



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON NUCLEAR WASTE  
WASHINGTON, DC 20555 - 0001

ACNWR-0248

October 17, 2006

The Honorable Dale E. Klein  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT:    PROBABILISTIC RISK ASSESSMENT OF DRY CASK STORAGE OF SPENT  
              NUCLEAR FUEL**

Dear Chairman Klein:

During the 172<sup>nd</sup> meeting of the Advisory Committee on Nuclear Waste (Committee), July 18-20, 2006, the Committee heard two presentations on probabilistic risk assessments (PRAs) for dry cask storage of spent nuclear fuel. The presenters were the Nuclear Regulatory Commission (NRC) and the Electric Power Research Institute (EPRI).

The accident scenarios analyzed in the two studies, and the analysis methods used, differed considerably from each other. The NRC staff analysis, intended as a pilot study, was based on a specific storage cask design (Holtec Hi-STORM 100, with a welded lid design) at a specific boiling water reactor (BWR) site. The EPRI study complements the NRC study, and uses a different dry cask storage system (TN-32, with a bolted lid design) intended to store pressurized water reactor (PWR) fuel at a generic U.S. East Coast site. Both studies used documented frequencies of occurrence for the accidents studied. Neither study included risks to workers.

The dry cask storage operation is divided into three phases: handling, transfer, and storage. The NRC study identified, screened, and categorized accidental events during all three phases of dry cask storage operations.<sup>1</sup> EPRI used an event-tree approach to identify accident-initiating events.

The NRC study analyzed mechanical and thermal loads on the subject cask using finite element analysis. To predict the failure of the fuel rods and the potential release of fission products, the NRC did a dynamic study of a single rod based on the acceleration predicted from drop analysis. If the single fuel rod model indicated failure, then the NRC assumed all rods to be failed.

EPRI, on the other hand, assumed that all drop events led to the failure of two rods. The EPRI study analyzed the response of the cask and fuel rods to accidents when safety systems were systematically removed. EPRI relied on published studies to develop profiles for accidents which they used in their analyses.

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<sup>1</sup> DRAFT: A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant, June 2006, Chapter 3.

Consequences and risks to the public were calculated by the NRC staff using the MACCS2 code. The NRC study results are reported as the average risk to an individual within 10 miles (16 km) of the storage site. The EPRI study results are reported as the risk to an individual at the site boundary (about 300 meters from the location of the event).

Both studies report that no prompt fatalities are expected. The NRC study concludes that the risk of dry cask storage is very small and dominated by postulated accidents during handling operations. The estimated risk to an individual was found to be  $1.8 \times 10^{-12}$  latent cancer fatality (LCF) per cask<sup>2</sup> for the first year of storage, including loading and transfer operations, and  $3.2 \times 10^{-14}$  LCF per cask<sup>2</sup> per year during the subsequent years of storage. The risk difference between the first and the following years is due to the absence of loading and transfer operations once the cask is put on the storage pad. The EPRI study also finds the risk to an individual member of the public during the first year to be very small:  $5.6 \times 10^{-13}$  LCF per cask. Subsequent risk was estimated to be even smaller:  $1.7 \times 10^{-13}$  LCF per year per cask.

#### **Observations by the Committee:**

1. The two studies yielded similar results, in spite of the considerable differences in approaches and assumptions. Estimated individual LCF per year per cask, in both studies, are very small.
2. Although the NRC study considered the probabilities of accidents during handling, transfer, and dry cask storage operations, the analysis of possible accidents is deterministic. The EPRI study is deterministic, but does incorporate some fault-tree and parametric analyses.
3. Results are expressed as individual LCF per year per cask. These results, while useful for relative comparisons, should not be interpreted as a meaningful estimate of individual latent fatal cancers.

#### **Recommendations:**

1. The Committee recognizes that the NRC study was a pilot study. However, based on the very small calculated impacts, the Committee recommends that a more generic study is unnecessary.

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<sup>2</sup> The presentation made to the Committee on July 20, 2006, cited these values as  $2.0 \times 10^{-12}$  and  $1.9 \times 10^{-13}$ , respectively, which are still very similar to the ones now being reported.

2. If, in the future, the NRC chooses to undertake a more generic study of these potential accidents, the Committee recommends that impacts to workers be considered, uncertainty be incorporated into the analyses, and the consequences be reported as doses, not as LCFs.

Sincerely,

**/RA/**

Michael T. Ryan  
Chairman