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ASSESSMENT OF SEISMIC HAZARDS AT YUCCA MOUNTAIN

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Seismic Hazard Information Needs

During the preclosure time period (approximately 100 yr), the prospective geologic repository at Yucca Mountain must provide for public and worker radiological safety and retrievability of emplaced waste. During the postclosure period (10,000 yr), the repository must ensure that cumulative radionuclide releases to the accessible environment comply with EPA release limits. Substantially complete containment must be provided by the waste packages for 300-1000 yr. All of these functions must be maintained should a severe seismic event occur and must be achieved with reasonably available technology.

The seismic phenomena of interest for the preclosure period are vibratory ground motion from a nearby earthquake or underground nuclear explosion (UNE), faulting beneath surface facilities that are important to safety, and faulting

in underground areas of emplaced waste. For the postclosure period, earthquake ground motion, underground faulting, and seismically induced adverse changes in hydrologic conditions have been identified as the most important seismic phenomena to be characterized. The NNWSI Project Site Characterization Plan describes a number of seismic parameters that are needed for repository design or performance assessment, along with tentative goals for each parameter. Key parameters, goals and current assessments, all subject to change as site characterization progresses, are summarized in the following sections.

Ground Motion

The goal for a design-basis earthquake for facilities important to safety (FITS) during the preclosure period is a ground-motion description that envelopes the most probable ground motion from 10,000-year-cumulative-slip earthquakes on nearby faults. A 10,000-year-cumulative-slip earthquake is a postulated event that corresponds to a fault displacement which, occurring every 10,000 years, would produce the average slip rate observed during recent (Quaternary) geologic time. Current information suggests that an earthquake of about magnitude 6 1/2 on the Paintbrush Canyon fault, about 1 km from the conceptual site of surface waste-handling facilities, will be the design-basis seismic event. The most probable peak ground acceleration for such an event appears to be about 0.5 g. (Engineering measures to accommodate this level of acceleration in the design of FITS are readily available.)

Another goal for the design-basis earthquake is that its annual probability of exceedance be on the order of 10^{-3} to 10^{-4}/yr. Because this range has been

found to correspond to the seismic design bases of a number of U. S. nuclear power plants[1] and because the risk profile of a repository is expected to be lower than that of a nuclear power plant, this goal appears to be quite conservative. Preliminary probabilistic seismic hazard estimates[2,3] indicate that the probability of exceeding 0.5 g at the site is about 1-to-5 x 10^{-4}/yr.

The maximum potential ground motion from a UNE at the Nevada Test Site is not expected to exceed the design-basis-earthquake ground motion. The Buckboard Mesa area, 23 km from the site, is the closest area of potential testing of high-yield nuclear devices. The onset of damage to high-rise buildings in Las Vegas limits the yield in this area to 700 kt[4]. (Current national policy is to limit test yields to 150 kt or less.) Regression relationships developed from recordings of nuclear tests at NTS predict a peak acceleration of about 0.06-0.24 g for a 700 kt shot at a distance of 23 km, accounting for local geologic effects on ground motion[4]. These effects will be investigated in detail during site characterization and the predicted motions will be refined.

Faulting

Although the foundations of the surface waste-handling buildings could be engineered to withstand substantial surface faulting, the preferred design solution is to locate these structures where the potential for such faulting is very low. One goal is to identify faults within 100 m of prospective sites of surface PITS that have a probability greater than 10^{-4}/yr of slipping 5 cm or more; faults meeting this criterion would be avoided. Such faults are not currently thought to exist at candidate sites, but this must be confirmed by

trenching surface materials and, where possible, dating continuous geologic horizons. A second goal is to confirm the current assessment that the total annual probability of experiencing more than 5 cm of fault offset beneath surface PITS is less than 10^{-4}/yr. This probability evaluation will consider, for example, the likelihood of secondary faulting at surface PITS sites, should an earthquake occur on the Paintbrush Canyon fault or some other local fault.

For the postclosure period, the goal for site characterization is to demonstrate that the annual probability of faulting with displacement over 5 cm in areas of emplaced waste is less than 10^{-4}/yr. Current information suggests that all goals related to faulting will be met.

Adverse Changes to Hydrologic Conditions

It is conceivable that local earthquake activity could cause increased percolation of water through the unsaturated zone or could increase the elevation of the water table during the postclosure period. For example, the average percolation flux might be changed by a fault offset that creates surface impoundments, alters drainage, or, by the juxtaposition of transmissive and nontransmissive geologic units, creates perched water tables. The tentative goal for site characterization is to demonstrate that the probability of increasing the average percolation flux through the repository by more than a factor of two is less than 10^{-5}/yr. Juxtaposition of geologic units in or near the saturated zone might affect the water table; the goal is to demonstrate with high confidence that this occurrence would not cause the water table to rise to within 100 m of the repository horizon in 10,000 yr.

Strain changes in the rock mass due to faulting might also affect the water-table elevation. The corresponding goal is to demonstrate that the probability of an increase in the potentiometric level of the ground water to 850 m MSL due to strain changes is less than 10^{-5}/yr. (The lovest elevation of the repository would be above 1000 m MSL.) Current information suggests that all goals related to seismically induced hydrologic changes will be met.

References

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