Risk Informed Decommissioning Emergency Planning

Evaluation of Spent Fuel Pool Seismic Failure Frequency

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Overview

- Review of LLNL/EPRI Seismic Hazard Studies
- Summarize NUREG/CR-4982 (BNL)
- Summarize NUREG/CR-5176 (LLNL)
- Summarize seismic section of NRC Draft Report (6/99)
- Compare Results from alternative methods

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Chronology of LLNL/EPRI Seismic Hazard Analyses

- NUREG/CR-1582 (1981)
- NUREG/CR-3756 (1984)
- EPRI PROGRAM INITIATED (1984)
- UCID-20421 (1985)
- NUREG/CR-5250 (1989)
- EPRI NP-6395-D (1989)
- NUREG-1488 (1993)

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SECY-91-102 IPEEE for Severe Accident Vulnerabilities

NRC response to question concerning use of both the LLNL and EPRI seismic hazard curves in the IPEEE.

'Based on the available information to date, the staff is unable to dispute the merit of either curve and considers both of them to be valid.'

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NUREG/CR-4982 (BNL) - Severe Accidents in Spent Fuel Pools ... July 1987

- Seismic Hazard
  - Millstone (BWR) - UCID-20421 (1985)
  - Ginna (PWR) - Synthesized
- Fragility
  - Millstone - Oyster Creek Reactor Building Used as Surrogate Median Fragility = 0.75g
  - Ginna - Zion Auxiliary Building Shear Walls Used as Surrogate Median Fragility = 1.1g

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NUREG/CR-5176 (LLNL) - Seismic Failure and Cask Drop Analyses of the Spent Fuel Pools ... January 1989

- Seismic Hazard
  - Preliminary Results Came From LLNL
  - Hazard Assumed to be Lognormally Distributed
  - Truncation of the Hazard Distribution (99%)
  - Family of 11 Hazard Curves

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NUREG/CR-5176 (LLNL) - Seismic Failure and Cask Drop Analyses of the Spent Fuel Pools ... January 1989 (continued)

- Based on Explicit Evaluation of Spent Fuel Pool Fragility

  Vermont Yankee - Median Fragility = 1.4g
  (BWR)
  Robinson - Median Fragility = 2.0g
  (PWR)

- Note - This methodology used in the draft EPRI SFP evaluation

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NRC Draft Report (6/99) - Seismic Events

- Spent fuel structures at operating nuclear power plants are inherently rugged in terms of being able to withstand loads substantially beyond those for which they were designed.
- SFP are considered robust for seismic events less than three times the SSE.
- It is assumed that the HCLPF capacity is on the order of 0.45g.

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NRC Draft Report (6/99) - Seismic Events

- Using mean LLNL (1993) seismic hazard curves, it was determined that the mean annual frequency of exceeding 0.45g is on the order of 2.0×10^{-5}.
- Using the definition of HCLPF, the working group applied a mathematical shortcut to get the frequency of a seismic event that will challenge the SFP integrity:
  - 2.0×10^{-5} per year x 0.05 = 1×10^{-6} per year.

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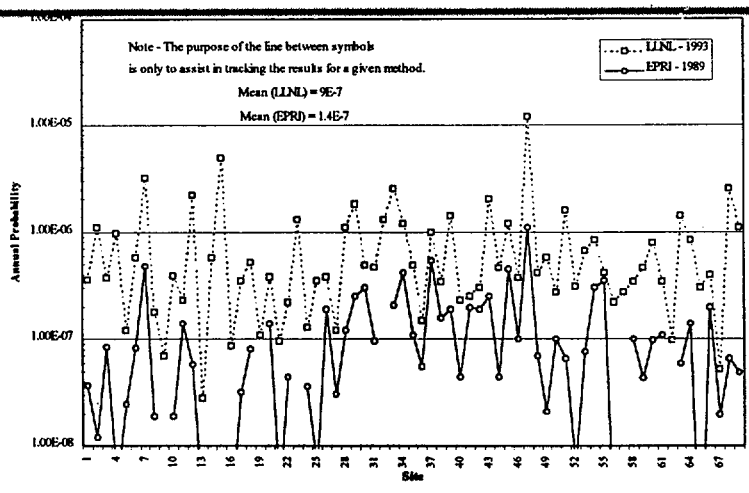
SFP Failure Probability Results - NUREG/CR-5176 Methodology



