Risk Assessment of the Spent Fuel Pool Island during Decommissioning

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1. Introduction

During decommissioning of a nuclear power plant, a spent fuel pool island is considered as one of the major initiatives to place the plant into "cold and dark' condition in which virtually all liquid containing systems have been drained, and electrical power to components has been removed [1].

Spent fuel pool island is an isolated, modified spent fuel pool aimed at attaining independence to safely store spent fuel during a nuclear power plant decommissioning. The spent fuel pool island is considered as a promising alternative to manage spent fuel temporarily during decommissioning of a nuclear power plant.

Modification of the existing spent fuel pool support systems for temporary storage of spent nuclear fuel is an approach that has been implemented particularly in the US. These modifications typically provide self-contained fuel pool cooling and cleanup systems as well as monitoring, controls and electrical power; effectively isolating the spent fuel pool from the remainder of the plant structures, systems and components forming a "nuclear island"[2].

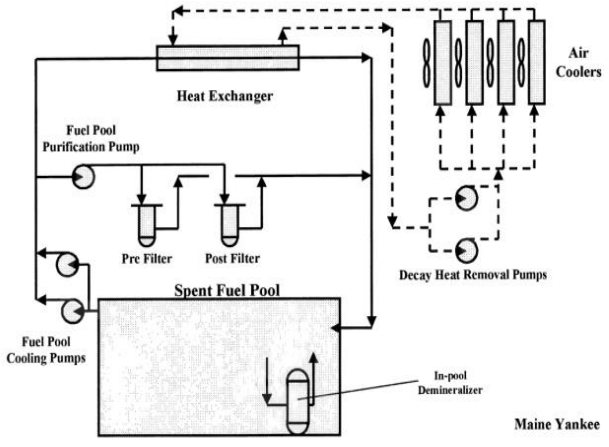

Fig. 1. SFPI schematic of Maine Yankee [2].

After cessation of operation of Kori Unit 1 in 2017, immediate fuel unloading and fuel transportation is necessary. During this period, the plant especially the spent fuel pool should be stored safely because the spent fuels are kept in the spent fuel pool. Loss of cooling in this system or incident can lead to a serious condition; therefore it is necessary to analyze risk of the spent fuel pool during decommissioning. The spent fuel assemblies are retained in the spent fuel pool and submerged in water to cool the remaining decay heat.

2. Risk Assessment

The One fuel is permanently removed from the reactor vessel, the primary public risk in an NPP decommissioning facility, is associated with the spent fuel pool. The most severe accident postulated for spent fuel pools are associated with loss of water from the pool. In this case, decay heat for the fuel clad heats up and Zirconium clad will reach the point of rapid oxidation in air [3].

Depending on the time since reactor shutdown, fuel burnup, and fuel rack configuration, there may be sufficient decays heat for the fuel clad to heat up, swell, and burst after a loss of pool water. The quantitative assessment of risk involves combining the estimated frequencies of severe accident sequences with their corresponding off-site consequences.

During risk assessment, severe accident consequences are assigned to each of the major types of event that lead to uncovery of the spent fuel, and then combined with the respective event frequencies to provide a scoping estimate of SFP risks [4].

2.1 Fuel Unrecovery

Based on the US 10 CFR Part 50 regulations, a significant loss of spent fuel pool water accident could result in fuel uncovery. These criteria are

used to qualitatively assess the resulting offsite consequences.

Fuel uncovery could result from the following initiating events including:

- Loss of offsite power from plant-centered events
- Loss of power from severe weather events
- Loss of pool cooling and loss of coolant inventory

Table 1 shows frequency of fuel uncovery per year from initiating events resulting from the spent fuel pool cooling safety analysis. This analysis was carried out by the Electric Power Research Institute (EPRI) and Lawrence Livermore National Lab (LLNL) in the US [4].

Table 1. Spent Fuel Pool Cooling Safety Analysis-Frequency of Fuel Uncovery (per year) [4]

Initiating Event	Frequency of Fuel Uncovery (EPRI)	Frequency of Fuel Uncovery (LLNL)
Seismic event	$2.0x10^{-07}$	$2.0x10^{-06}$
Cask drop	$2.0x10^{-07}$	Same
Loss of offsite power initiated by severe weather	$1.1x10^{-07}$	Same
Loss of offsite power from plant-centered and grid-related event	$2.9x10^{-08}$	Same
Internal fire	$2.3x10^{-08}$	Same
Loss of pool cooling	$1.4x10^{-08}$	Same
Loss of coolant inventory	$3.0x10^{-09}$	Same
Aircraft impact	$2.9x10^{-09}$	Same
Tornado missile	$<1.0x10^{-09}$	Same
Total	$5.8x10^{-07}$	$2.4x10^{-06}$

Initiating event frequencies for loss of cooling, loss of inventory, and loss of offsite power are based on generic data. The probability of power recovery is also based on generic information. Site-specific differences will proportionately affect the risk from these initiating events [3].

3. Conclusion

The results from the study estimated that the likelihood of a radiological release from the spent fuel pool resulting from the selected severe seismic event analyzed is on the order of one time in ten million years or lower. A spent fuel pool island can contribute to the safe storage of spent fuel if properly designed based on the spent fuel conditions, as well as the spent fuel pool size, chemistry and proposed use. Past spent fuel pool risk studies have also shown that spent fuel pool storage is safe and risk of a release due to an accident is low.

4. Acknowledgments

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5. REFERENCES

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