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Probabilistic Performance Assessment of a Low-Level Radioactive Waste Disposal Site on the Nevada Test Site

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The Area 5 Radioactive Waste Management Site on the Nevada Test Site has been disposing of low-level, mixed low-level, and transuranic radioactive waste since 1961. In 1988, the U.S. Department of Energy implemented performance objectives for low-level radioactive waste disposal site performance and required all site operators to prepare a performance assessment. Since then, an iterative performance assessment process has been implemented that consists of repeated cycles of site characterization, conceptual model formation/revision, and performance assessment modeling. At the end of each cycle uncertainty and sensitivity analysis are used to determine the need for revision and to identify topics requiring additional research and development. The performance assessment model is implemented in the GoldSim® probabilistic simulation platform. The current site conceptual model, based on site characterization data and process model results, assumes that there is no groundwater pathway under current climatic conditions and that radionuclide releases are predominately upward to the land surface.

Radionuclides are released to the land surface by upward liquid advection/diffusion, gas diffusion, biointrusion, and inadvertent human intrusion. The model calculates dose for four members of public exposure scenarios and two intruder scenarios. The highest mean-dose, 0.04 mSv yr^{-1}, is expected for a low-probability exposure scenario: establishment of a rural community at the site boundary at the end of institutional control. At the end of institutional control, doses are contributed primarily by ^{3}H in agricultural products produced onsite. After approximately 300 years, the doses are contributed equally by ^{99}Tc and ^{210}Pb ingested in vegetables grown at the residence. Technetium is released to the surface by the coupled processes of liquid advection/diffusion occurring deep in the cover and plant uptake/animal burrowing occurring at shallower depths. Lead-210 is deposited in shallow cover soil by the radioactive decay of ^{222}Rn diffusing in the gas phase. The highest mean dose for the more likely exposure scenario of transient recreational use of the site is 0.002 mSv yr^{-1}. The transient visitor's dose is contributed predominantly by external irradiation from ^{214}Pb and ^{214}Bi, deposited in the cover by diffusion of ^{222}Rn.

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