One-dimensional GoldSim Radionuclide Transport Modeling for the Wolsong LILW Disposal Center

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1. Introduction

The safety assessment was performed for the license application of the Wolsong LILW Disposal Center and demonstrated that an acceptable level of radiation protection for human health and the environment could be achieved. The endpoints of this assessment need to be met with the Korean regulatory requirements[1] on individual effective dose and the associated risk to members of criteria groups. Radionuclide concentrations at the geosphere-biosphere interface (GBI) should be included in the Safety Analysis Report (SAR)[2]. In there, the safety assessment calculations for scenarios were made by using MASCOT[3]. In this study, one-dimensional radionuclide transport modeling was performed by using GoldSim[4] which was developed by GoldSim Technology Group and the assessment results were compared with those using MASCOT.

2. Scenarios

Two reference (BS-1 and BS-2), two alternative (ES-1 and ES-2) and three human intrusion (HS-1, HS-2 and HS-3) scenarios were developed in the SAR. Among those, four scenarios were revealed in detail in this study.

a. BS-1 Reference Scenario

In BS-1 scenario, the degradation of the engineered concrete barrier is assumed. The groundwater in the bedrock infiltrates into the disposal silo. After the groundwater comes into contact with disposed waste packages, radionuclide dissolution and/or leaching processes commence. Radionuclides released from the waste matrix migrate into the near-field through the disposal container, backfills and the engineered concrete material via diffusion and/or advection processes.

b. ES-1 Alternative Scenario

The ES-1 scenario considers the premature failure of the engineered concrete barrier due to natural and artificial events. The early release of radionuclides from the near-field into the geosphere is considered.

c. ES-2 Alternative Scenario

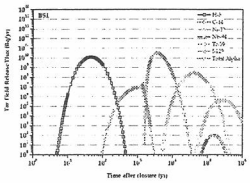
The ES-2 scenario considers the normal release in the near-field like the BS-1 reference scenario. Further considerations include the acceleration of radionuclide transport due to the formation of preferential flow path in the far-field.

d. HS-3 Human Intrusion Scenario

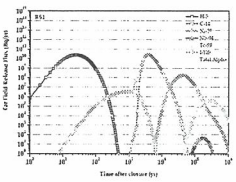
Drilling activity intended to develop the well for water source is considered in the HS-3 human intrusion scenario. The HS-3 does not assume that the well directly intrude into the disposal silo. Radionuclides released from the disposal silo are assumed to be extracted to the surface through the well.

3. Comparison of the far-field release rate using MASCOT

The safety assessment modeling consists of groundwater modeling, radionuclide transport modeling and biosphere modeling. The results of GoldSim calculation for the four scenarios are compared with those using MASCOT. The far-field release rates (Bq/yr) at the GBI are shown in Figures 1-4. For comparison, the results obtained by using MASCOT are also shown in Figures 1-4. The GoldSim results are in good agreement with MASCOT results for all the major radionuclides. The comparison of the far-field peak of release rate between MASCOT and GoldSim is presented in Table 1. The overall peaks of release rates are comparable, and the differences are less than approximately an order of magnitude. Given the differences in the conceptual model in GoldSim and MASCOT the two analyses are in good agreement.

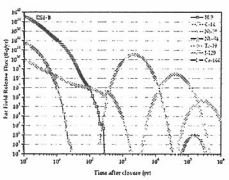


(a) MASCOT

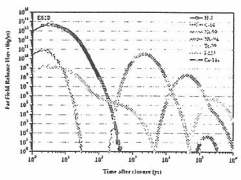


(b) GoldSim

Fig. 1. BS-1 MASCOT and GoldSim far-field release rate [Bq/yr]

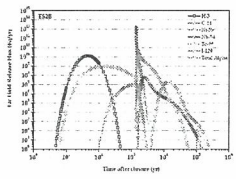


(a) MASCOT

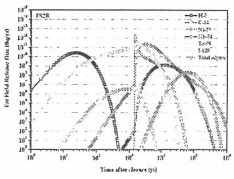


(b) GoldSim

Fig. 2. ES-1 MASCOT and GoldSim far-field release rate [Bq/yr]

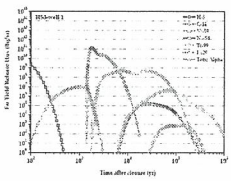


(a) MASCOT

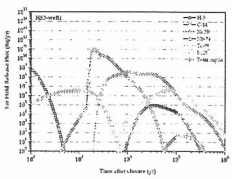


(b) GoldSim

Fig. 3. ES-2 MASCOT and GoldSim far-field release rate [Bq/yr]



(a) MASCOT



(b) GoldSim

Fig. 4. HS-3 MASCOT and GoldSim far-field release rate [Bq/yr]

Table 1. The comparison of the far-field peak release rate between MASCOT and GoldSim

Scenario	Nuclide	MASCOT		GoldSim	
		Far-Field Release Rate Peak time (yr)	Far-Field Release Rate (Bq/yr)	Far-Field Release Rate Peak time (yr)	Far-Field Release Rate (Bq/yr)
BS-1	C-14	3,600	3.08E+10	3,700	2.49E+10
ES-1	H-3	1	3.48E+14	3	4.54E+13
ES-2	C-14	1,402	1.65E+13	1,600	5.65E+11
HS-3	C-14	1,780	1.34E+11	2,000	9.48E+10

4. Conclusion

In this study, four scenarios defined for the Wolsong LILW Disposal Center have been evaluated using GoldSim, and the results are compared the MASCOT results. The two results agree reasonably well, although the MASCOT results are slightly higher than those of GoldSim scenarios. During and after the construction phase of the Wolsong LILW Disposal Center, the safety assessment needs to be developed further based on new findings from the geological analysis, improved engineering of the barrier system, and new knowledge of waste characteristics.

References

1. MEST Notice 08-63, "Radiological Protection criteria for long-time safety on LILW Disposal", Ministry of Education and Science, (2008).
2. KRMC, "The Safety Analysis Report for the Wolsong LILW Disposal Center", (2008).
3. Sinclair, J.E. and Agg, P.J., "MASCOT and MOP Programs for Probabilistic Safety Assessment PART A: Overview, NSS/R336 AEA-D&R-0476 PART A", AEA Technology, Harwell, (1994).
4. GoldSim Technology Group LLC, "GoldSim Probabilistic Simulation Environment User's Guide", (2009).