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AN INTEGRATED SIMULATION MODEL FOR THE PERFORMANCE ASSESSMENT OF A RADIOACTIVE WASTE REPOSITORY

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Summary. Disposal facilities for radioactive wastes comprise a series of engineered and natural (geologic) barriers to contain the radionuclides until their radiation hazard has decreased to acceptable levels. It is required that the long-term functionality of the containment barriers be evaluated by a quantitative risk analysis, also termed performance assessment. This entails the implementation of a Probabilistic Safety Assessment model of the stochastic failure behavior of the repository barriers and the release and transport of radionuclides into the groundwater bodies, to estimate the doses which can be transferred to humans from subsequent ingestion of water and other intake paths. Here, we propose an integrated model for the analysis of the safety performance of a radioactive waste repository, accounting for barrier degradation processes and groundwater transport processes. The model combines a Monte Carlo simulation-based reliability module for the estimation of radionuclide release from the repository (due to failures in the engineered barriers) and a numerical solution of flow and transport processes in the aquifer (performed by MODFLOW and MT3DMS codes). The model strengths are: 1) modularity of modeling of (a) failure of the engineered barriers and (b) groundwater contaminant transport and intake processes: this allows zooming in and out at different levels of detail while keeping the computational efforts manageable; 2) simplicity and flexibility of the Monte Carlo simulation module which can account for various physical aspects. The model can be used for screening analyses aimed at identifying the need for further detailed studies on relevant phenomena. An application to a case study of literature is presented to validate the approach and demonstrate its merits.