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Highlights of Report "Probabilistic Risk Assessment of Nuclear Power Plant Spent Fuel Handling and Storage Programs: Methodology and Application to the Diablo Canyon Power Plant"

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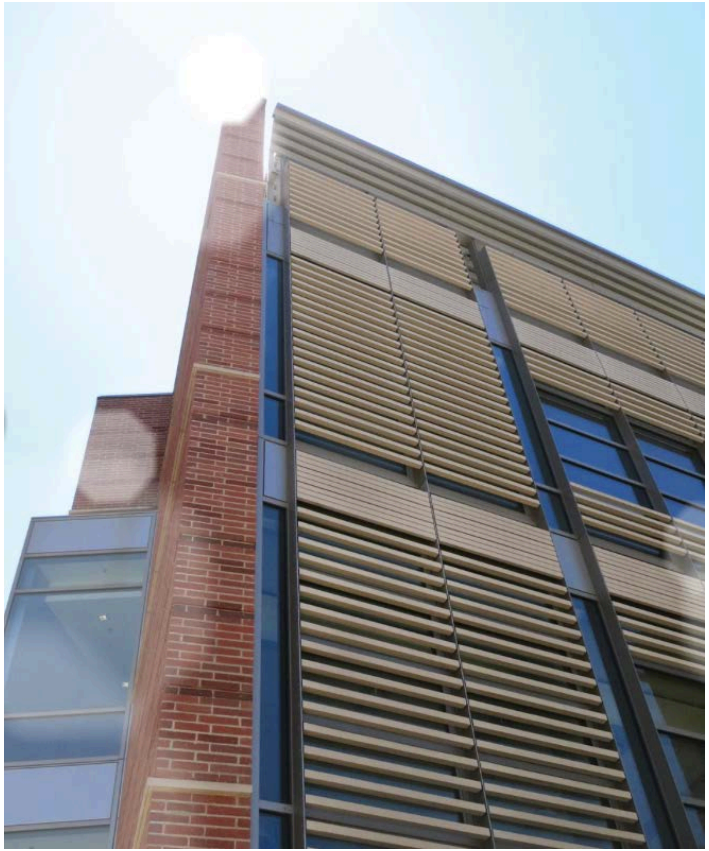

The B. John Garrick Institute for the Risk Sciences
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Statement of Task

- Develop a probabilistic risk assessment methodology for nuclear power plant onsite spent fuel handling and storage activities
- Demonstrate the methodology by assessing the risks to public health while comparing the results to the USNRC's safety goals and quantitative health objectives (QHO)
- Compare the risks of four proposed offload scenarios using a surrogate risk metric

Diablo Canyon Power Plant

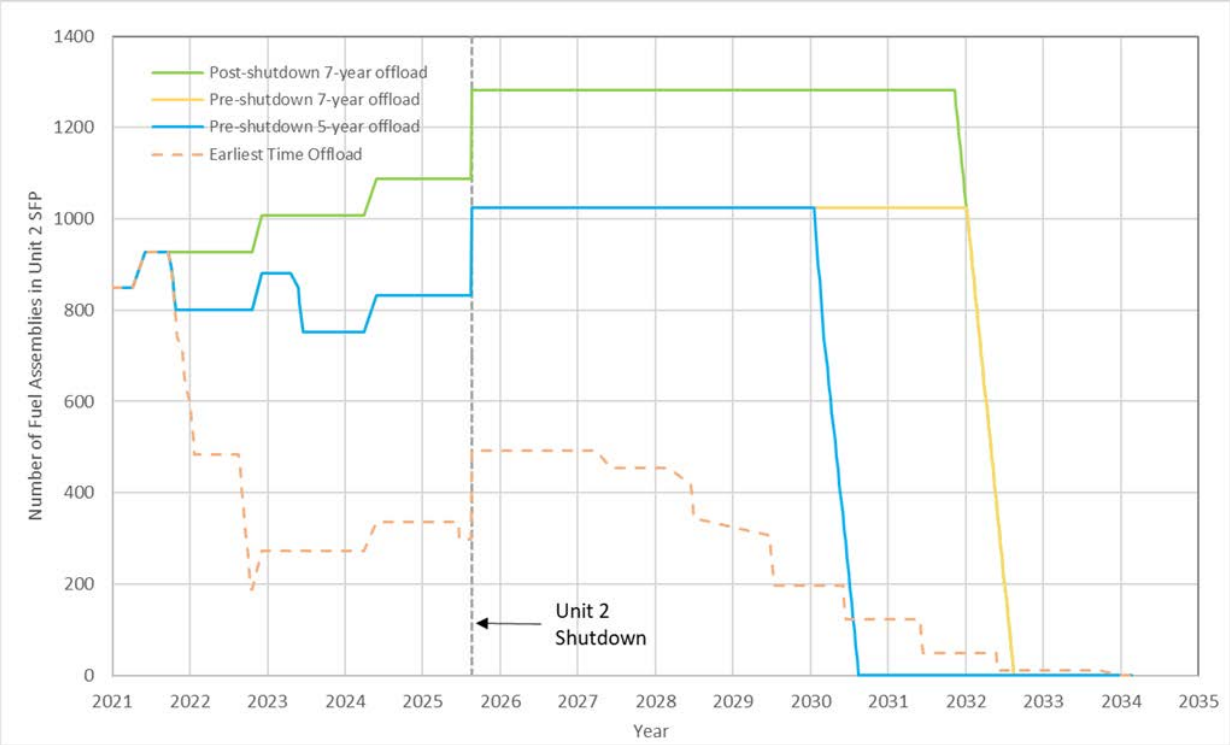
Four Offload Scenarios Considered (1/2)

