Modeling Potential Tephra Dispersal at Yucca Mountain, Nevada

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Quaternary basaltic volcanoes exist within 20 km of the potential radioactive waste repository at Yucca Mountain, Nevada, and future basaltic volcanism at the repository is considered a low-probabilty, potentially high-consequence event. If radioactive waste was entrained in the conduit of a future volcanic event, tephra and waste could be tranpsported in the resulting eruption plume. During an eruption, basaltic tephra would be dispersed primarily according to the height of the eruption column, particle-size distribution, and structure of the winds aloft. Following an eruption, contaminated tephra-fall deposits would be affected by surface redistributiion processes. CNWRA developed the computer code TEPHRA to calculate atmospheric dispersion and subsequent deposition of tephra and spent nuclear fuel from a potential eruption at Yucca Mountain, to help prepare NRC to review a potential U.S. Department of Energy license application.

The TEPHRA transport code uses the Suzuki model to simulate the thermo-fluid dynamics of atmospheric tephra dispersion. TEPHRA models the transport of airborne pyroclasts based on particle diffusion from an eruption column, horizontal diffusion of particles by atmospheric and plume turbulence, horizontal advection by atmospheric circulation, and particle settling by gravity. More recently, TEPHRA was modified to calculate potential tephra deposit distributions using stratified wind fields based on upper atmosphere data from the Nevada Test Site. Wind data are binned into 1-km [0.62-mi]-high intervals with coupled distributions of wind speed and direction produced for each interval. Using this stratified wind field and discretization with respect to height, TEPHRA calculates particle fall and lateral displacement for each interval. This implementation permits modeling of split wind fields. We use a parallel version of the code to calculate expected tephra and high-level waste accumulation at specified points on a two-dimensional spatial grid, thereby simulating a three-dimensional initial deposit. To assess subsequent tephra and high-level waste redistribution and resuspension, modeling grids were devised to measure deposition in eolian and fluvial source regions. The eolian grid covers an area of 2,600 km^2 [1,000 mi^2] and the fluvial grid encompasses 318 km^2 [123 mi^2] of the southernmost portion of the Fortymile Wash catchment basin. Because each realization is independent, distributions of tephra and high-level waste reflect anticipated variations in source-term and transport characteristics.

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