WIPP Performance Assessment Approach and Results

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The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, has been developed by the U.S. Department of Energy (DOE) for the geologic (deep underground) disposal of transuranic waste. Containment of this waste at the WIPP is regulated by the U.S. Environmental Protection Agency (EPA). Containment requirements are stringent, requiring the DOE to demonstrate with a reasonable expectation that the probabilities of cumulative radionuclide releases from the disposal system during the 10,000 years following closure remain below specified limits. The DOE demonstrates compliance with these requirements by means of performance assessment (PA) calculations. WIPP PA is an analysis that 1) identifies the processes and events that might affect the disposal system; 2) examines the effects of these processes and events on the performance of the disposal system; 3) estimates the cumulative releases of radionuclides caused by all significant processes and events; and 4) accounts for uncertainty in the parameters of the models. These items give rise to a methodology for quantifying the probability distribution of possible radionuclide releases from the WIPP repository for the regulatory period of 10,000 years after facility closure, while characterizing the uncertainty in that distribution due to imperfect knowledge about the parameters contained in the models used to predict releases.

PA analyses supporting the determination of compliance are quantitative and consider uncertainties caused by all significant processes and events that may affect the disposal system, including future inadvertent human intrusion into the repository. PA calculations were included in the 1996 Compliance Certification Application. Based in part on the PA calculations, the EPA certified that the WIPP met the containment criteria in the regulations and was approved for disposal of transuranic waste in 1998. Models used in WIPP PA are maintained and updated with new information as part of the repository recertification process. It is required that the WIPP is recertified at five-year intervals following receipt of the first shipment of waste at the site, which occurred in 1999. PA calculations were also an integral part of the 2004 Compliance Recertification Application, after which the EPA recertified the WIPP in 2006. For the 2009 Compliance Recertification Application, which is currently under EPA review, the DOE has also submitted PA calculations.

For PA, the effects of all significant processes and events that may impact the disposal system are determined, the associated uncertainties of the processes and events are considered, and the probable cumulative releases of radionuclides are estimated. The PA methodology accommodates both stochastic (i.e., aleatory) and subjective (i.e., epistemic) uncertainty in its constituent models. Stochastic uncertainty pertains to unknowable future events, such as intrusion times and locations that may affect repository performance. Subjective uncertainty concerns parameter values that are assumed to be constants whose true values are uncertain because of a lack of knowledge about the system.

The WIPP PA methodology includes twenty-four conceptual models that are used to represent specific features of the disposal system. Releases from the WIPP fall into two principal categories: 1) long term releases, which may take place throughout the regulatory period, and 2) direct releases, which may occur at the time of a drilling intrusion.

Long term releases include radionuclide transport in groundwater through the various geologic units to the land withdrawal boundary. The most transmissive unit is the Culebra. Radionuclides may be transported to the Culebra primarily by brine flow up boreholes. Other transport paths, such as through the shaft seals, or through the marker beds, have been demonstrated to be insignificant.

Direct releases are subdivided into three components: cuttings and cavings, spallings, and direct brine releases (see Fig. 1). Cuttings refer to the waste material actually encountered by a drill bit as it passes through the waste. Cavings include materials that are eroded from the walls of the waste and are brought to the surface by the drilling fluid. Generally, cuttings and cavings are grouped together. Spallings accounts for additional material that may be brought to the surface through venting of repository gas pressure to the lower-pressure borehole. Direct brine releases are flows of pressurized brine from the repository to the surface during the first few days before a borehole is assumed to be plugged.

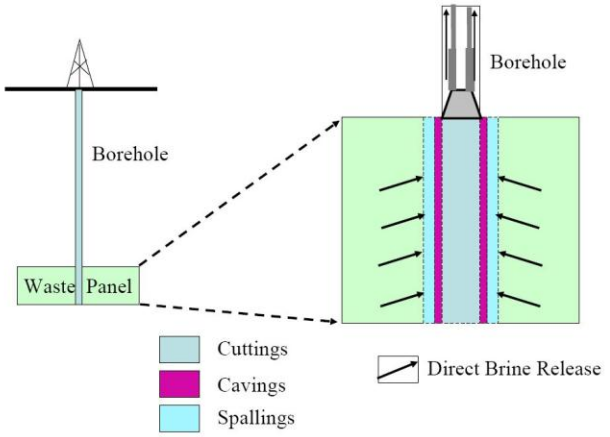

Fig. 1. Schematic of Direct Release Mechanisms Modeled in WIPP PA.

For an undisturbed repository, radionuclide transport in the groundwater is the only release mechanism considered. PA calculations for the undisturbed repository establish that the maximum annual dose and radionuclide concentration at the land withdrawal boundary are considerably lower than the regulatory limits.

For a disturbed repository, PA analyses supporting the 2009 Compliance Recertification Application demonstrate that the WIPP continues to comply with containment requirements, with release probabilities remaining entirely below the limits specified by the EPA. No releases are predicted to occur at the ground surface in the absence of human intrusion. A sensitivity analysis of the results shows that the total releases are dominated by radionuclide releases that could occur on the surface during an inadvertent penetration of the repository by a future drilling operation.

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