UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APR 2 4 1989

MEMORANDUM FOR: Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

FROM: Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

SUBJECT: **RESOLUTION OF GENERIC ISSUE 82, "BEYOND DESIGN BASIS ACCIDENTS IN SPENT FUEL POOLS"**

The subject generic issue has been resolved and requires no further study. It relates to the concern that for a postulated accident sequence which results in the loss of water from a LWR spent fuel storage pool, a Zircaloy cladding fire could occur and propagate to older stored fuel. This issue was identified during hearings concerning spent fuel pool reracking amendments when licensees were starting to use high-density storage racks in the late 1970s. High-density racks are used to accommodate the storage of spent fuel in spent fuel storage pools at reactor sites until such time as the DOE repository is available and the spent fuel can be removed from the reactor sites. Maintaining a low density storage configuration for recently discharged spent fuel fuel would reduce the Zircaloy fire probability by an order of magnitude, but at a greater cost for additional on-site storage space. The issue was evaluated and assigned a MEDIUM priority classification in NUREG-0933 in 1983.

The enclosed Regulatory Impact Analysis (RIA), NUREG-1353 (Enclosure 1), is in part based on technical findings reported by the Brookhaven National Laboratory (BNL) in NUREG/CR-4982 (Enclosure 2), and NUREG/CR-5281 (Enclosure 3), and by the Lawrence Livermore National Laboratory (LLNL) in NUREG/CR-5176 (Enclosure 4). Additional consideration to more recent seismicity information from NRR (memorandum from G. Bagchi to K. Kniel, dated December 29, 1988) was also given and is discussed in the following paragraphs.

The RIA indicates that the risk from spent fuel pool accidents is dominated by the beyond design basis earthquake, which comprises 90% to 95% of the total risk. The "mean" frequency for a Zircaloy cladding fire resulting from an earthquake, for either a PWR or a BWR spent fuel pool, is estimated to be on the order of 2×10^{-6} per reactor year. (Given that a complete drainage of pool water occurs, the probability of a Zircaloy cladding fire is estimated to be 0.25 in a BWR spent fuel pool and 1.0 in a PWR spent fuel pool equipped with high density storage racks.) With a maximum potential for spent fuel damage frequency (SFDF) reduction on the order of 2×10^{-6} per reactor year, the reduction in risk is calculated to be about 480 person-rem per spent fuel pool, based on fission product release from one-third of an equivalent reactor core (the last discharge from a normal refueling cycle), over an average remaining licensed lifetime of 30 years.

The inherent safety margins in the design and construction of the spent fuel pools to withstand earthquakes were found to be large. A fragility analysis for two older spent fuel pools was performed by LLNL. The likelihood of a structural failure and loss of water from a spent fuel pool for an earthquake which is as much as three times greater than the design basis safe-shutdown earthquake (SSE) is very small.

The remaining risk, from non-seismic events, is estimated to be on the order of $2x10^{-7}$ per reactor year and is primarily attributed to consideration of heavy load drop, seal failure, inadvertent drainage or siphoning, and loss of cooling/make-up accidents. Operator diagnosis and recovery are important factors considered in the development of event frequency estimates for these scenarios. Since numerous Inspection and Enforcement Information Notices and Bulletins, and Generic Letters, have been issued to all licensees covering these non-seismic accidents sequences, portions of our evaluation are premised on licensees having taken appropriate actions in response to the concerns identified to prevent future similar occurrences, or at least understand the potential consequences of these events and develop appropriate procedures to respond to them and to mitigate the consequences.

Because most of the spent fuel pool risk is due to beyond design basis earthquakes, we acknowledge that large uncertainty exists in quantifying the risk. As shown in NUREG/CR-5176, and also noted by NRR in the December 29, 1988 memorandum from G. Bagchi (NRR/ESGB) to K. Kniel (RES/RPSIB), the uncertainty in estimating the seismic risk is about an order of magnitude, and relates to how expert judgment is used in the development of the site characterizations. In Section 6.3 of the enclosed RIA, we considered the impact of the higher seismic failure frequencies identified by NRR, a factor of 5.5 higher for the BWR spent fuel pool and a factor of 2.6 higher for the PWR spent fuel pool. At these higher seismic failure frequencies, the alternatives considered for the resolution of GI-82 are still not cost-effective. As noted in Section 5.2 of the enclosed RIA, a factor of 10 increase in the frequency of spent fuel damage would not alter the conclusions regarding cost-effectiveness. Further, the inherent safety margins in the seismic design of the spent fuel pools is also a principal factor in the decision making process.

The risks associated with a severe accident in the spent fuel pool were also compared to the objectives and guidance in the Safety Goal Policy Statement. The estimated frequency of a spent fuel pool accident, $2x10^{-6}$ per reactor year, resulting in spent fuel damage meets a target objective of a few percent of a $1x10^{-4}$ to $5x10^{-5}$ per reactor year value for overall core damage frequency. The target objective for a "large release" on the order of $1x10^{-6}$ per reactor year is marginally met, within a best estimate factor of two, but subject to interpretation since the definition of "large release" is still under development. In meeting the societal risk objective of 0.1% of the normally occurring risk to the public given the release frequency of $2x10^{-6}$ per reactor year, the latent cancer fatality rate from a spent fuel pool accident is estimated to be less than 3% of the target value for the operation of a nuclear power plant.

Based on the enclosed regulatory analysis and its supporting documentation, we conclude that no cost-effective alternatives exist which, if implemented, would result in a substantial safety improvement. Hence, Alternative Resolution No. 1 - "No Action," as recommended in the enclosed RIA, is adopted as the appropriate resolution of the generic issue in accordance with the Backfit Rule, 10 CFR Part 50.109(a)(3).

Although these studies conclude that most of the spent fuel pool risk derives from beyond design basis earthquakes, this risk is no greater than the risk from core damage accidents due to seismic events beyond the safe-shutdown earthquake. Therefore, reducing the risk from spent fuel pools due to events beyond the safe-shutdown earthquake would still leave a comparable risk due to core damage accidents. Because of the large inherent safety margins in the design and construction of the spent fuel pool, the recommendation for the approval of Alternative 1 - "No Action" is reasonable.

Resolution of this generic issue has been accomplished in accordance with the procedures contained in RES Office Letter No. 3, Revision 2, "Procedures and Guidance for the Resolution of Generic Issues," dated March 27, 1989. The ACRS has reviewed the enclosed RIA and its supporting documentation and concurs with our recommended resolution (Enclosure 5).

NUREG/CR-4982, NUREG/CR-5176 and NUREG/CR-5281 have been issued to provide a record of the technical findings on the safety significance of the subject issue, which is considered resolved. NUREG-1353 is in the process of being issued to complete the technical findings record. Generic Issue 82 will be removed from the list of active generic issues, and the section of NUREG-0933 dealing with GI-82 will be revised accordingly.

Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

Enclosures:
1. NUREG-1353, "Regulatory Analysis for the Resolution of Generic Issue 82, Beyond Design Basis Accidents in Spent Fuel Pools."

2. NUREG/CR-4982, "Severe Accidents in Spent Fuel Pools in Support of Generic Safety Issue 82."

3. NUREG/CR-5281, "Value/Impact Analyses of Accident Preventive and Mitigative Options for Spent Fuel Pools."

4. NUREG/CR-5176, "Seismic Failure and Cask Drop Analyses of the Spent Fuel Pools at Two Representative Nuclear Power Plants."

5. Letter from F. J. Remick, ACRS, to V. Stello, Jr., EDO, dated April 11, 1989, "Proposed Resolution of GI-82, Beyond Design Basis Accidents in Spent Fuel Pools."

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