Aircraft

The working group 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 6). The generic data provided in DOE-STD-3014-96, "Accident Analysis for Aircraft Crash Into Hazardous Facilities," U.S. Department of Energy, October 1996, 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. To account for the wing span and the skidding of the aircraft after it hits the ground, the DOE model modifies the point target approach to include the additional area the aircraft could cover. Further that model includes the glide path in the evaluation by including the height of the structure which effectively increase the area of the target.

The working group's 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 a direct hit is based on the point target area model for a 100 x 50 foot pool with a conditional probability of 0.3 (large aircraft penetrating 6-ft of reinforced concrete) that the crash results in significant damage. The point target model was chosen to model a direct hit on the pool. If the aircraft skidding into the pool or a wing clipped the pool, significant damage may not occur. If 1-of-2 aircraft are large and 1-of-2 crashes result in spent fuel uncovery, then the estimated range of catastrophic damage to the spent fuel pool is 4.3x10-8 to 9.6x10-12 per year. The mean value is estimated to be 2.9x10-9 per year. The frequency of a catastrophic BWR spent fuel pool damage resulting from a direct hit is the same as that for the PWR. Mark-I and Mark-II secondary containments generally do not appear to offer any significant structures to reduce the likelihood of 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 as the spent fuel pool may be considered to be protected on one side by additional structures. These frequencies of catastrophic spent fuel pool failure are bounded by other initiators.

~~Ed, I find this paragraph unclear. Could you please expand it a little to explain which is a point model, which is a wing and skid model, why we use different models, why we use two different volumes for the estimate, note that the values given do not account for the probability of recovery, and generally please tie down the numbers so someone can read this and tell what the bottom line is. Thanks.~~

The working group's estimate of the frequency of significant damage to a spent fuel pool support systems (e.g., power supply, heat exchanger, or makeup water supply) is estimated based on the DOE model including the glide path and the wing and skid area for a 400 x 200 x 30 foot ~~area~~ structure with a conditional probability of 0.01 that one of these systems is hit. This model accounts for damage from the aircraft including, for example, being clipped by a wing. It was assumed that critical systems occupied only 1% of the total structure. The estimated frequency range for significant damage to the support systems is 1.0x10-6 to 1.0x10-10 per year. The mean value is estimated to be 7.0x10-8 per year. Alternatively, the value for the loss of a support system (power supply, heat exchanger or makeup water supply) can be estimated based on the DOE model including the glide path and the wing and skid area for a 10x10x10 foot structure. The estimated frequency of support system damage ranges from 1.1x10-5 to 1.1x10-9 per year with the wing and skid area modeled, with the mean estimated to be 7.3x10-7 per year. Using the point model for this structure, the estimated value range is 1.1x10-8 to 2.4x10-12 per year without the wing and skid area modeled, with the mean estimated to be 7.4x10-10 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 10E-7 per year, or less, range. As an initiator to failure of a support system, an aircraft crash is bounded by other more probable events.

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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.

Aircraft *(REV 2 , 12-16-99, P.M.)*

The working group 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 6). The generic data provided in DOE-STD-3014-96, "Accident Analysis for Aircraft Crash Into Hazardous Facilities," U.S. Department of Energy, October 1996, 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. To account for the wing span and the skidding of the aircraft after it hits the ground, the DOE model modifies the point target approach to include the additional area the aircraft could cover. Further that model includes the glide path in the evaluation by including the height of the structure which effectively increase the area of the target (see Appendix 6).

The working group's 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 a direct hit is based on the point target area model for a 100 x 50 foot pool with a conditional probability of 0.3 (large aircraft penetrating 6-ft of reinforced concrete) that the crash results in significant damage. The point target model was chosen to model a direct hit on the pool. If the aircraft skidded into the pool or a wing clipped the pool, significant damage may not occur. If 1-of-2 aircraft are large and 1-of-2 crashes result in spent fuel uncovery, then the estimated range of catastrophic damage to the spent fuel pool is 4.3x10-8 to 9.6x10-12 per year. The mean value is estimated to be 2.9x10-9 per year. The frequency of a catastrophic BWR spent fuel pool damage resulting from a direct hit is the same as that for the PWR. Mark-I and Mark-II secondary containments generally do not appear to offer any significant structures to reduce the likelihood of 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 as the spent fuel pool may be considered to be protected on one side by additional structures. These frequencies of catastrophic spent fuel pool failure are bounded by other initiators.

The working group's estimate of the frequency of significant damage to spent fuel pool support systems (e.g., power supply, heat exchanger, or makeup water supply) is estimated 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 (the support systems are located inside a large building) with a conditional probability of 0.01 that one of these systems is hit. This model accounts for damage from the aircraft including, for example, being clipped by a wing. It is assumed that critical systems occupied only 1% of the total structure. The estimated frequency range for significant damage to the support systems is 1.0x10-6 to 1.0x10-10 per year. The mean value is estimated to be 7.0x10-8 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 (the support system is housed in a small building). The estimated frequency of support system damage ranges from 1.1x10-5 to 1.1x10-9 per year, with the mean estimated to be 7.3x10-7 per year. The third case uses the point model for this structure, and the estimated value range is 1.1x10-8 to 2.4x10-12 per year without glide path and the wing and skid area modeled, with the mean estimated to be 7.4x10-10 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 7x10E-7 per year, or less, range. As an initiator to failure of a support system, an aircraft crash is bounded by other more probable events. Recover 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.