Los Alamos National Laboratory's Seismic Hazard Characterization Program: A Look Back and a Path Forward

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Los Alamos National Laboratory (LANL) sits within a geologically unique environment – adjacent to and overlying the Pajarito fault system (a complex normal fault system locally forming the active western margin of the Rio Grande rift), and positioned on the eastern flank of Valles Caldera, a latent volcanic system made famous as the type location for large caldera formation and resurgence. The LANL geologic environment presents many seismic design challenges because it resides on the hanging wall of an active, complex normal fault exhibiting limited historic seismicity. Consequently, hazard uncertainties are large because: (1) determination of deformation rates is difficult; (2) empirical data on near-field vertical and horizontal ground motion are very limited; and (3) the variable depositional characteristics of Plinian eruptive volcanic units produce complex site characterization issues and topographic anomalies.

LANL performed an initial PSHA study in 1995, and completed a SSHAC Level 2 PSHA update in 2007. The perceived hazard and design basis ground motion increased dramatically from 1995 to 2007: horizontal ground motion increased by 40% ($4x10^{-4}$/yr), and vertical ground motion increased by approximately 100%. Although the 1995 assessment fully incorporated uncertainties understood at that time, additional geologic data acquired from the seismic source (Pajarito fault system) and site-specific geophysical data, combined with a greater understanding of the earthquake process and modeling methodologies, contributed to the significant increase in design basis. Both the 1995 and 2007 PSHAs (and related sensitivity studies) were instrumental in defining the critical data and uncertainties that control the LANL design basis ground motions: these include the rate of deformation along the PFS, ground motion prediction in the near-field of a complex normal fault, and site response. LANL developed a Seismic Hazard Program Plan to prioritize and execute technical research activities for the next 10-yr period that could reduce those uncertainties in preparation for the next PSHA. The Plan activities address uncertainty in the following six focus areas: source models, path (GMPEs), site characterization modeling, and PSHA methodology. Improved earthquake monitoring, volcanic hazards investigations, and exploration of the interrelationships of the volcanic and seismic systems are also part of the Plan.

The purpose of this presentation is to summarize current and future LANL activities supporting the next PSHA update. These activities include: updating ground motion prediction models; improving weak and strong ground motion instrumentation in the Los Alamos Seismic Network; using active and passive experiments to infer shallow crustal and site properties; and new data collection efforts supporting chronology of volcanic and faulting events.