NRC Staff Feedback on DOE Aircraft Hazard Analyses

Note: In this attachment, "Frequency Analysis Report" is U.S. Department of Energy (DOE) report, "Frequency Analysis of Aircraft Hazards for License Application," (DOE Document 000-00C-WHS0-00200-000-00C, May, 2005); "Technical Exchange" is the June 1, 2005, Technical Exchange between DOE and U.S. Nuclear Regulatory Commission (NRC); and "USAF Mishap Reports" are mishap reports issued by the Air Force Safety Center, Kirkland Air Force Base, N.M.

1. **Implementation of No-fly Zone and Monitored-Fly Zone:** As currently written in Section 5.1.1 of the Frequency Analysis Report, a no-fly zone and a monitored-fly zone will surround the North Portal in order to reduce the likelihood of onsite aircraft crashes. At the Technical Exchange, DOE informed NRC that a memorandum of understanding (MOU) between DOE and the U.S. Air Force would be generated to establish the no-fly zone and the monitored-fly zone.

   If DOE intends to rely on this MOU in its license application (LA), it should provide the MOU to the NRC and describe its plans for implementing such zones as part of the LA.

2. **Pilot Actions Outside of No-Fly Zone:** As currently assumed in Section 5.3.8 of the Frequency Analysis Report, aircraft malfunctions occurring outside the no-fly zone will not lead to intrusions inside the no-fly zone. The apparent basis for this assumption is that pilots are assumed with 100% reliability to attempt landing at recovery airfields at Indian Spring and Tonopah during mishaps, thus staying clear of the no-fly zone boundaries. Historical data does not appear to support such a high degree of reliability.

   If DOE intends to rely on this 100% reliability assumption in its LA, it should justify the assumption. Alternatively, DOE should use available historic data to provide an estimate of the likelihood of an aircraft having a mishap outside the no-fly zone, entering the no-fly zone, and crashing onto the surface structures associated with the monitored geological repository at Yucca Mountain. DOE should also provide the basis for this estimate.

3. **Crash Frequency Analysis Methodology Using Solomon's Model:** As currently described in Section 6.2.4.2 of the Frequency Analysis Report, the crash frequency analysis methodology of NUREG-0800 is modified by using the Solomon's model. Specifically, a parameter "1/γ" is used in the formula for the crash density beyond the edge of an airway. This parameter is defined as the mean distance of a crash, in a direction normal to the intended flight path. Specific values of γ are attributed to different aircraft types, independent of flight altitude. For a given aircraft type, it is reasonable to expect that the mean crash distance could vary with flight altitude. Lower altitude flights could be expected to have a smaller mean crash distance than flights at higher altitudes.

   If DOE intends to rely on the Solomon's Model in its LA, it should provide the basis for the values of γ used in the crash frequency analysis. Alternatively, a sensitivity analysis on the effects of flight altitude may sufficiently address this issue.

4. **Use of United States Air force (USAF) Mishap Reports:** Table III-1 of the Frequency Analysis Report provides crash data corresponding to 51 F-16 crashes from Fiscal Year (FY) 1989 through FY 1998. Based on the USAF Mishap Reports, a total of 142 Class A mishaps (i.e., mishaps in which the resulting total cost of property damage, injury, and illness is $1,000,000 or greater; or an Air Force aircraft is destroyed; or a fatality occurs) occurred during this same time period. In these 142 mishaps, 139 aircraft were destroyed (i.e., it was uneconomical to repair the aircraft).

   If DOE intends to rely on USAF Mishap Reports in its LA, it should provide the basis for not including available crash data for these additional mishaps. Otherwise, DOE should consider these additional mishaps.

5. **Categorizing USAF Mishap Reports:** As currently described in Section 5.3.9 of the Frequency Analysis Report, aircraft mishaps are subjectively classified as Type 0 (not applicable to Yucca Mountain facilities), Type 1 (applicable with pilot has control of the aircraft), or Type 2 (pilot does not have control of the aircraft), on the basis of descriptive statements given in each mishap report or summary. The sensitivity of potential misclassifications of mishaps on the estimated glide ranges was not determined.

   If DOE intends to rely on USAF Mishap Reports in its LA, it should provide a sensitivity analysis of the effects of categorizing mishaps on estimated glide ranges. If such an analysis indicates that the estimated glide ranges are sensitive to the categorization process, DOE should consider additional confirmatory analyses to estimate glide ranges and provide sufficient technical basis for classifying a specific mishap as a particular mishap type.

