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Radionuclide Release in Performance Assessment Under Future Waste Management Scenarios

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Abstract

The abstraction of radionuclide release is a key component of performance assessment for high-level nuclear waste disposal. Future directions in nuclear power generation and spent nuclear fuel management in the United States may necessitate evaluating release from waste packages of different designs containing a wider variety of waste forms than have been previously considered. The range of waste form types intended for geologic disposal may expand from UO_2 spent nuclear fuel and high-level waste glass, which currently dominate the national inventory of high-level waste, to types such as mixed oxide spent fuel and new high-level waste forms resulting from reprocessing. Waste characteristics could also be affected by potential changes in nuclear fuel management such as higher levels of reactor burn-up or waste loading and long-term storage. Aside from radionuclide inventory and degradation rates (see Ahn, et al., in this abstracts volume), important release-relevant waste characteristics affected by these potential changes include materials (i.e., physical or chemical) properties of waste form, waste package, and waste package internals, physical features such as fractures, cladding protection, reduction/oxidation state of groundwater including radiolysis, and formation of gaseous radionuclides. These characteristics will affect radionuclide release rates and radionuclide aqueous concentrations. For example, a ceramic waste form may not buffer solution pH—which affects radionuclide solubility limits and sorption—to the same degree as spent UO_2 fuel alteration phases. The in-package environment will also be affected by materials characteristics and the extent of damage of (i) the outer container and (ii) inner container features such as the inner liner, criticality control components, and spacers. For example, degradation of metal components will affect solution ionic strength to varying degrees, and the nature of metal degradation (e.g., damage geometry or degradation products) may affect the transport rate of radionuclides out of the waste package. Container designs and, therefore, in-package physical and chemical conditions would also be affected by changes in spent fuel management practices. In developing methods for simulating and evaluating radionuclide release from future high-level nuclear waste disposal facilities, it is important for implementers and regulators to consider the range of potential waste management practices, waste forms, waste package, and in-package environments that will affect release.

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