U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

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Office of Nuclear Regulatory Research

# Overview of Spent Fuel Pool Study (SFPS)

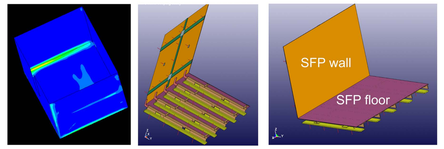
## Overview of Spent Fuel Pool Study (SFPS)

- Events at Fukushima led to questions about safety of spent fuel storage in pools during earthquakes
- Past SFP risk studies have shown that storage of spent fuel in pools or casks is safe and risk is low
- Should NRC require expedited movement of spent fuel from pools to casks?
- SFPS used state-of-the-art tools to compare accident progression and consequences of a beyond design basis earthquake on a high density and low density loaded SFP
- BWR4 Mark I was used as reference plant
- SFPS results are consistent with past studies

## Technical Approach

- Two conditions considered:
  - Representative of the current situation for the reference plant (i.e., high-density loading and a relatively full SFP)
  - Representative of expedited movement of older fuel to a dry cask storage facility (i.e., low-density loading)
- Elements of the study include
  - Seismic and structural assessments based on available information to define initial and boundary conditions
  - SCALE analysis of reactor building dose rates
  - MELCOR accident progression analysis (effectiveness of mitigation, fission product release, etc.)
  - Emergency planning assessment
  - MACCS2 offsite consequence analysis (land contamination and health effects)
  - Probabilistic considerations
  - Human reliability analysis of mitigation measures

## Seismic/Structural Results

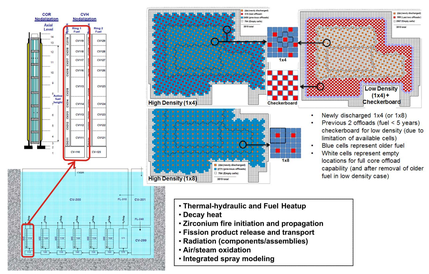



*Maximum liner strains to show location of strain concentrations*

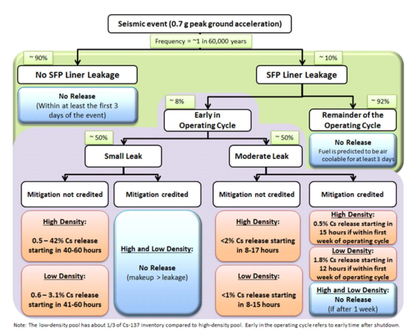
*Liner attachments*

- Considered a 1 in 60,000 year seismic event
- No liner tearing and no leaking with 90% likelihood
- Liner tearing spreading along the base of the walls with 5% likelihood (Moderate leak state)
- Liner tearing localized in parts of the liner at the base of the walls with 5% likelihood (Small leak state)
- No leakage of water below the top of the fuel was reported for 20 SFPs affected by two major recent earthquakes in Japan
  - Consistent with low likelihood of leakage estimated for this study

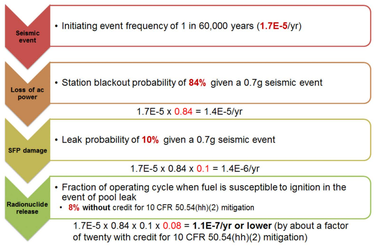
## MELCOR Model



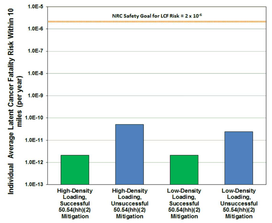

## Accident Progression Results



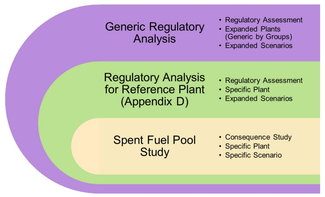

## Likelihood of Release




## Risk of Latent Cancer Fatality




## Regulatory Analysis




## SFPS Summary

- The study analyzed the potential radiological consequences of a postulated beyond-design-basis earthquake affecting the spent fuel pool for a U.S. Mark I boiling water reactor under both high-density and low-density loading conditions.
- The structural analysis shows the spent fuel pool in this study has a 90-percent probability of surviving the severe earthquake with no liner leakage (or conversely, a 10-percent probability of damaging the liner such that leakage will occur).
- In the unlikely situation that a leak occurs, spent fuel is only susceptible to a radiological release within a few months after the fuel is moved into the spent fuel pool. After that time, the spent fuel is coolable by air for at least 3 days.
- The study estimated the likelihood of release from the SFP for the seismic event studied to be about 1 time in 10 million years or lower.
- A favorable loading pattern or successful mitigation strategies significantly reduced potential releases.
- For such a radiological release, this study shows public and environmental effects are generally the same or smaller than earlier studies.
- No early fatalities were predicted for any of the scenarios studied.
- Individual latent cancer fatality risk is low for the scenarios studied because effective protective actions limit exposure.
- Implementation of protective actions may require significant land interdiction and displacement of individuals.
- Individual risks are dominated by long-term exposures to very lightly contaminated areas for which doses are small enough for the areas to be considered habitable.
- The regulatory analysis indicates that expediting movement of spent fuel from the pool does not provide a substantial safety enhancement for the reference plant.
- The insights from this analysis will inform a broader regulatory analysis of the SFPs at all U.S. operating nuclear reactors as part of Japan Lessons-learned Tier 3 plan.
- The staff continues to believe, based on this study and previous studies, that spent fuel pools provide adequate protection of public health and safety.

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