Summary Updates for Decommissioning Risk Study
and Comments on NEI Review

Structural Integrity of Spent Fuel Pool Structures Subject to Heavy Loads Drops

NEI Comments: (Section 3.2.4, page 31 to 36)

NEI is correct in that there may be plants with reduced risk due to segregated cask handling pits, however, the staff study considers a plant without a segregated area.

NEI is correct in stating that if the cask handling is delayed beyond the time during which a release may occur then the risk is negligible. NEI may not be correct in pointing out the general administrative guideline for not moving fuel to a shipping cask until it has decayed 5 years. There is no known reason to believe that a decommissioning plant will not remove 10 to 20 year old fuel shortly after the core was off loaded.

NUREG-1353 results will be addressed in the revised report. Coupled with the revised statistical treatment of the data base, the revised report and the NUREG-1353 results are similar. There remains a factor of 10 (increase) between the reported best estimate value in NUREG-1353 and the revised assessment: In NUREG-1353 a drop onto the pool wall was considered with a 1-in-10 chance of significant damage resulting in a loss-of-inventory. In the revised assessment, the staff also considered a drop onto the pool floor, which from the maximum height may likely cause significant damage - hence no additional 1-in-10 credit. NUREG-1353 equivalent value would be 1.5×10^{-7} per year for 100 lifts, as compared to the revised report value of 2.4×10^{-7} per year for 100 lifts.

The revised report will point out areas were conformance with A-36 (NUREG-0612) were considered in the determination of the heavy loads assessment in both NUREG-0612 and the revised study.

New Navy data, believed to be more appropriate for the heavy loads assessment will be documented in the revised report. In addition, a new human error analysis for rigging errors has been included in the revised report.

The data base is comprised of a set of high and low estimates. There are no probability distributions associated with the data.

There is no know information available to justify the expected additional reduction of 2 to 3 orders of magnitude from improvements in Human interface.

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Summary Updates for Decommissioning Risk Study
and Comments on NEI Review

Structural Integrity of Spent Fuel Pool Structures Subject to Heavy Loads Drops (con't)

Updates: (text taken from revised draft)

The base data used in this evaluation considered a range of values comprised of a high estimate and a low estimate to represent an initiator rate or a demand rate. The method used to describe the result was based on the geometric mean of these ends points — the likelihood of being higher or lower than the geometric mean is equal, and is the median value for the range. For example, the median value for the handling system failure rate would be computed as 3.9×10^{-5} incidents per year. As a results of the uncertainties in the base data, the possibility of interdependencies of conditional failure (demand) rates, and their confidence limits, this median value was used for this evaluation.

This generic assessment of a heavy load (cask) drop which may result in significant damage to the spent fuel pool indicates that the likelihood of a loss-of-inventory from the spent fuel pool is in the range of 2.1×10^{-6} to 2.8×10^{-8} per year for 100 lifts, with a median value of 2.4×10^{-7} per year. A heavy load (cask) drop leading to the uncovery of spent fuel in a decommissioning plant's spent fuel pool appears to be a credible event, even for a plant with a single-failure proof handling system. A segregated cask transfer area, a plant specific load drop analysis confirming acceptable consequences, or a load drop limiter (for example, cask crash pads) would most likely demonstrate that the heavy loads event need not be considered as a significant contributor to the risk.

A sensitivity evaluation was performed assuming no interdependencies in the base data. ... The loss-of-inventory range remains the same, 2.1×10^{-6} to 2.8×10^{-8} per year. A mean value for a loss-of-inventory, assuming no interdependencies in the base data, was estimated to be 5.2×10^{-7} per year. The median value for a loss-of-inventory, assuming no interdependencies in the base data, was estimated to be 2.5×10^{-7} per year.

NOTES:

			Predecisional					
C_F / R_F	3 / 6		*1 / 1*		*1 / 0*		*0 / 1*	
	Mean	Median	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*
Base	5.2×10^{-7}	2.5×10^{-7}	*1.5×10^{-7}*	*5.6×10^{-8}*	*1.3×10^{-7}*	*2.6×10^{-8}*	*2.3×10^{-8}*	*1.6×10^{-8}*
C:1/10	1.7×10^{-7}	1.2×10^{-7}	*3.5×10^{-8}*	*2.2×10^{-8}*	*1.2×10^{-8}*	*2.6×10^{-9}*	*2.3×10^{-8}*	*1.6×10^{-8}*
			Predecisional					

