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Safety assessment of an existing repository for low- and intermediate level waste from the view point of the concept of the "containment providing rock zone"

Matthias Niemeyer (1), Matthias Ranft (2), and Jürgen Wollrath (2)

(1) CSD ENGINEERS, Aarau, Switzerland (M.Niemeyer@csd.ch), (2) Bundesgesellschaft für Endlagerung mbH (BGE), Peine, Germany (Juergen.Wollrath@bge.de)

In Germany the concept of the containment providing rock zone (CRZ) has been introduced as a main feature in the site selection process for a repository for high-level radioactive waste. The CRZ is that part of the host rock that together with the necessary geotechnical and technical barriers has to ensure the confinement of the waste for the assessment period. Following a recommendation of the German Nuclear Waste Management Commission (ESK), the concept of the CRZ has also been discussed in the safety assessment for the existing Morsleben repository.

The Morsleben repository contains low- and intermediate level nuclear waste. It is located in a former salt mine in Northern Germany with a total excavated volume of 8.9 Mio m^3. The salt structure is traversed by banks of Anhydrite and beds of Carnallite. The long time period of more than 100 years since the mine has been opened caused substantial progression of excavation damage. In general, these preconditions are not favourable for a repository site, especially from the viewpoint of the CRZ concept. But as the total radionuclide inventory is small (2.6×10^{14} Bq by the end of 2014) and dominated by short-lived radionuclides, a period of 100,000 years is sufficient for post-closure safety assessment.

The closure concept requires backfilling with large volumes of salt concrete in order to stabilize the mine building. Furthermore, the disposal areas containing the main part of the longer-lived radioactive inventory will be sealed. However, sealing measures will minimize influx into the mine building as well as fluid access to the waste and thus provide a safe containment of the waste. As performance assessments demonstrate, the radiologic safety criteria will be met.

According to scenario analysis, likely long-term evolutions exist where the inflow rates of solutions into the repository from the cap rock remain so low that the mine building will not be flooded completely during the entire assessment period for post-closure safety, and thus no radionuclides will be released.

In other scenarios, where radionuclides will be released from the salt structure, the containment capability of the barrier system within the salt structure is compared to the retardation and dilution (due to dispersion and diffusion) capability of the cap rock. The containment capability within the salt structure is quantified by a performance indicator, defined as the ratio of the initially disposed radiotoxicity to the integrated radiotoxicity flux out of the salt structure during the safety assessment period. Dispersion and dilution in the cap rock are calculated using a 3D-goundwater model, considering density effects. The calculations of dose values demonstrate that dilution in the cap rock is not critical no meet the safety criteria because the major fraction of the disposed radionuclide activity decays within the barrier system. Additionally, the predictability for the barrier efficiency of the cap rock is sufficient for the whole assessment period. Thus, it can be demonstrated that the long-term safety of the Morsleben repository is mainly based on the containment capability of the host rock.