6. **USAF Mishap Reports (unknown causes of mishaps):** In section 5.3.9 of the Frequency Analysis Report, DOE assumes (except for one instance) that if the cause of a mishap is listed as unknown in the USAF mishap report, the mishap is Type 0 (i.e., not applicable to Yucca Mountain facilities).

   If DOE intends to rely on USAF Mishaps Reports in its LA, it should provide the basis for this assumption.

7. **USAF Mishap Reports (mismatch of data):** In Table III-1 of the Frequency Analysis Report, altitude information for several mishaps does not match the information in the corresponding USAF mishap reports. There is at least one case (October 25, 1994 mishap, PFS Exhibit 174) where the ejection-to-ground-impact distance described in Table III-1 differs from what is reported in the accident summary report.

   If DOE intends to rely on USAF Mishap Reports in its LA, it should explain or provide the basis for these apparent discrepancies.

8. **Jettisoned Ordnance:** The Frequency Analysis Report does not include the effects or likelihood of jettisoned ordnance in the assessment of aircraft mishaps posing a potential hazard to the proposed repository.

   In its LA DOE should either provide the basis for not including an analysis of jettisoned ordnance or include an analysis of jettisoned ordnance.

9. **Cruise Missile Testing at Nevada Test Site:** The Frequency Analysis Report does not include the effects of cruise missile testing in the assessment of aircraft mishaps posing a potential hazard to the repository. At the Technical Exchange, DOE indicated that the cruise missile tests are infrequent, conducted a long distance from the repository site, and closely controlled by the USAF.

   In its LA, DOE should either provide a quantitative basis for not including an analysis of cruise missile testing or include an analysis of cruise missile testing.

10. **Birdstrikes:** In section 5.3.9 of the Frequency Analysis Report, DOE states that birdstrikes are not applicable because they are unlikely at high altitudes. At the Technical Exchange, DOE indicated that the basis for this assumption is USAF data and that bird strikes contribute about 0.35% to the mishap rate.

    In its LA, DOE should either provide a specific reference or present data that would support this estimate or provide an analysis of the effects of birdstrikes.

11. **Utilization Factor - Aging Pads:** In section 5.3.10 of the Frequency Analysis Report, DOE proposes to use a utilization factor of 0.87 to reduce the effective target area.

    If DOE intends to rely on a utilization factor in its LA, it should explain how its proposed utilization factor meets the requirements of 10 CFR 63.21(c)(5) - "For the purposes of this analysis, it is assumed that operations at the geologic repository operations area will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application."

12. **Structural Credit - Analysis Methodology:** In sections 5.1.5 and 5.1.6 of the Frequency Analysis Report, DOE credits the structural robustness of the surface facility wall structures and aging pad barriers to reduce the probability of release for potential aircraft impacts. At the Technical exchange, DOE indicated that it plans to use the energy balance method, instead of the time history analysis method, of DOE Standard DOE-STD-3014-96, to analyze the structural robustness of walls and other engineered barriers to aircraft impact. These engineered barriers may support important to safety SSCs in the vicinity of an aircraft impact. It is not clear, however, that overall dynamic characteristics of these engineered barriers can be adequately represented by a single-degree-of-freedom (SDOF) nonlinear energy-absorbing system.

    If DOE intends to take credit for the structural robustness of engineered barriers, it should justify the suitability of the energy balance method for analyzing the global response of the engineered barriers. In addition, DOE should consider the following items which may be related to the structural evaluation of engineered barriers: (1) the comprehensive dynamic characteristics of the SSCs that could be more complex than SDOF nonlinear energy-absorbing systems; (2) potential vibration effects of aircraft impact on the SSCs; (3) adequate representation of appropriate impacting aircraft shapes in a global structural evaluation; and (4) evaluation of the SSCs under aircraft impact with various aircraft types with associated impact speeds.

13. **Structural Credit - Transportation Casks:** In Section 5.2.4 of the Frequency Analysis Report, DOE assumes that transportation casks (with impact limiters) will not breach as a result of an accidental aircraft crash. DOE's rationale is that such casks provide adequate protection against aircraft crash solely because they are licensed for transportation.

In its LA, DOE should either provide a technical basis for its assumption or present a structural evaluation of transportation casks situated at the repository.