NUCLEAR ENERGY INSTITUTE

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Mr. John Zwolinski
Director, Division of Licensing Project Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Zwolinski:

Industry presented a methodology for updating the NRC's seismic analysis for examining beyond design basis accidents in spent fuel pools, at an NRC public meeting, April 13, 1999, on risk informing decommissioning regulations. NRC requested a description of the methodology and requested that industry complete the analysis using the updated seismic information for all nuclear power plants. I am transmitting the industry's Seismic Methodology Description.

It is our understanding that NRC intends to prepare recommendations to the Commission by June, 18 1999, on how to risk inform decommissioning regulations. Given the short time available for providing industry's input, I am requesting that NRC review the methodology and provide comments back to NEI by May 4, 1999. Once we have received NRC's comments on the methodology we will complete the analysis for all plants in the eastern United States and for plants in the western United States to the extent practical.

I will follow up with you to see if these dates meet your needs for timely input.

Sincerely,

Lynnette Hendricks

Lynnette Hendricks

Enclosure

cc: Decommissioning Working Group

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SEISMIC METHODOLOGY DESCRIPTION

EPRI/NEI PROJECT

RISK INFORMED DECOMMISSIONING EMERGENCY PLANNING

OVERALL PROJECT OBJECTIVE

The overall objective of this project is to provide a risk-informed evaluation whether inclusion of "beyond design basis accidents", particularly a zircaloy oxidation reaction [fire] accident as the basis for Decommissioning Emergency Planning is warranted.

OVERALL PROJECT CONCLUSIONS

1. The issue was satisfactorily resolved for all plants by NUREG-1353 (1) in 1989.

2. The conclusions remain valid today, because the decommissioning state does not affect the results on which the conclusions are based.

3. There is significant improvement in the results on which the previous conclusions were based. This is because more recent work by both the regulator and the industry has reduced the calculated seismic hazard, which is the dominant contributor to the results. There are not only lower calculated values for the seismic hazard but there is closer agreement between the regulator and the industry on the values.

PURPOSE OF THIS DOCUMENT

The purpose of this document is to describe the methodology of the seismic technical analysis that will be used to achieve the results that demonstrate the above conclusions are valid. NUREG-1353 "Regulatory Analysis for the Resolution of Generic Issue 82 Beyond Design Basis Accidents in Spent Fuel Pools", dated April 1989 is considered a valid framework for the analysis. Given the NUREG-1353 framework, the Spent Fuel Pool failure frequencies due to seismic will be updated using current seismic hazard results.

NUREG-1353 ANALYTICAL RESULTS

The following table is reproduced from NUREG-1353 [1] verbatim:

Table 4.7.1
Summary of SFP Accident Frequencies

Accident Sequence	PWR Frequency		BWR Frequency	
	Best Estimate (per R-year)	Upper Bound (per R-year)	Best Estimate (per R-year)	Upper Bound (per R-year)
Structural Failures				
1. Missiles	1.0 E-8	1.0 E-7	1.0 E-8	1.0 E-7
2. Aircraft crashes	6.0 E-9	2.0 E-8	6.0 E-9	2.0 E-8
3. Heavy Load Drop	3.1 E-8	3.1 E-7	3.1 E-8	3.1 E-7
Pneumatic Seal Failures	3.0 E-8	5.0 E-7	3.0 E-8(1)	5.0 E-7(1)
Inadvertent Drainage	1.2 E-8	1.0 E-7	1.2 E-8	1.0 E-7
Loss of Cooling/Make-up	6.0 E-8(2)	1.4 E-6	6.0 E-8(2)	1.4 E-6
Total	1.5 E-7	2.4 E-6	1.5 E-7	2.4 E-6
Seismic Structural Failure	1.8 E-6		6.7 E-6	
Conditional Probability of Zircaloy Cladding Fire Given Loss of Water (High Density Storage Racks)	1.0		0.25	

Notes:
(1) BWRs do not, in general, use pneumatic refueling cavity seals, but other pneumatic seals are used in the transfer canal.
(2) Includes beyond design basis seismic induced loss of cooling and make-up.

KEY RESULTS FROM NUREG 1353

The following key results are derived from the preceding table:

1. Frequency of Fuel Pool Accident Resulting in Spent Fuel Damage = 2E-6

2. Seismic Contribution to Total Initiator Frequency:

PWR = 92%

BWR = 97%

PRELIMINARY CURRENT PROJECT RESULTS

The preliminary results of the project evaluation are that a factor of 5 to 10 reduction in the Spent Fuel Pool failure frequency is achieved when updated LLNL seismic hazard curves are used, and greater than a factor of 10 is achieved with use of updated EPRI seismic hazards. These results are shown below.

1. Seismic Structure Failure Frequencies

	PWR	BWR
NUREG-1353	1.8E-6	6.7E-6
Seismic Factor of 5 Improvement	3.6E-7	1.3E-6
Seismic Factor of 10 Improvement	1.8E-7	6.7E-7

Note that all other initiators = 1.5E-7

2. Frequency of Fuel Pool Accident Resulting in Spent Fuel Damage

NUREG-1353	2E-6
Seismic Factor of 5 Improvement	9E-7
Seismic Factor of 10 Improvement	5E-7

SEISMIC METHODOLOY

The remainder of this document describes the seismic methodology used to achieve these preliminary results, and which will be used to complete the evaluation.

BACKGROUND

The analysis is in essence a NUREG-1353 [1] analysis with the exception being that new seismic hazard curves are used to calculate spent fuel pool failure frequencies.