C_F - number of drops due to crane failure
C_R - number of drops due to rigging human error
C:1/10 - Reduce random component and single component failures by factors of 10 (both high and low) and reduce load hangup and two-blocking by 1e-10 (effective omit them)

Structural Integrity of Spent Fuel Pool Structures Subject to Heavy Loads Drops (con't)

PREDECISIONAL (Back of the envelope analysis)

Point estimates of the incident rate may be calculated with the following equations for those events not observed (zero occurrence — no drops or any other reportable event) in C number of components (lifts) for T years:

$$\lambda_{95\%\ \text{confidence limit}} = 3.0/(C \times T) \text{ incidents per year}$$
$$\lambda_{50\%\ \text{confidence limit}} = 0.69/(C \times T) \text{ incidents per year}$$

For the current experience base for LWRs, $\lambda_{95\%} = 7.1\text{x}10^{-4}$ incidents per year (assuming each cask load requires two lifts). At the 50% confidence limit, $\lambda_{50\%} = 1.6\text{x}10^{-4}$ incidents per year. If the GCR data is considered and added to the LWRs data, then $\lambda_{95\%} = 2.7\text{x}10^{-4}$ incidents per year and $\lambda_{50\%} = 6.2\text{x}10^{-5}$ incidents per year. The cask handling data indicates that the incident rate range used in this assessment is reasonable, $1.5\text{x}10^{-4}$ to $1.0\text{x}10^{-5}$ compared to the $\lambda_{50\%}$ range of $1.6\text{x}10^{-4}$ to $6.2\text{x}10^{-5}$ per year.

Using new Navy data and the WIPP rigging method:

	Crane + Rigging			Crane Only			Rigging Only		
C_{lev}	High	Median	Low	High	Median	Low	High	Median	Low
95	$2.9\text{x}10^{-6}$	$2.1\text{x}10^{-7}$	$1.5\text{x}10^{-8}$	$2.8\text{x}10^{-6}$	$1.7\text{x}10^{-7}$	$1.0\text{x}10^{-8}$	$2.9\text{x}10^{-8}$	$2.1\text{x}10^{-8}$	$1.5\text{x}10^{-8}$
50	$6.9\text{x}10^{-7}$	$6.8\text{x}10^{-8}$	$6.7\text{x}10^{-9}$	$6.4\text{x}10^{-7}$	$3.9\text{x}10^{-8}$	$2.4\text{x}10^{-9}$	$5.4\text{x}10^{-8}$	$1.5\text{x}10^{-8}$	$4.4\text{x}10^{-9}$

Using the NUREG-0612 data:

	Crane + Rigging			~~Crane Only~~			~~Rigging Only~~		
C_{lev}	High	Median	Low	~~High~~	~~Median~~	~~Low~~	~~High~~	~~Median~~	~~Low~~
95	$3.3\text{x}10^{-6}$	$2.2\text{x}10^{-7}$	$1.5\text{x}10^{-8}$	~~$3.3\text{x}10^{-6}$~~	~~$9.3\text{x}10^{-7}$~~	~~$2.6\text{x}10^{-7}$~~	~~$1.9\text{x}10^{-7}$~~	~~$5.3\text{x}10^{-8}$~~	~~$1.5\text{x}10^{-8}$~~
50	$7.4\text{x}10^{-7}$	$5.1\text{x}10^{-8}$	$3.5\text{x}10^{-9}$	~~$7.4\text{x}10^{-7}$~~	~~$2.1\text{x}10^{-7}$~~	~~$5.9\text{x}10^{-8}$~~	~~$4.3\text{x}10^{-8}$~~	~~$1.2\text{x}10^{-8}$~~	~~$3.9\text{x}10^{-9}$~~

Summary Updates for Decommissioning Risk Study
and Comments on NEI Review

Structural Integrity of Spent Fuel Pool Structures Subject to Tornados and High Winds

NEI Comments: (Section 3.2.7, page 39)

NEI is correct in that the value presented was for the highest tornado region. The exceedance values are best estimate. Because of the rush to release the report, some last minute changes did not get into the draft as released, and 5.6×10^{-7} per year (exceeding an F4) is the correct value. It is appropriate to use a regionalization even if a region (state) has no sites. For example, if Oklahoma is not considered, the value drops to 5.4×10^{-7} per year.

The tornado induced failure of equipment is based on exceeding an F2 (1.5×10^{-5} per year).

