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BOUNDING PEAK GROUND VELOCITIES FOR SEISMIC EVENTS AT YUCCA MOUNTAIN, NEVADA

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Earthquake ground motions have been assessed using a probabilistic seismic hazard analysis (PSHA) of the proposed repository for spent nuclear fuel and high-level radioactive wastes at Yucca Mountain, Nevada. To meet the applicable regulations, consideration must be given to ground motions that have probabilities of exceedance as low as 10^{-8}/yr. In the PSHA, aleatory variability in ground motion attenuation relations is characterized by unbounded lognormal distributions. At extremely low annual probability levels, the tails of these distributions, along with large assessed epistemic uncertainties in ground motions from large, close earthquakes, result in upper-percentile and mean ground motions that are extremely high and probably unphysical. To address this issue, we evaluated site-specific geologic evidence with respect to an upper bound on peak ground velocity (PGV), the ground motion measure that is correlated with damage to underground repository systems. Ground-motion amplitudes are limited by the strength of the materials through which they propagate. At high enough levels of seismic shaking, the rocks at the waste-emplacement level, particularly the lithophysal tuffs, will fracture and fail. A key finding of geologic relations from underground explorations and rock-mechanics modeling is the absence of mechanical damage of the type expected from seismic shaking in the 12.8 my old volcanic rocks at the waste-emplacement level (Buesch and Damjanac, this session). Rock mechanics tests and computer modeling provide estimates of the shear strains required to fail the lithophysal rock. In turn, a site-response model is used to calculate PGVs that would cause these shear strains at repository depths. The threshold shear strains required to cause significant damage are estimated to range from 0.09 to 0.35%. This translates to site-specific average PGV values ranging from about 153 to 451 cm/sec. Considering that ground motions of this amplitude are not evidenced in the 12.8 my old lithophysal tuffs, and considering corroborating estimates of the conditional probabilities of ground motions from earthquakes with recurrence rates of 10^{-5}/yr, we conclude that this range of PGVs represents a reasonable upper bound on PGVs that need to be considered in Yucca Mountain performance assessments.

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