Table 4.7.1 of NUREG-1353 [1] summarizes the frequency of spent fuel damage resulting from accident sequences which can result in the loss of water from the spent fuel pool (SFP) either through drainage or boiling as a result of loss of cooling. As described in Reference 1, the seismic event contributes over 90% of the PWR spent fuel damage probability, and nearly 95% for the BWR. However, since publication of NUREG-1353 [1] revisions have been made to the published seismic hazard results [2] at those sites previously evaluated for SFP failure frequency. In particular, revisions to the Lawrence Livermore National Laboratory (LLNL) seismic hazard results at the 69 Eastern United States (EUS) sites were published in 1993 [3]. In addition, Electric Power Research Institute (EPRI) hazard results [4] are also available for these EUS sites. On April 13, 1999 a presentation was made to the NRC by NEI with the following conclusions:

1. Application of current seismic hazard curves to update the results of NUREG-1353 [1] is appropriate.

2. Most plants are projected to see a reduction in the SFP failure frequency by between a factor of 5 to 10 using the revised LLNL [3] results and greater than 10 using EPRI [4] data.

3. For the four plants analyzed, a SFP failure frequency on the order of 10^{-6} results when the 1993 LLNL results are applied, and on the order of 10^{-7} when the EPRI results are applied.

The purpose of the following discussion is to describe the seismic methodology which was used in the preliminary analyses and which will be used to document the above conclusions.

TASK 1

The methodology to calculate spent fuel pool failure frequency is described in NUREG/CR-5176 [5].

Key Assumptions

The assumptions described in Reference 5 were accepted and used in NUREG-1353 [1]. They are:

a. The probability of exceedance at a given acceleration level is assumed to be lognormally distributed.

b. The lognormal distribution is truncated at the 99 percentile.

c. For BWRs the SFP fragility is defined by:

The median fragility (x_{50})	= 1.4g
The random uncertainty β_R	= 0.26
The uncertainty in location β_U	= 0.39

d. For PWRs the SFP fragility is defined by:

The median fragility (x_{50})	= 2.0g
The random uncertainty β_R	= 0.28
The uncertainty in location β_U	= 0.40

e. The conditional probability of zircaloy fire give loss of SFP water will be 1.0 for PWRs and 0.25 for BWRs.

Key Approaches

The fundamental approach, taken from NUREG-1353 and NUREG/CR-5176, used in this study is:

a. Given the median and the 95th percentile the logarithmic standard deviation (β) is calculated (β = (alog(x_{95}/x_{50})/1.64)). β can also be calculated from the ratio of the log of the ratio of the 85th percentile to the median. Given β, the probability of exceedance (P_e) can then be calculated at various percentiles ($P_e = x_{50} * e^{z\beta}$).

b. A family of 11 hazard curves will be generated at each acceleration level.

These assumptions and approaches (procedure to generate the family of seismic hazard and fragility curves) will be used to calculate the SFP failure frequency at all EUS sites.

TASK 2

Electronic files containing the seismic hazard results for all 69 EUS sites from References 2, 3, and 4 are available at DE&S. These results have been previously obtained from either the NRC or LLNL. These files will be structured such that all the plants are sequenced in the same order and an integer flag will be inserted to indicate whether the plant is a PWR or a BWR.

TASK 3

The SFP failure frequency at all EUS sites will be calculated based on the methodology described in Task 1 and the data files developed in Task 2. The evaluation at all EUS sites will be performed three times. The first will be based on use of the 1989 LLNL (2) seismic hazard curves, the second evaluation will be based on use of the revised LLNL (3) seismic hazard curves, and the third evaluation will be based on use of the EPRI (4) seismic hazard curves.

TASK 4

Based on the results of Task 3, the reduction in seismically induced spent fuel pool failure due to use of the revised LLNL (3) and EPRI (4) seismic hazard results will be quantified. In addition to quantifying the reduction due to the change in the seismic hazard curves, the results for each site be carried through to the total probability of a release. The annual probability of a release due to a zircaloy cladding fire is equal to the annual probability of a SFP failure due to seismic plus the annual probability of SFP failure due to other accident sequences times the conditional probability of zircaloy fire given loss of SFP water.

Acceptance Criterion

The result of this step would allow for a direct comparison of the results of this analysis with the figure of merit (2.0×10^{-6}) presented in NUREG-1353 [1].

TASK 5

Document the results in the form of an EPRI Technical Report. The outline would be:

Introduction
Methodology

Results
Conclusions

TASK 6 - Optional

A similar analysis will be performed for west coast plants that have a site-specific seismic hazard study. Results of seismic hazard studies for Western US plants will be acquired by NEI for use in this study.

REFERENCES

1. U.S. Nuclear Regulatory Commission (USNRC), "Regulatory Analysis for the Resolution of Generic Issue 82, 'Beyond Design Basis Accidents in Spent Fuel Pools'," NUREG-1353, April 1989.

2. Lawrence Livermore National Laboratory (LLNL), "Seismic Hazard Characterization of 69 Nuclear Plant Sites East of the Rocky Mountains," NUREG/CR-5250, January 1989.

3. U.S. Nuclear Regulatory Commission (USNRC), "Revised Seismic Hazard Estimates for 69 Nuclear Plant Sites East of the Rocky Mountains," NUREG-1488, October 1993.

4. Electric Power Research Institute (EPRI), "Probabilistic Seismic Hazard Evaluation at Nuclear Plant Sites in the Central and Eastern United States: Resolution of the Charleston Issue," EPRI NP-6395-D, April 1989.

5. Lawrence Livermore National Laboratory (LLNL), "Seismic Failure and Cask Drop Analyses of the Spent Fuel Pools at Two Representative Nuclear Power Plants," NUREG/CR-5176, January 1989.