NRC STAFF FEEDBACK ON DOE AIRCRAFT HAZARD ANALYSES

Note: In this enclosure, "FAR" is U.S. Department of Energy (DOE) report, "Frequency Analysis of Aircraft Hazards for License Application" (DOE Document 000-00C-WHS0-00200-000-00E, October, 2006); "IR" is DOE report, "Identification of Aircraft Hazards" (DOE Document 000-30R-WHS0-00100-007, October 2006); "TE" is the November 7, 2006 Technical Exchange between DOE and U.S. Nuclear Regulatory Commission (NRC); "USAF mishap report" is a mishap report issued by the Air Force Safety Center, Kirkland Air Force Base, N.M.; and "LA" is the license application that DOE may submit for the proposed repository at Yucca Mountain, Nevada.

1. Implementation of Restricted Fly Zones: At the TE, DOE clarified its plans for implementation of restricted fly zones. Establishment and enforcement of flight restricted zones are key aspects of DOE's strategy to "screen out" aircraft crash hazards.

If DOE relies on restricted fly zones in its LA, the LA should provide sufficiently detailed information to assure that such zones have been (or can be) established and can be enforced, including information on agreements and coordination with affected parties.

2. Pilot Actions: In section 3.3.9 of the FAR, DOE notes that, "The pilot is assumed to eject immediately after the engine failure or the cause of the in-flight emergency that leads to a crash." DOE asserts, without explanation or basis, that this assumption is conservative. DOE uses this assumption in estimating crash frequencies in sections 7.2 and 7.3 of the FAR.

If DOE relies on this assumption in its LA, DOE should demonstrate that the assumption, and the assertion that the assumption is conservative, are valid. NRC staff believes that the assumption is not realistic and may not be conservative. In particular, for certain engine failure mishaps, pilots may glide while trying to restart the engine. These engine failure events may constitute a significant fraction of events with longer distances from mishap initiation to crash point than from pilot ejection to crash point. Therefore, the use of the cumulative distribution function in Figure 5 and the data in Table III-1 of the FAR may not be appropriate in crash frequency calculations.

3. Effectiveness of a Flight-Restricted Airspace: In sections 7.2 and 7.3 of the FAR, DOE develops a new methodology for estimating frequencies of aircraft crashes into surface facilities.

The technical basis for DOE's starting equation 3 appears to be flawed because, among other issues, it does not consider the aircraft glide distance as a variable distinct from the variable 'r' for the aircraft mishap location. In addition, DOE assumes that the location of ejection points and the directions of travel after ejection are uniformly distributed throughout the flight area. This latter assumption may not be valid for those flights that intend to fly over a flight-restricted airspace, but suffer a crash-initiating event enroute to the flight-restricted airspace. Furthermore, DOE's methodology is based on the assumption, discussed in item 2 of this enclosure, that the pilot would eject immediately after the mishap initiation. DOE's methodology also uses the limited glide ratio data in Table III-1 of the FAR to estimate the fraction, p_c, of those crash initiating events during overflight of the flight-restricted airspace that pose a risk to repository surface facilities.

In view of these comments about DOE's methodology, DOE should address the following:

a. Examine the validity of equation 6 of the FAR, to account for the mishaps occurring outside of a flight-restricted airspace. This might increase the estimated frequency of aircraft crash on the surface facilities.

b. Examine the section 7.3.3 methodology to account for crashes of flights enroute to the flight-restricted airspace outside the of the flight-restricted airspace. Equation 10 of the FAR, based on the NUREG-0800 approach, represents a possible alternative method to estimate crash frequency for this case. This would increase the frequency of aircraft crash on the surface facilities.

4. **Future Flight Activities:** The FAR does not provide a clear or logical basis for the assumptions and factors considered in assessing future flight activities. For example:

(a) In section 3.3.4 of the FAR, DOE analyzes two weeks of aircraft counts on the Beatty Corridor. DOE asserts that the two weeks of data can reasonably be extrapolated to estimate an annual count. DOE needs to provide justification for this extrapolation.

(b) In section 3.3.4 of the FAR, DOE notes that landings at McCarran International Airport increased by about 25 percent from 1996 to 2004 (about a 2.5 percent increase compounded per year), but that the landings increased about 13 percent from 2002 to 2004 (about a 6.3 percent increase compounded per year). DOE then uses the 2.5 percent growth factor to predict landings for the next 65 years. If DOE uses the 2.5 percent growth factor (instead of a 6.3 percent growth factor) in its LA, it should justify the lower growth factor.

(c) In section 3.3.8 of the FAR, DOE assumes that a uniform crash-frequency density applies to military flight activities in the Nevada Test and Training Range, the Nevada Test Site, and the Military Operations Area surrounding the flight-restricted airspace in all directions, except in the Southwest quadrant (which is omitted because it is almost entirely within the Beatty corridor). This uniform crash-frequency density is apparently based solely on historical crash data. If DOE intends to use this density in its LA, it should justify why the density has not been corrected to account for future growth of Nellis Air Force Base or for future aircraft designs.

5. **Solomon model**: In section 7.2.4 of the FAR, DOE considers two models (NUREG-0800 and the Solomon Model) to estimate crash frequencies for flights in the Beatty Corridor. DOE concludes, without explanation, that "the edge adjustment of the NUREG-0800 model is too conservative [. . .] The [Solomon] model has a much more pronounced edge effect and appears more reasonable."

If DOE uses the Solomon Model in its LA, it needs a clear technical justification for the use of that model for the Yucca Mountain project, including the parameters it uses in that model.

6. **Sensitivity Analysis:** In Attachment VI of the FAR, DOE presents sensitivity calculations of some of the parameters in its analyses. DOE should provide the basis or criteria for how these parameters were selected for consideration in the sensitivity analyses. DOE should expand these sensitivity calculations to include all significant parameters in the analyses. For quantities estimated with empirical data, DOE needs to account for the uncertainty in the quantities.

7. **Previous issues:** In previous correspondence, NRC staff provided feedback on: (a) DOE's omission of some US Air Force (USAF) Mishap Reports; (b) DOE's categorization of the mishap reports; (c) apparent discrepancies between DOE's analysis of information in the mishap reports and the conclusions of the mishap reports; (d) DOE's omission of jettisoned ordnance and cruise missile testing in its analyses; (e) DOE's screening out of birdstrikes as credible initiating events; (f) DOE's use of a utilization factor for the aging pads; (g) duration of emplacement activities to 50 years or less; and (h) DOE's analysis of the structural robustness of engineered barriers and transportation casks. DOE has addressed these issues in either the FAR or the IR. NRC staff has no further comments on these issues at this time. Note NRC staff will continue to evaluate aircraft hazards and make a final determination on these issues, if they are still relevant to licensing, during the review of the LA.