Comparison of Safety Assessment Codes for Near-Surface Disposal of LILW with the Compartment Model: SAGE and VR-KHNP

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SAGE(Safety Assessment Groundwater Evaluation) and VR-KHNP(Virtual Repository for KHNP) codes for performance assessment of the LILW disposal repository were developed by joint collaboration between KHNP and foreign consulting organizations. In both codes, the disposal facility consists of a series of compartments that represent the waste form, the engineered barrier system(EBS), the unsaturated and saturated zone. SAGE[1] has been developed as a new customized code for evaluation of the engineered vault disposal concept for LILW in Korea. The conceptual model in SAGE is focused on releases from a gradually degrading EBS to geosphere. Doses can be calculated for several surrounding biosphere systems. VR-KHNP has been developed by modifying the applicability to the repository configuration and by adopting basic governing equations of the original Virtual Repository (VR) code[2] for radionuclide transport in the region interior to the HLW repository, with the multi-compartment model. In VR-KHNP, the continuity of concentration distribution can be retained at the interface between unsaturated and saturated zones. It directly calculates the mass distribution at any specified time, without needing to calculate the histories of mass distribution for all time steps until the specified time. For the purpose of benchmarking, numerical results between SAGE and VR-KHNP were compared with four repository configurations as shown in Figure 1: A) single repository model parallel to the water stream, B) single repository model perpendicular to the water stream, C) multiple vaults model parallel to the water stream, and D) multiple vaults model perpendicular to the water stream. In the present calculation, the near field-far field interface(NFI) is defined as the points in the aquifer below the edge of the repository. The geospher-biosphere interface(GBI) is 200m away in the downstream from the NFI. All four models have a [3]
common total initial mass for each radionuclide.

The results are successfully compared to the release rate at the NFI and some discrepancy was observed at the GBI(Typically the results on model A are shown in Figure 2.). The radionuclides such as ^{3}H, ^{14}C, ^{59}Ni, ^{94}Nb, ^{129}I, ^{238}U, and ^{239}Pu with half-lives longer than the residence time in the aquifer survive the transport to the biosphere. Discrepancy at GBI is caused by the mass transfer in SAGE and VR-KHNP. In SAGE, the mass transfer is defined by advection, molecular diffusion and longitudinal/transverse dispersion, while it is defined by advection at groundwater velocity in VR-KHNP. Also, it still remains to differ from the cross-sectional area of aquifer compartments on both codes. Nonetheless, the effect of repository configuration in relation to the water flow at the GBI is not significant.

ACKNOWLEDGEMENT

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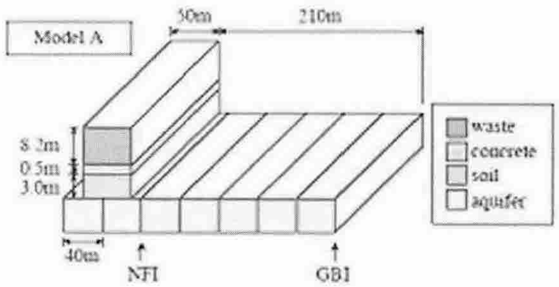

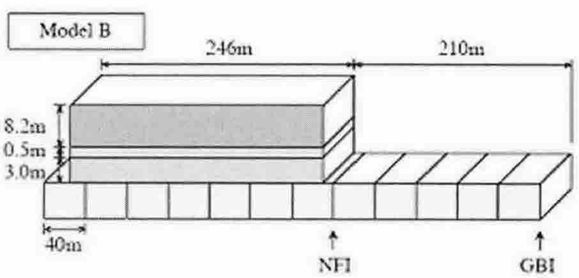

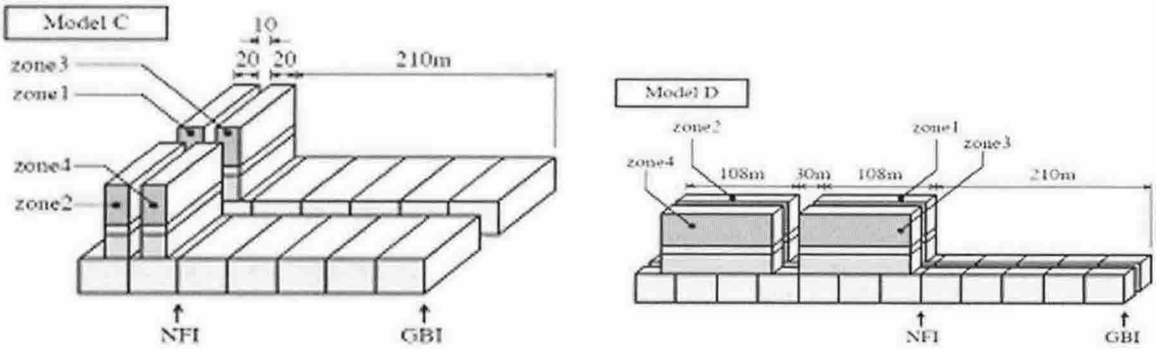

Figure 1. Considered four different geometry models

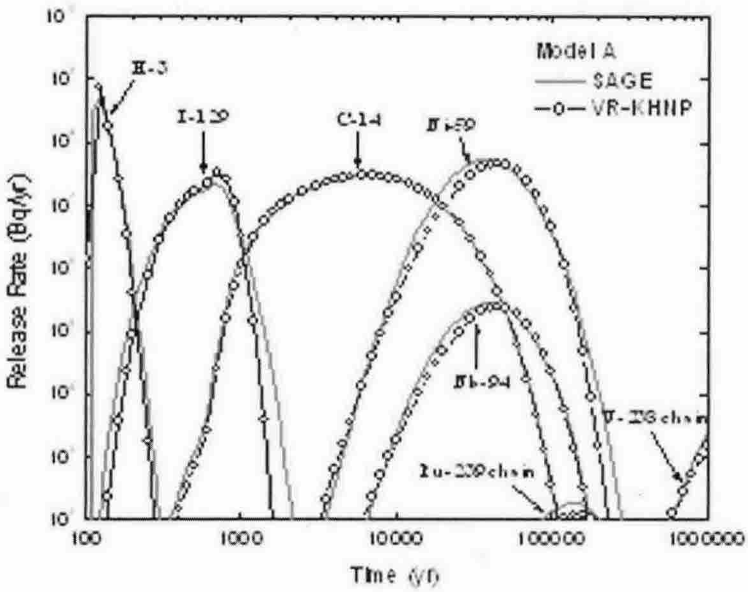

Figure 2. The release rates of configuration model A