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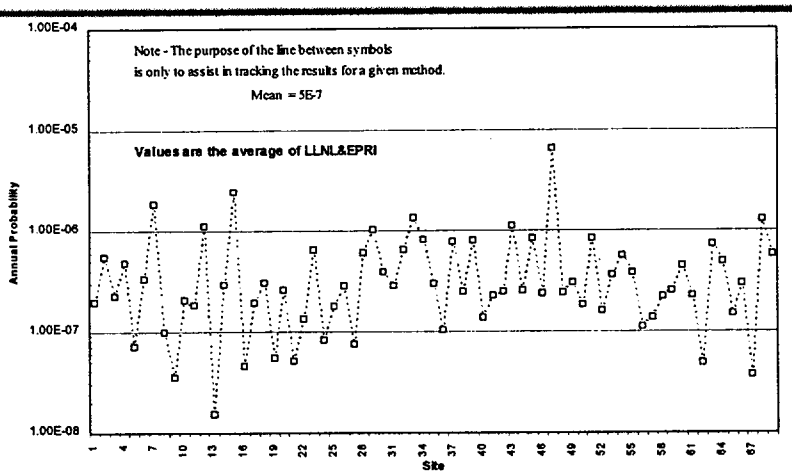
Average SFP Failure Probability Results - NUREG/CR-5176 Methodology



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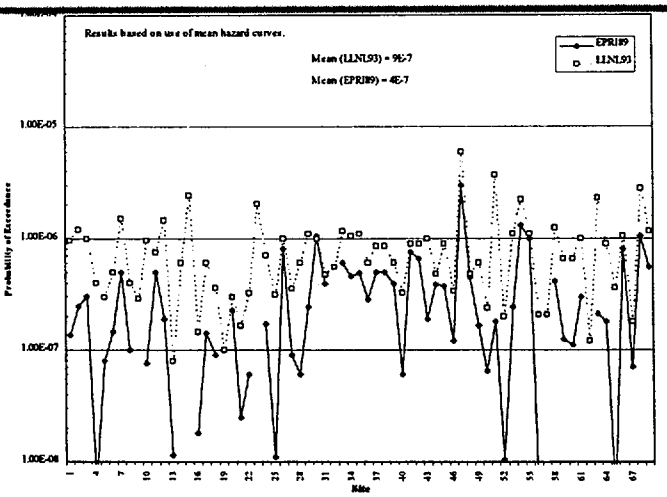
NRC HCLPF Approach - Draft Report



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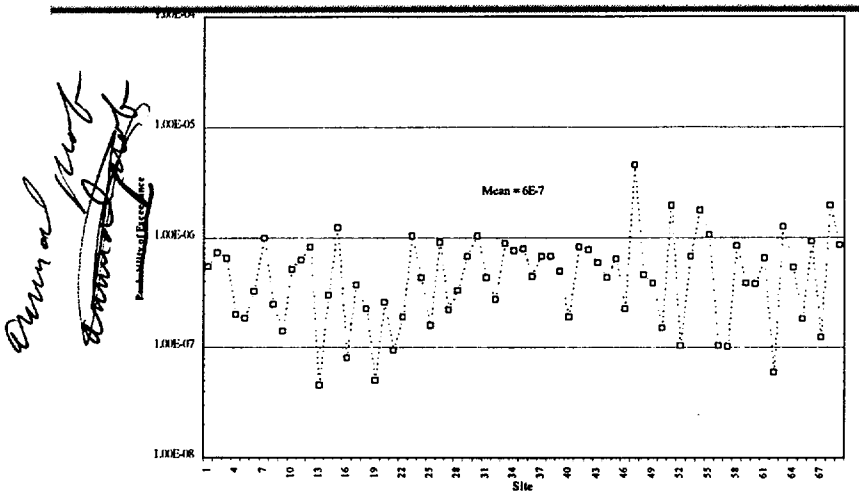
NRC HCLPF Approach - Draft Report
Average of LLNL & EPRI



