050077]

[13] NUREG/CR-2300, "PRA Procedures Guide," U.S. Nuclear Regulatory Commission, (Vols. 1 and 2) January 1983.

The SSMRP is also tied to systems research involving PRA such as the IREP/NREP effort. The SSMRP will provide the seismic risk methodology that is currently lacking in these programs.

Reliable estimates on how much the seismic risk would change as a result of the completion of this program were not obtained because the frequencies and magnitudes of earthquakes are uncertain and the failure probabilities (i.e., fragility) cannot be inferred directly from the objectives and expected results of this program. However, because this program has a direct bearing on Item B-6 (Loads, Load Combinations, Stress Limits), which has a high priority ranking, as well as this program's relationship to PRA, plant costs, and overall plant safety, the issue was given a medium priority ranking.

However, a reevaluation of this issue by DE in October 1984 revealed that the programs covered by the issue were intended to gather and develop information; there were no plans to revise regulatory requirements upon completion of the programs. It was determined that the programs were long range ongoing activities jointly

sponsored by NRR and RES and were being adequately tracked.[14] Thus, this issue was RESOLVED and no new requirements were established.

[14] Memorandum for T. Speis from H. Denton, "Generic Issue A-41; 'Long Term Seismic Program,'" October 10, 1984. [9705200066]