Reassessment of NUREG-0612 for Spent Fuel Pool Risk-Informed Evaluation

Figure B-2 (pg B-16) provides a fault tree for load handling over spent fuel pool.
Item 2.1.1.1 is the handling system failure value of 1.0×10^{-4} [P1a] to 1.5×10^{-3} [P1b] per lift. This value was based on a nuclear power plant estimate expected to be in the 1.0×10^{-5} [P2a] to 1.5×10^{-4} [P2b] per lift range, including a factor-of-2 improvement over the Navy data evaluated (reported to be in the 2.5×10^{-5} to 3.0×10^{-4} per lift range), **AND** included an assumption that failure of the interlocks and/or failure to follow an approved load path lead to a factor-of-10 reduction in the load handling system reliability (the interlock/load path range is 2.0×10^{-3} [P3a] to 1.0×10^{-1} [P3b] per R-yr.).

The per lift range from the Savannah River study is nearly the same as the expected NUREG-0612 range, 1.5×10^{-5} to 1.5×10^{-4} for this type of load handling.

Only some fraction of the load drops will lead to significant spent fuel pool damage. In NUREG-0612 it was assumed that the only 10 percent of the critical load path is over the spent fuel. If the prescribed load path is not followed it was estimated that 2.0×10^{-3} to 1.0×10^{-1} drops would be into the spent fuel pool. Therefore the load drop is in the range 2.0×10^{-7} [P4a = P2a x P3a] to 1.5×10^{-4} [P4b = P2b x P3b] per R-yr (*applying the NUREG-0612 methods and assumptions*). If the NUREG-0612 assumption on the load handling system reliability is not considered *(for example, the load drop is not related to failure of the interlock or the load path)* then the load drop is in the range 2.0×10^{-8} [P4a'] to 1.5×10^{-5} [P4b'] per R-yr.

Figure B-3 (pg B-17) provides a fault tree for load handling over spent fuel pool for a single-failure-proof handling system.
The failure of the handling system (Item 3.2.2(A)) was evaluated to be in the range of 4.0×10^{-7} [P5a] to 1.0×10^{-4} [P5b] per R-yr (compared to the 1.0×10^{-4} to 1.5×10^{-3} per lift). The likelihood of the drop occur over spent fuel (Item 3.1.3(A)) was evaluated to be 5.0×10^{-2} [P6a] to 2.5×10^{-1} [P6b] per event (using an estimate of between 5 percent to 25 percent of the load path - 10 percent of the total path). The resulting range is 2.0×10^{-8} [P7a = P5a x P6a] to 2.5×10^{-5} [P7b = P5b x P6b] per R-yr, a reduction from the pervious case range of 2.0×10^{-7} to 1.5×10^{-4} per R-yr. The single-failure-proof handling system reduced a load drop by a factor of 10.

Therefore, for the base case (non-single-failure-proof) load handling system the likelihood of a load drop into the spent fuel pool is in the range of 2.0×10^{-7} to 1.5×10^{-4} per R-yr. For a single-failure-proof load handling system the range is reduced by about a factor of 10 (2.0×10^{-8} to 2.5×10^{-5} per R-yr). An estimate of the likelihood of substantial damage (rapid pool draining) given the drop is needed.

For the failure of the pool wall, it can be assumed that the load is over the wall 2 percent (0.02 [P8a1]) of the time (10 percent of the 5 to 25 percent) with a one-in-ten (0.1 [P8a2]) change of significant damage for a failure rate in the 2.0×10^{-7} [P9a = P1a x P8a1 x P8a2] to 3.0×10^{-6} [P9b = P1b x P8a1 x P8a2] for the non-single-failure-proof system and 8.0×10^{-10} [P10a = P5a x P8a1 x P8a2] to 2.0×10^{-7} [P10a = P5a x P8a1 x P8a2] per R-yr for the single-failure-proof system. (The NUREG/CR-4982 value was 3.7×10^{-7} per R-yr.)

Failure of the pool floor may be assumed to be about 0.1 (one-in-ten events), for a failure rate range of 2.0×10^{-8} [P11a = 0.1 x P4a] to 1.5×10^{-5} [P11b = 0.1 x P4b] per R-yr for the non-single-failure-proof

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system and $2.0x10^{-9}$ [P12a = 0.1 x P9a] to $3.0x10^{-6}$ [P12b = 0.1 x P9b] per R-yr for the single-failure-proof system.