3.4.3 Tornadoes and High Winds

We performed a risk evaluation of tornado threats to spent fuel pools (details are in Appendix 2E). We assumed that very severe tornadoes (F4 to F5 tornadoes on the Fujita scale) would be required to cause catastrophic damage to a PWR or BWR spent fuel pool. These tornados have wind speed that result in damage characterized as devastating or incredible. We then looked at the frequency of such tornadoes occurring and the conditional probability that if such a tornado hit the site, it would seriously damage the spent fuel. To do this we examined the frequency and intensity of tornadoes in each of the continental United States using the methods described in NUREG/CR-2944 [Ref. 7]. The frequency of having an F4 to F5 tornado is estimated to be 5.6×10^{-7} per year for the central U.S., with a U.S. average value of 2.2×10^{-7} per year.

We then considered what level of damage an F4 or F5 tornado could do to a spent fuel pool. Based on the buildings housing the spent fuel pools and the thickness of the spent fuel pools themselves, the conditional probability of catastrophic failure given a tornado missile is very low. Hence, the overall frequency of catastrophic pool failure caused by a tornado is extremely low (i.e., the calculated frequency of such an event is less than 1×10^{-9} per year).

We assumed that an F2 to F5 tornado would be required if significant damage were to occur to spent fuel pool support systems (e.g., power supply, cooling pumps, heat exchanger, or makeup water supply). These tornados have wind speed that result in damage characterized as significant, severe or worse. The frequency of having an F2 to F5 tornado is estimated to be 1.5×10^{-5} per year for the central U.S., with a U.S. average value of 6.1×10^{-6} per year. 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, a tornado is bounded by other more probable events. Recovery of the support system will reduce the likelihood of spent fuel uncovery.

Missiles generated by high winds (for example, straight winds or hurricanes) are not as powerful as those that are generated by tornados. Therefore high winds are estimated to have a neglible impact on the catastrophic failure of the spent fuel pool resulting in fuel uncovery. Buildings and structures for sites where high winds are anticipated are expected to be designed and built to comply with the guidelines in SRP 2.3.1, "Regional Climatology," and ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," American National Standards Institute (1972), or American Society of Civil Engineers ASCE 7-95 guidelines, "Minimum Design Loads for Buildings and Other Structures," 1995, or other local building codes which embody similar requirements. The ASCE 7-95 wind design criteria is based on an exceedance probability of 2.0×10^{-2} per year and the wind-force resisting system of structures should not collapse under design loads. Wind or water damage may occur within the structure as a result of a breach. Based on DOE-STD-1020-94, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," January 1996, there are no missile criteria associated with this exceedance probability. For wind speeds with exceedance probabilities of less than 1.0×10^{-3} per year, the design missile is a 2x4-in timber plank weighing 15-lb with a horizontal velocity of 50 mph with a maximum height of 30-ft. Without specific design details it is not possible to determine the probability of high winds resulting in the loss of a spent fuel pool support systems (e.g., power supply, cooling pumps, heat exchanger, or makeup water supply). It appears that a reasonable, conservative value would be on the order

of 1.0×10^{-3} per year. 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, high winds are bounded by other more probable events. Recovery of the support system will reduce the likelihood of spent fuel uncovery.