THE WORKSHOP ON EXTREME GROUND MOTIONS AT YUCCA MOUNTAIN

Thomas C. Hanks
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

This workshop has its origins in the probabilistic seismic hazard analysis (PSHA) for Yucca Mountain, the designated site of the underground repository for the nation's high-level radioactive waste. Completed in 1998, this SSHAC Level-4 (Budnitz *et al.*, 1997) study was the most complicated and complex PSHA ever undertaken at the time. The procedures, methods, and results of this PSHA are described in Stepp *et al.* (2001), mostly in the context of a probability of exceedance (hazard) of 10^{-4}/yr for ground motion at Site A, a hypothetical, reference rock outcrop site at the elevation of the proposed emplacement drifts within the mountain. Analysis and inclusion of both aleatory and epistemic uncertainty were significant and time-consuming aspects of the study, which took place over three years and involved several dozen scientists, engineers, and analysts.

Because of these uncertainties, the 1998 Yucca Mountain PSHA provides for progressively higher ground motions as it is extended to progressively lower hazard levels: at mean-value hazard levels of 10^{-6}/yr, 10^{-7}/yr, and 10^{-8}/yr, the resulting peak ground accelerations (PGA) and peak ground velocities (PGV) are 3 g, 6 g, and 11 g and 3.5 m/sec, 7 m/sec, and 13 m/sec, respectively (Figs. 1 and 2). We refer to these as *extreme ground motions*, the extremely large-amplitude ground motions that will arise in any PSHA at extremely low probabilities-of-exceedance, given untruncated ground-motion distribution functions. These large-amplitude ground motions have generated considerable consternation in the scientific, engineering, and regulatory communities, for such PGV's and PGA's have never been recorded for earthquakes, present exceptional challenges to the design and construction of the underground facilities, and are regarded by at least some qualified seismologists as "physically unrealizable."

In the fall of 2003, the Science and Technology Program of the Office of Civilian Radioactive Waste management in the U.S. Department of Energy formed a committee of six scientists (N.A. Abrahamson, M. Board, D.M. Boore, J.N. Brune, C.A. Cornell, and T.C. Hanks, chair) to look into this matter of extreme ground motions at Yucca Mountain and how they came to be. This workshop is the first recommendation of this committee and is made possible with the support of the Science and Technology Progam. It brings together scientists from a wide range of the earth and engineering sciences that speak to extreme ground motions, in terms that are often specific to Yucca Mountain but in other cases are quite general.

References

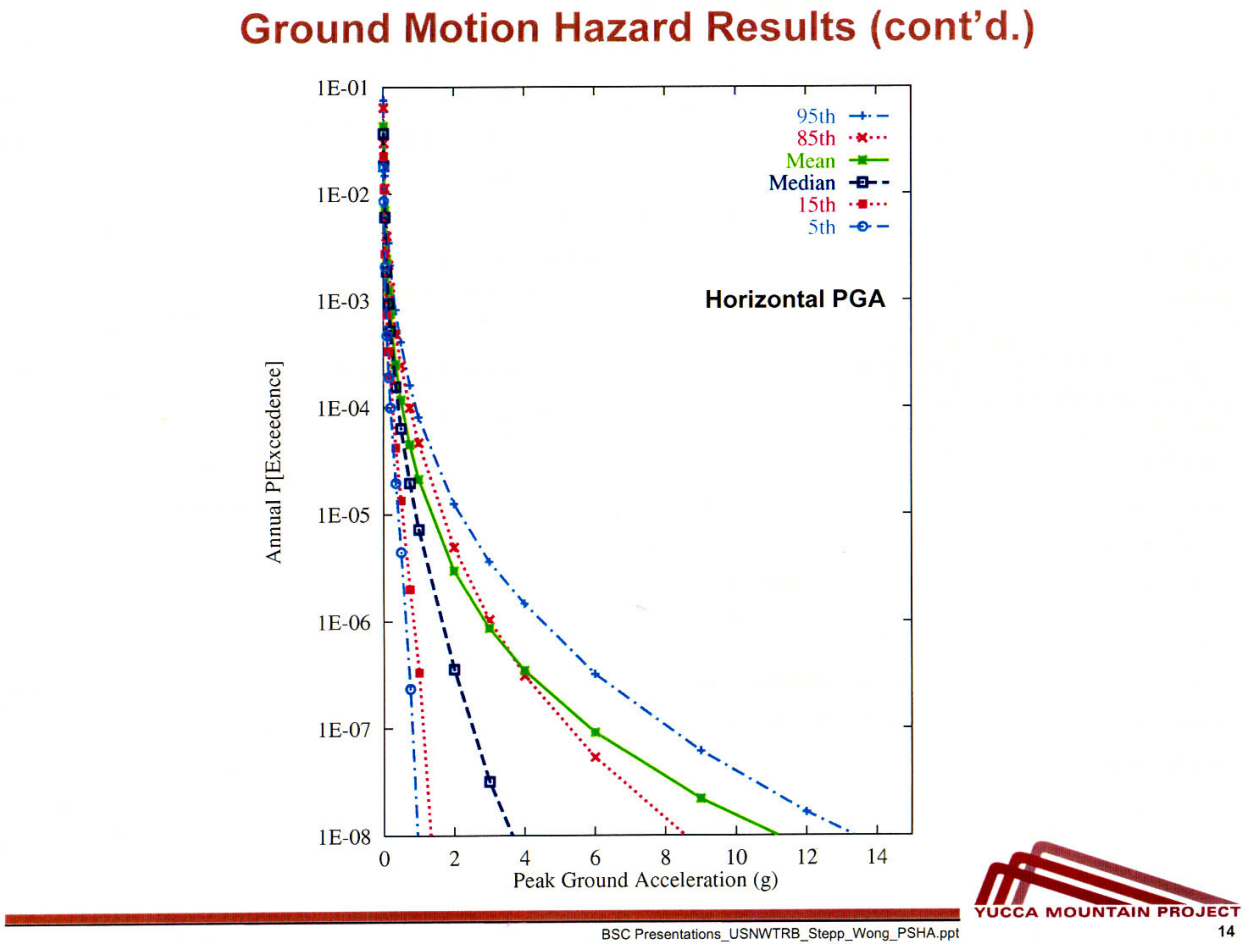
Budnitz, R.J., G. Apostolakis, D.M. Boore, L.S. Cluff, K.J. Coppersmith, C.A. Cornell, and P.A. Morris (1997). Recommendations for probabilistic seismic hazard analysis: guidance on uncertainty and the use of experts, *NUREG/CR-6372*, U.S. Nuclear Regulatory Commission.

