REQUEST FOR ADDITIONAL INFORMATION (RAI)
Volume 3—Postclosure Chapter 2.2.1.3.2 (Mechanical Disruption of Engineered Barriers)
4th Set (RAIs 1 through 3)
(DEPARTMENT OF ENERGY'S SAFETY ANALYSIS REPORT SECTION 2.3.4)

The information is needed to verify compliance with 10 CFR 63.114(a).

Subject: Seismically induced rockfall.

RAI #1
Explain how the cumulative effects of thermal stress and initial seismic events are considered in analyses of the extent of rockfall from multiple seismic events and affect repository performance.

Basis: In addition to forming a small amount of rockfall, DOE analyses show that a 10^{-4} seismic event creates block interfaces that have failed in shear or tension (e.g., BSC, 2004, figure 6-120). Based on the DOE UDEC-Voronoi model calibration, such block failures should reduce the strength of the rock mass. However, an analysis of multiple 10^{-4} seismic events in a heated drift (BSC, 2004, figure S-49) shows the same amount of rockfall as occurs in a single 10^{-4} seismic event in a heated drift (BSC, 2004, figure S-47). DOE has not explained how the apparent weakening in rock strength from an initial seismic event, especially in the area close to the drift opening (e.g., BSC, 2004, figure 6-120), stabilizes the rock mass such that no additional rockfall occurs during a subsequent seismic event. This result also does not appear consistent with caving relationships in BSC (2004, Figure 6-149), which show that caving potential increases as the hydraulic radius of the opening increases.

Reference
BSC, 2004. Drift degradation AMR

RAI #2
Demonstrate that the dimensions of the tessellated domain in the UDEC-Voronoi model do not affect significantly the calculations of rockfall volume from seismic events.

Basis: The upper boundary of the tessellated domain in UDEC-Voronoi model is set 10.25 m above the initial drift roof (BSC, 2004, Figure 6-116). However, contours of block displacement magnitude intersect the upper boundary of the tessellated domain, indicating that some additional displacement occurs outside this domain (e.g., BSC, 2004, Figure 6-176). Also, plots of the final position of the Voronoi blocks after an analysis (e.g., BSC, 2004; Figures P-17, P-18, and P-24) indicate blocks at the top of the model could be predicted to separate from the overlying elastic domain, which would suggest the caved zone might have extended higher if the model upper boundary had been higher. DOE does not provide a technical basis for the selecting the dimensions of the tessellated domain, and does not provide sensitivity analyses in BSC (2004, section 6.4.2.1) to demonstrate that uncertainty in the dimensions of the tessellated domain do not affect significantly the calculations of rockfall volume during seismic events.

RAI #3
Demonstrate that appropriate variations in block size and shape have been considered in UDEC-Voronoi analyses of rockfall during seismic events in the Topopah Spring lower lithophysal tuff, such that potential drip shield static loads due to rubble are not under-estimated or that barrier and repository performance are not over-estimated.

Basis: The UDEC-Voronoi model uses an average block diameter of 0.3m, with a roughly equant block shape. Variations in block size appear to be restricted, relative to the mean size, with a ratio between the minimum and the maximum block size of approximately 2 (DOE, 2009). DOE describes the Topopah Spring lower lithophysal tuff as having predominantly vertical fractures, with spacings on the order of several centimeters (BSC, 2004, section 7.3.2). Such fracture spacings appear to support the formation of roughly tabular blocks, with average sizes on order of centimeters. Analyses in, for example, BSC (2004, appendices P, V) indicate that calculated rubble load can be sensitive to assumptions in block size or shape. DOE has not presented a reasoned basis to reconcile the in-situ characteristics of the lithophysal tuff with the expected size and shapes of rubble resulting from seismic events. In addition, DOE has not demonstrated that expected variations in rubble size and shape would not affect the calculation of rubble load significantly.

Reference
DOE. 2009. RAI response 3.2.2.1.2.1-001 (Volume 3, Chapter 2.2.1.2.1 -Scenario Analysis- Set 1, Number 1).