3.4.2 Aircraft Crashes

We evaluated the likelihood of an aircraft crashing into a nuclear power plant site and seriously damaging the spent fuel pool or its support systems (details are in Appendix 2D). The generic data provided in DOE-STD-3014-96 [Ref. 6], were used to assess the likelihood of an aircraft crash into or near a decommissioning spent fuel pool. Aircraft damage can affect the structural integrity of the spent fuel pool or affect the availability of nearby support systems, such as power supplies, heat exchangers, or water makeup sources, and may also affect recovery actions. There are two approaches that can be taken to evaluate the likelihood of an aircraft crash into a structure. The first is called the point target model which uses the area (length times width) of the target to determine the likelihood that an aircraft will strike the target. The aircraft itself does not have real dimensions when using this model. In the second approach, the DOE model modifies the point target approach to account for the wing span and the skidding of the aircraft after it hits the ground by including the additional area the aircraft could cover. Further, that model takes into account the plane's glide path by introducing the height of the structure into the equation, which effectively increase the area of the target (see Appendix 2D).

Our estimate of the frequency of catastrophic PWR spent fuel pool damage (i.e., the pool is so damaged that it rapidly drains and cannot be refilled from either onsite or offsite resources) resulting from an aircraft crash is based on the point target area model for a direct hit on a 100 x 50 foot spent fuel pool. Based on studies in NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States," it was estimated that 1-of-2 aircraft are large enough to penetrate a 6-ft of reinforced concrete wall. The conditional probability of a large aircraft crash resulting in penetration of a 6-ft of reinforced concrete wall was taken as 0.32 (from NUREG/CR-5042). It was further estimated that 1-of-2 crashes result in significant damage to the spent fuel pool resulting in uncovery of the stored fuel (for example, 50% of the time the location of the damage is above the height of the stored fuel). The estimated range of catastrophic damage to the spent fuel pool, resulting in uncovery of the spent fuel, is 9.6×10^{-12} to 4.3×10^{-8} per year. The mean value is estimated to be 2.9×10^{-9} per year. The frequency of catastrophic BWR spent fuel pool damage resulting from a direct hit by a large aircraft is estimated to be the same as that for the PWR. Mark-I and Mark-II secondary containments generally do not appear to have any significant structures that might reduce the likelihood of aircraft penetration, although a crash into one of four sides of a BWR secondary containment may have a reduced likelihood of penetration due to other structures being in the way of the aircraft. Mark-III secondary containments may reduce the likelihood of penetration somewhat, as the spent fuel pool may be considered to be protected on one side by additional structures. If instead of a direct hit, the aircraft skidded into the pool or a wing clipped the pool, catastrophic damage may not occur. We estimate that skidding aircraft will be negligible contributors to the frequency of fuel uncovery resulting from catastrophic failure of the pool as the impact velocity will likely be sufficiently reduced to preclude penetration of the wall. The estimated frequencies of air craft induced catastrophic spent fuel pool failure are bounded by other initiators.

Our estimate of the frequency of significant damage to spent fuel pool support systems (e.g., power supply, heat exchanger, or makeup water supply) was developed for three different situations. The first case is based on the DOE model including the glide path and the wing and skid area for a 400 x 200 x 30 foot structure (i.e., the support systems are located inside a large building) with a conditional probability of 0.01 that one of these systems is hit (the critical system occupies a 30 x 30 x 30 foot cube within the large building). This model accounts for damage

from the aircraft including, for example, being clipped by a wing. The estimated frequency range for significant damage to the support systems is 1.0×10^{-10} to 1.0×10^{-6} per year. The mean value is estimated to be 7.0×10^{-8} per year. The second case estimates the value for the loss of a support system (power supply, heat exchanger or makeup water supply) based on the DOE model including the glide path and the wing and skid area for a 10 x 10 x 10 foot structure (i.e., the support systems are housed in a small building). The estimated frequency of support system damage ranges from 1.1×10^{-9} to 1.1×10^{-5} per year, with the mean estimated to be 7.3×10^{-7} per year. The third case uses the point model for this 10x10 structure, and the estimated value range is 2.4×10^{-12} to 1.1×10^{-8} per year, with the mean estimated to be 7.4×10^{-10} per year. Depending on the model approach (selection of the target structure size; use of the point target model or the DOE model), the mean value for an aircraft damaging a support system is in the 7×10^{-7} per year, or less, range. This is not the estimated frequency of fuel uncovery or a zirconium fire caused by damage to the support systems, since the frequency estimate does not include recovery, either onsite or offsite. As an initiator to failure of a support system leading to fuel uncovery and a zirconium fire, an aircraft crash is bounded by other more probable events. Recovery of the support system will reduce the likelihood of spent fuel uncovery.

Overall, the likelihood of significant spent fuel pool damage from aircraft crashes is bounded by other more likely catastrophic spent fuel pool failure and loss of cooling modes.