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Deep borehole disposal as a potential solution for high-level waste (HLW) and spent nuclear fuel (SNF) in Norway – current status and a first generic safety assessment

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Abstract. Deep borehole disposal (DBD) is currently being investigated as a potential solution for the disposal of the existing spent nuclear fuel (SNF) in Norway. Over the past years, BGE TECHNOLOGY GmbH (BGE TEC), together with the Finnish companies A-Insinöörit Oy (AINS Group), Mitta Oy and VTT Technical Research, has supported the Norwegian agency Norwegian Nuclear Decommissioning (NND) in the development of a deep borehole concept, including work on different technical details. At the end of 2022, the consortium was able to win a follow-up contract to further deepen and advance the work. For this second framework agreement, additional companies were added to further strengthen the expertise. The Geological Survey of Finland (GTK), Posiva Solutions Oy (PSOY) and Rambøll are now part of the new consortium group, which works under the acronym GeoReN (Geological Repositories for Norway).

This paper provides an overview of the work carried out in the past for the deep borehole concept in Norway. In detail, this includes a basic description of the concept developed for the waste that originates from different institutions. Initial calculations indicate that a 69 BSK-R canister may be sufficient for the waste inventory to be considered. As the current conceptual borehole design provides the basis for most of the other work carried out, it will be presented and discussed within the paper.

Furthermore, as part of the concept development, a first generic post-closure safety assessment was also performed for the DBD concept. The main results of the long-term calculations are discussed and presented in this paper as well. The main objectives of the generic safety assessment were the identification of critical parameters and assumptions for the model of the DBD repository and the performance of a first assessment of possible consequences of the potential post-closure release of radionuclides from the borehole. To be able to give a prediction at the present stage of the project, the assessment used conservative assumptions, models and data. The preliminary results for the normal evolution of the deep borehole repository indicate that highly mobile radionuclides, such as I-129, Cl-36, Ni-59 and Se-79, are the major dose contributors and that the expected potential radiological impact on future generations associated with these releases is extremely small. In addition, alternative scenarios have been assessed, which assume a hydraulic gradient leading to advective flow either upward through the borehole and surrounding excavation damaged zone (EDZ) or between certain parts of the borehole and the surface via a transmissive fracture system. Despite the pessimistic assumptions chosen for these scenarios, the maximum dose rates are significantly lower than the expected regulatory limit.

However, it needs to be pointed that the present generic safety assessment is still on a conceptual level. With more detailed planning and updated information regarding the inventory, the geological environment, and the integrity and performance of the engineered barriers, repeated safety assessments will need to be performed to derive more substantiated results.

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