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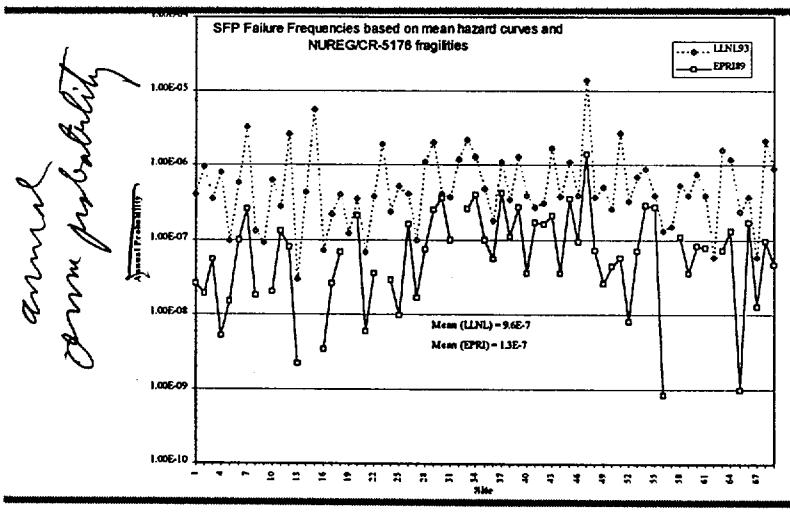
SFP Failure Frequencies Based on Mean Hazard Curves & NUREG/CR-5176 Fragilities



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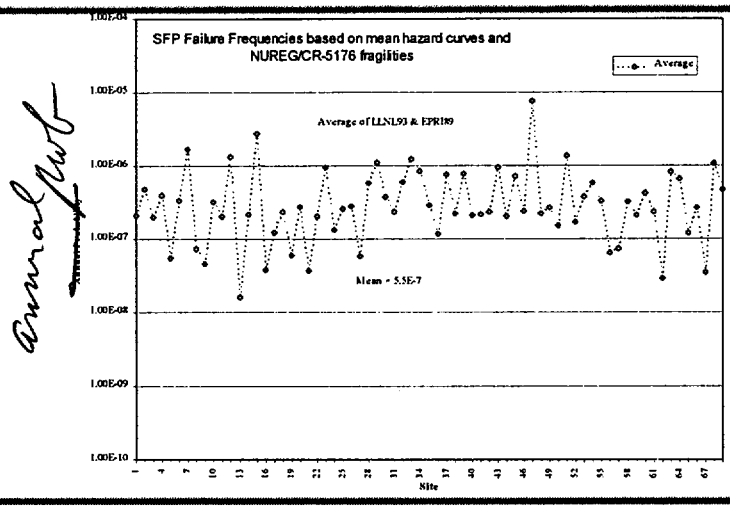
Average SFP Failure Frequencies Based on Mean Hazard Curves & NUREG/CR-5176 Fragilities



Annual Fail

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Conclusions

- Based on the NUREG/CR-5176 methodology and alternative seismic hazard inputs the mean SFP failure probability estimates for EUS NPPs are:
- LLNL89 - 6.5E-6
- LLNL93 - 9.0E-7
- EPRI - 1.4E-7
- Average (LLNL93&EPRI) = 5.0E-7
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Conclusions

- Based on the NUREG/CR-5176 fragilities and alternative **mean** seismic hazard inputs the mean SFP failure probability estimates for EUS NPPs are:
- LLNL89 - 1.1E-5
- LLNL93 - 9.6E-7
- EPRI - 1.3E-7
- Average (LLNL&EPRI) - 5.5E-7

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Conclusions

- Based on the draft NRC HCLPF approach and alternative mean seismic hazard inputs the mean SFP failure probability estimates for EUS NPPs are:
- LLNL89 - 1.2E-5
- LLNL93 - 9.0E-7
- EPRI - 3.5E-7
- Average (LLNL&EPRI) - 6.3E-7

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Conclusions

- Based on three alternative methods to estimate SFP failure frequency, it is concluded that the SFP failure frequency for the population of EUS NPPs is $< 10^{-6}$.
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