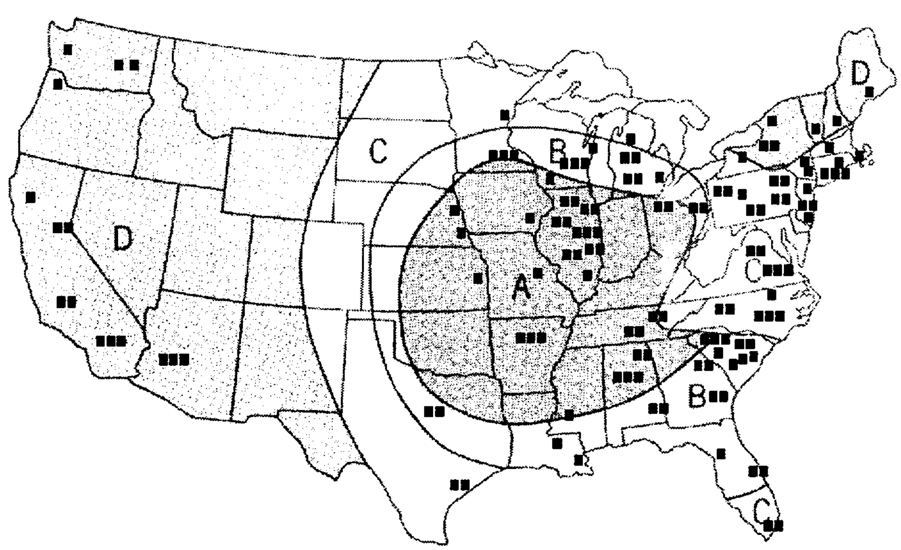
Updates:

The revised report will include the following table and figure to show the regional variations:

Table 3 - Exceedance probability for each F-scale

NUREG/CR-2944 Region	Exceedance probability (per year)					
	F0	F1	F2	F3	F4	F5
A	7.4E-05	4.4E-05	1.5E-05	3.5E-06	5.6E-07	3.1E-08
B	5.6E-05	3.3E-05	1.1E-05	2.5E-06	3.7E-07	2.1E-08
C	2.9E-05	1.5E-05	4.1E-06	8.9E-07	1.3E-07	4.7E-09
D	3.6E-06	1.6E-06	3.9E-07	8.7E-08	1.6E-08	---
USA	3.5E-05	2.0E-05	6.1E-06	1.4E-06	2.2E-07	1.0E-08

Figure 4 - Tornado risk regionalization scheme (from NUREG/CR-2944)



Summary Updates for Decommissioning Risk Study
and Comments on NEI Review

Structural Integrity of Spent Fuel Pool Structures Subject to Aircraft Crashes

NEI Comments: (Section 3.2.8, page 39)

A careful reading of the original draft shows that the range presented was for the average (2.7×10^{-9} per year) and the upper bound (4.0×10^{-8} per year). Unfortunately the rush to release the draft did not catch the use of the upper bound in the summary table. The revised report will include the lower, average and upper estimates.

Updates: (text taken from revised draft)

Significant pool damage

PWR The value for significant PWR spent fuel pool damage resulting from a direct hit was estimated based on the point target model for a 100x50 foot pool with a conditional probability of 0.32 (large aircraft penetrating 6-ft of reinforced concrete) that the crash resulted in significant damage. If 1-of-2 aircraft are large and 1-of-2 crashes result in spent fuel uncovery, then the estimated range is 4.3×10^{-8} to 9.6×10^{-12} per year. The average value was estimated to be 2.9×10^{-9} per year.

BWR The value for significant BWR spent fuel pool damage resulting from a direct hit was estimated to be the same as that for the PWR, 4.3×10^{-8} to 9.6×10^{-12} per year. The average value was estimated to be 2.9×10^{-9} per year. Mark-I and Mark-II secondary containments do not appear to offer any significant structures to reduce the likelihood of penetration, although on one side there may be a reduced likelihood due to other structures. Mark-III secondary containments may reduce the likelihood of penetration as the spent fuel pool may be considered to be protected by additional structures.

Support system availability

The value for loss of a support system (power supply, heat exchanger or makeup water supply) was estimated based on the DOE model including wing and skid area for a 400x200x30 foot area with a conditional probability of 0.01 that one of these systems is hit. The estimated value range was 1.0×10^{-6} to 1.0×10^{-10} per year. The average value was estimated to be 7.0×10^{-8} per year.

