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Additional Comments Concerning Seismic Screening and Seismic Risk Of Spent Fuel Pools for Decommissioning Plants

by
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August 2000

1. Introduction

In October 1999, I wrote a brief report entitled *Comments Concerning Seismic Screening and Seismic Risk of Spent Fuel Pools for Decommissioning Plants* (Ref. 1). On August 22 and 23, 2000, I attended meetings with the NRC staff and NEI to further discuss seismic screening and seismic risk of Spent Fuel Pools for decommissioning plants. The following are my additional comments as a result of these meetings.

2. Additional Comments

Screening checklist criteria have been developed which provide reasonable confidence that any Spent Fuel Pool which pass this criteria will have a HCLPF seismic capacity of at least about 1.2g PSA where PSA is defined as the peak 5% damped spectral acceleration of the ground motion within the 2.5 to 10 Hz natural frequency range. This screening level is what I called Screening Level 2 in Ref. 1. Defining seismic risk as the inability of the Spent Fuel Pool to retain water, I presented in Table 3 of Ref. 1 my estimates of the annual frequency of seismic induced failure using both LLNL93 and EPRI89 seismic hazard curves for a Spent Fuel Pool that had a seismic capacity exactly equal to the screening level of 1.2g PSA. Table 3 of Ref. 1 is reproduced herein.

It is my understanding that the NRC staff is considering recommending that Spent Fuel Pools that pass the seismic screening check list have adequate seismic capacity to preclude the need for additional seismic review except for sites for which the seismic risk exceeds $5x10^{-6}$ based on the LLNL93 Hazard curves and a screening HCLPF capacity of 1.2g PSA. With this criteria, only Spent Fuel Pools at four Central and Eastern U.S. sites (Sites 36, 18, 25, and 8 in Table 3) plus Diablo Canyon and San Onofre would require additional seismic review if they passed the seismic screening checklist. Spent Fuel Pools at other sites will be considered to have adequately low seismic risk of not retaining water. I support this proposed staff recommendation.

However, in order to provide a better understanding of the recommended approach, I believe that it is important to clearly indicate that the seismic risk of Spent Fuel Pool failure shown in Table 3 for the LLNL93 seismic hazard tends to represent a

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"bounding" estimate of the mean seismic risk for the following two reasons.

First, the estimates of the ground motion that corresponds to a mean annual frequency of exceedance in the 10^{-5} to 10^{-7} range is highly uncertain and depends upon subjective judgements concerning a number of parameters. Both the LLNL93 and the EPRI89 hazard studies are considered to be credible seismic hazard studies. However LLNL93 tends to produce considerably higher ground motion corresponding to mean exceedance frequencies in the 10^{-5} to 10^{-7} range than does EPRI89. As a result, the mean annual seismic-induced failure probability associated with a HCLPF capacity of 1.2g PSA is a factor of 4 to 100 times higher using the LLNL93 hazard curve than obtained using the EPRI89 hazard curve (see Table 3). This large factor of difference indicates the uncertainty that exists in estimating the mean seismic risk within the 10^{-5} to 10^{-7} range. However, since both estimates are considered to be credible estimates, it is likely that the true mean seismic risk will be less than that obtained using the LLNL93 hazard curve. I recommend that the mean seismic risk associated with a HCLPF capacity of 1.2g PSA be shown for both LLNL93 and EPRI89 hazard curves with no inference as to which hazard curve is more correct. As a result, except for the four sites (Sites 36, 18, 25, and 8), the bounding mean seismic risk is in the range of 5×10^{-6} (LLNL93) to 0.6×10^{-6} (EPRI89).

Secondly, the screening level HCLPF capacity of 1.2g PSA used to estimate the seismic risk is likely to be conservatively low for many Spent Fuel Pools. If detailed fragility estimates were performed, it is likely that somewhat higher HCLPF capacities could be justified in many cases, particularly for PWR Spent Fuel Pools. For example, for the Robinson Spent Fuel Pool (PWR), Ref. 2 has estimated the plant specific fragility in terms of PGA to be:

$$C_{HCLPF} = 0.65g \text{ PGA} \qquad (1)$$
$$C_{50\%} = 2.0g \text{ PGA}$$

This estimate was obtained using the NUREG/CR-0098 response spectrum shape for which PSA/PGA = 2.12. Thus in terms of PSA:

$$C_{HCLPF} = 1.38g \text{ PSA} \qquad (2)$$
$$C_{50\%} = 4.24 \text{ PSA}$$

If this plant specific fragility had been used for Site 36, the reported seismic risk for LLNL93 would have been reduced as follows:

	Plant Specific	Generic
C_{HCLPF} PSA (g)	1.38	1.20
$C_{50\%}$ PSA (g)	4.24	3.05
$C_{10\%}$ PSA (g)	2.28	1.82
P_F	8.2×10^{-6}	13.6×10^{-6}

This 25% increase in $C_{10\%}$ results in a 40% reduction in the reported seismic-induced failure probability. This case is only one case and should not be extrapolated to other Spent Fuel Pools, but it does illustrate the bounding nature of using the generic fragility estimate for plants which pass the seismic screening checklist.

3. Concluding Statement

Except for the four Central and Eastern sites and two Western sites previously mentioned, passing the seismic screening checklist is sufficient to demonstrate that the seismic-induced risk of the Spent Fuel Pool failing to retain water is low. In fact this seismic risk is sufficiently low that the estimated mean seismic risk is driven by uncertainty in estimating the seismic hazard and cannot realistically be estimated within about a factor of 10. However, it is expected that this mean seismic risk will be less than the 5×10^{-6} to 0.5×10^{-6} range.

References

1. Kennedy, R.P., *Comments Concerning Seismic Screening and Seismic Risk of Spent Fuel Pools for Decommissioning Plants*, October 1999

2. *Seismic Failure and Cask Drop Analyses of the Spent Fuel Pools at Two Representative Nuclear Power Plants,* NUREG/CR-5167, Prepared for Nuclear Regulatory Commission, January 1989

Table 3
Seismic Risk Associated With Screening Level 2

C_{HCLPF} = 1.2g Peak Spectral Acceleration

Site Number	Annual Seismic-Induced Probability of Failure P_F (to be multiplied by 10^{-6})	
	LLNL93 Hazard	EPRI89 Hazard
36	13.6	0.14
18	8.3	1.9
25	6.6	0.57
8	5.5	0.21
43	4.5	0.12
59	4.4	*
21	4.2	*
62	4.1	*
27	2.9	0.38
49	2.8	0.27
40	2.5	0.10
16	2.5	0.14
38	2.3	0.21
63	2.2	0.06
54	2.2	0.26
19	1.8	0.17
32	1.8	0.17
28	1.7	0.04
4	1.6	*
50	1.5	0.20
44	1.5	*
20	1.5	0.55
31	1.4	0.06
39	1.4	0.14
14	1.3	0.60
13	1.3	0.33

* Not Available