Stepp, J.C., I. Wong, J.Whitney, R. Quittmeyer, N. Abrahamson, G. Toro, R. Youngs, K. Coppersmith, J. Savy, T. Sullivan and Yucca Mountain PSHA project members (2001).

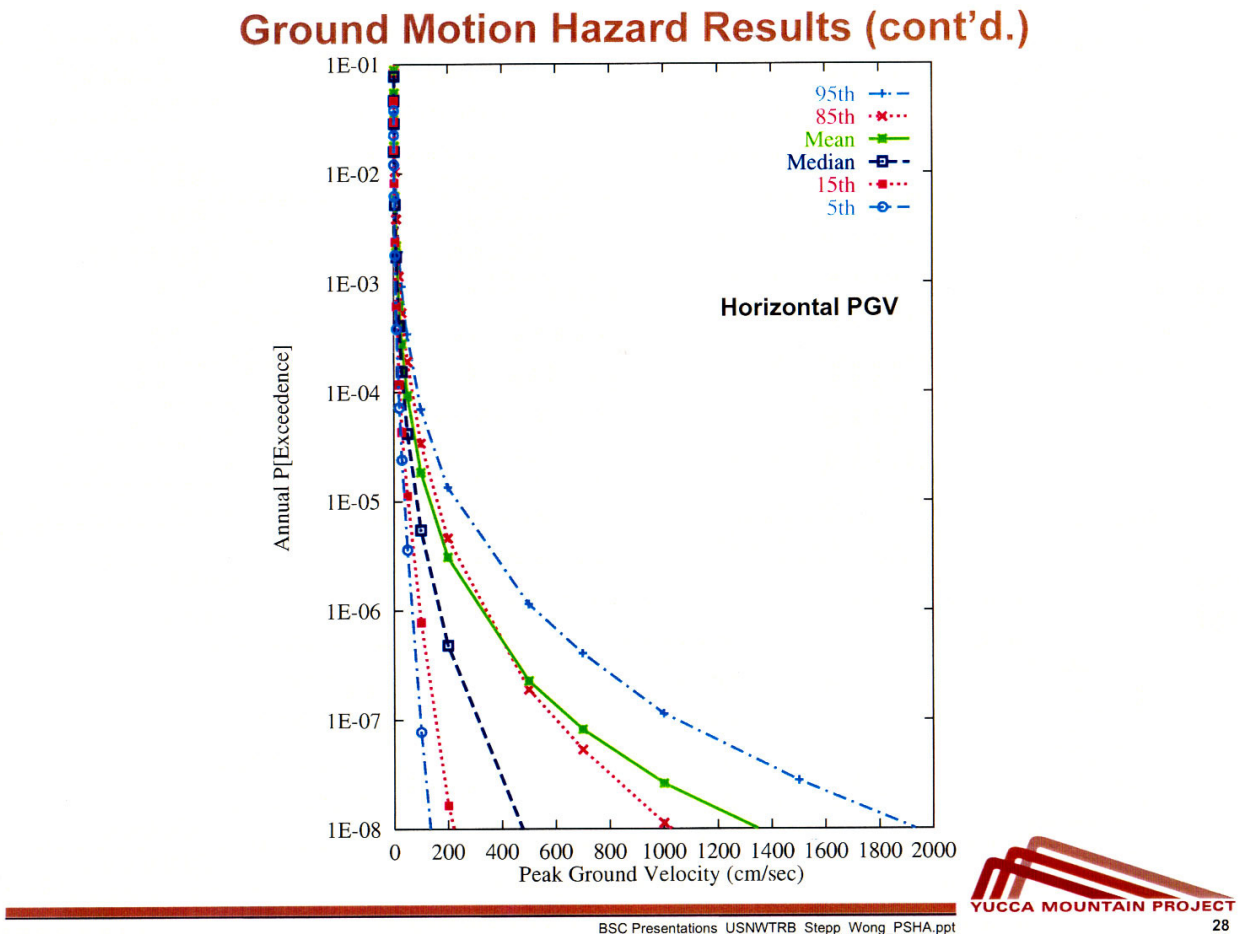
Probabilistic seismic hazard analyses for ground motions and fault displacements at Yucca Mountain, *Earthquake Spectra* **17**, 113-151.

Stepp, C. and I.G. Wong, Probabilistic seismic hazard analysis (PSHA) for Yucca Mountain, presented to U.S. Nuclear Waste Technical Review Board, 24 February 2003.)

Figures



1. Seismic hazard curves for Yucca Mountain, Horizontal PGA (peak ground acceleration), from Stepp and Wong (2003).



2. Seismic hazard curves for Yucca Mountain, Horizontal PGV (peak ground velocity), from Stepp and Wong (2003).