Alternatively, the value for loss of a support system (power supply, heat exchanger or makeup water supply) was estimated based on the DOE model including wing and skid area for a 10x10x10 foot structure. The estimated value range was 1.1×10^{-5} to 1.1×10^{-9} per year with the wing and skid area modeled, with the average estimated to be 7.3×10^{-7} per year. Using the point model, the estimated value range was 1.1×10^{-8} to 2.4×10^{-12} per year without the wing and skid area modeled, with the average estimated to be 7.4×10^{-10} per year.

Summary Updates for Decommissioning Risk Study
and Comments on NEI Review

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Structural Integrity of Spent Fuel Pool Structures Subject to Heavy Loads Drops (con't)

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	Mean	Median	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*
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C:1/10	1.7×10^{-7}	1.2×10^{-7}	*3.5×10^{-8}*	*2.2×10^{-8}*	*1.2×10^{-8}*	*2.6×10^{-9}*	*2.3×10^{-8}*	*1.6×10^{-8}*
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C_F - number of drops due to crane failure
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PREDECISIONAL (Back of the envelope analysis)

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Using new Navy data and the WIPP rigging method:

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C_{lev}	High	Median	Low	High	Median	Low	High	Median	Low
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Using the new Navy Data and NUREG-0612 rigging method:

	Crane + Rigging			Crane Only			Rigging Only		
C_{lev}	High	Median	Low	High	Median	Low	High	Median	Low
95	5.2×10^{-6}	3.6×10^{-7}	2.5×10^{-8}	2.8×10^{-6}	1.7×10^{-7}	1.0×10^{-8}	2.4×10^{-7}	1.8×10^{-7}	1.4×10^{-8}
50	1.2×10^{-6}	8.1×10^{-8}	5.7×10^{-9}	6.4×10^{-7}	3.9×10^{-8}	2.4×10^{-9}	5.3×10^{-7}	4.2×10^{-8}	3.9×10^{-9}

Using the NUREG-0612 data:

	Crane + Rigging			Crane Only			Rigging Only		
C_{lev}	High	Median	Low	High	Median	Low	High	Median	Low
95	3.3×10^{-6}	2.2×10^{-7}	1.5×10^{-8}	3.3×10^{-6}	9.3×10^{-7}	2.6×10^{-7}	1.9×10^{-7}	5.3×10^{-8}	1.5×10^{-8}
50	7.4×10^{-7}	5.1×10^{-8}	3.5×10^{-9}	7.4×10^{-7}	2.1×10^{-7}	5.9×10^{-8}	4.3×10^{-8}	1.2×10^{-8}	3.9×10^{-9}

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Structural Integrity of Spent Fuel Pool Structures Subject to Tornados and High Winds

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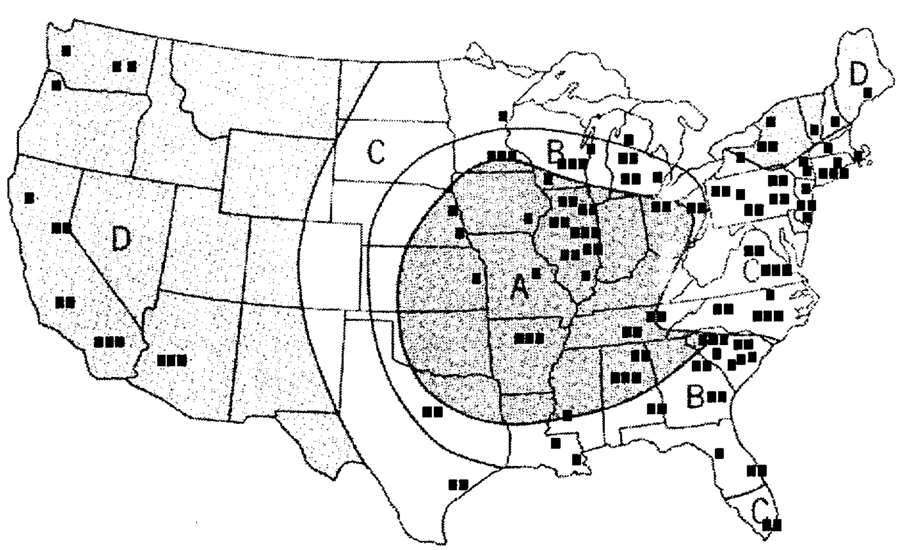
D	3.6E-06	1.6E-06	3.9E-07	8.7E-08	1.6E-08	---
USA	3.5E-05	2.0E-05	6.1E-06	1.4E-06	2.2E-07	1.0E-08

Figure 4 - Tornado risk regionalization scheme (from NUREG/CR-2944)



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