1. Transfer all spent nuclear fuel (SNF) after reactor shutdown and complete in 7 years
   - Spent fuel pool (SFP) emptied August 2032
   - Transfer to dry storage completed with one campaign
   - Reduced occupational exposures
2. Transfer some SNF before and remainder after reactor shutdown and complete 7 years after reactor shutdown
   - SFP emptied August 2032
   - Reduced fuel assembly inventory prior to permanent reactor shutdown
   - Retain enough cold spent fuel assemblies (SFAs) to complete final campaign as quickly as possible

Four Offload Scenarios Considered (2/2)

3. Transfer some SNF before and remainder after reactor shutdown and complete 5 years after reactor shutdown.
   - SFP emptied August 2030
   - Reduced fuel assembly inventory prior to reactor shutdown
   - Earliest date to fully empty SFP
   - Retain enough cold SFAs to facilitate transfer campaign for last fuel cycle
4. Transfer some SNF before and remainder after reactor shutdown at the earliest times considering MPC heat generation limits and Unit 1 outages
   - SFP emptied January 2034
   - Delays time to empty due to heat load management strategy
   - Largest reduction in SFP inventory prior to permanent reactor shutdown

Figure 1. Time Dependent Number of Fuel Assemblies in the Unit 2 SFP vs Calendar Year for Four Offload Scenarios



Goal/Risk Framework/Risk Metric

Goal: Quantification of the comparative risks to public health of four offload scenarios for transferring the SNF from the SFPs to the DCPP ISFSI for dry storage

Risk Assessment Framework: What can go wrong? (accident sequences); How likely is it? (probability of frequency); What are the consequences? (accident sequence end states)

Intermediate Metric: The frequency of fuel damage at each location. This metric is used to screen out risk insignificant accident sequences.

Specialized Risk Metric: Probability of an SFP severe accident weighted by the amount of cesium that may be released due to fuel overheating and summed over all times that SNF is in the SFP. This metric accounts for the consequences based on the time-dependent amount of fuel in the SFP.

Approach/Areas of Emphasis

Approach

- Extensive reliance on typical PWR studies of spent fuel risks, especially those prepared by USNRC and EPRI (64 references)
- Use of DCPP specific procedures, design, and safety analysis information where applicable

Areas of Emphasis

- Accountability of time dependent SNF amounts stored and the effects on amount of radionuclides released in a severe accident
- Screening of low risk accidents, and quantify the risk significant sequences associated with the SFP
- Comparison of severe accident risks with USNRC's quantitative health objectives
- Assessment of comparative risks between offload scenarios, neglecting risks which are the same in each offload scenario
- Consideration of "beyond design basis" events, especially seismic events that may lead to large offsite releases capable of impacting public health
- Actual public health dose calculations were not computed; the amount of cesium released is used as a surrogate for consequence

Severe Accidents Involving the SFP

- The uncovering of water over the spent fuel stored in the pool can result in fuel overheating and the release of their radioactive fission products.
- Two general categories of fuel uncovery are 1) accidents resulting in a loss of active spent fuel pool cooling, or 2) a loss of coolant. The former would also result in a loss of coolant due to boiling.
- It was necessary to hypothesize threats beyond those considered in the design basis for licensing the spent fuel pool for there to be noticeable differences in risks between the different offload scenarios.

Risk Acceptance Guidelines

- Public health risk acceptance is based on the quantitative health objectives of the USNRC safety goals
- The DCPP spent fuel intermediate risk results are consistent with USNRC spent fuel risk studies
- A beyond design basis seismic event having the potential to uncover fuel in the spent fuel pool and enable a large cesium release was assessed to have a recurrence interval of about once every 57,000 years
- The public health risks each year of DCPP SFP operation were found to be well below the safety goal's QHOs

The Risk Ranking of the Four Offload Scenarios

- Pre-Shutdown Earliest Offload (.036)
- Pre-Shutdown 5-Year Offload (.056)
- Pre-Shutdown 7-Year Offload (.065)
- Post Shutdown 7-Year Offload (.067)

Key Takeaways (1/2)

- The public health risk of each of the offload scenarios is small and well within the quantitative health objectives of the USNRC's safety goals
- There is limited variation in the risk metrics comparing the four offload scenarios. The lowest offload scenario risk is just 46% lower than the highest
- The earliest offload scenario (#4, beige line) provides the largest reduction in risk but not substantially lower than the others
- Risk contribution from dry storage (which contains many more fuel assemblies than the SFP) is a fraction of that from the SFP, though risks at both locations are small
- Seismic capacity of the SFP is robust, even for large seismic events

Key Takeaways (2/2)

- Accident sequences initiated by seismic events much larger than the design basis represent 95% of the SFP risk
- It is unlikely that more than two reactor core equivalents of fuel assemblies (i.e., ~400 fuel assemblies) would overheat following fuel uncovery for any of the four offload scenarios
- Primary uncertainties are human performance, extent of cesium release given fuel uncovery, and the seismic capacities of the fuel handling and auxiliary buildings which enclose the SFP