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UNCERTATINTY IN SCENARIOS AND ITS IMPACT ON POST CLOSURE LONG TERM SAFETY ASSESSMENT IN A POTENTIAL HLW REPOSITORY

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Abstract

In assessing the long term post closure radiological safety assessment of a potential HLW repository in Korea, three categories of uncertainties exist. The first one is the scenario uncertainty where series of different scenarios are developed by stakeholders. The second one is the modeling uncertatinty where different mathematical models are applied for an identical scenario. The last one is the data uncertainty which can be expressed in terms of probabilistic density functions. In this analysis, three different scenarios are seleceted; a small well scenario, a radiolysis scenario, and a naturally discharged scenario. The AMBER code, a probabilistic safety asssessment code based on the compartment theory is applied to asssess the annual individual doses at the generic biosphere. Results illustrate that the discrepanies among doses for the different scanrios are significant. However, total doses are still well below the guidelines of 2 mRem/yr. Detailed analyses with model and data uncertainties are underway to further assure the safety of a Korean reference dispsoal concept.

1. INTRODUCTION

Uncertainties in dose assessment of a HLW repository come from three different areas. The first one is in scenarios. For example, in the SKB studies for a deep repository project[SKB 1997], five categories of scenarios were identified. The base scenario, the canister defect scenario, climate change scenario, tectonics/earthquake scenario, and scenarios based on human actions are those assessed in the SR97 studies. These are futher developed in the following Project SAFE. The likelihood of the base scenario is further developed. Even though most statements in that study can be applied to the Korean studies, differences in geological conditions and the design concept exists. The same is true to the scenario studies in H12[JNC 1999] where natural disruptive events were the major concerns. As shown in Figure 1, thirty seven cases were quantatively assessed. Among them four different scenarios such as base, uplift/erosion, initial defect of the engineer barriers, and no natural barrier ones were studied. Then, as illustrated in Figure 2, the annual individual dose from many international studies were compared, even though each individual calculation was for the specific scenario, to assure the overall safety of the disposal system.

The same approach is adopted to assure the safety of a potential HLW repository in Korea. At first, major scenarios were identified from the combination of the screened FEP[Y S Hwang, 2002] Then all needed computational tools[Kang 1999] and associated input data were collecet2d from laboratory and field experiments as well as literature surveys[KAERI 2002]. In this study three base scenarios are selected for the performance assessment.

For better understanding of the Korean Base Scenarios, the likelihood of the base scenarios can de summarised as:

1) The expected initial state of the components at repository closure can be defined based on the selection of barrier materials and the design of a repository aswell as the characteristics of the waste and the site.
2) The development of the ecosystem will change from present day conditions, but reasonable further developmets, based on the specific conditions of a site, can be included in the Base Scenario.

3) The boundary conditions to the system, e.g. climate factors, etc, at the time of repository closure are also rather well know.
4) The trend in future climate evolution for the coming several 1,000 years is less clear. In contrast, there is a rather well established consensus for the development of galicial conditions etc over longer time periods. The H12 studies state that within the next 100,000 years, the North-east Asia will be under the strong influence of the glaciation. For the nearest 2,000 years, diffenet short term tends such as global warming compete each other.

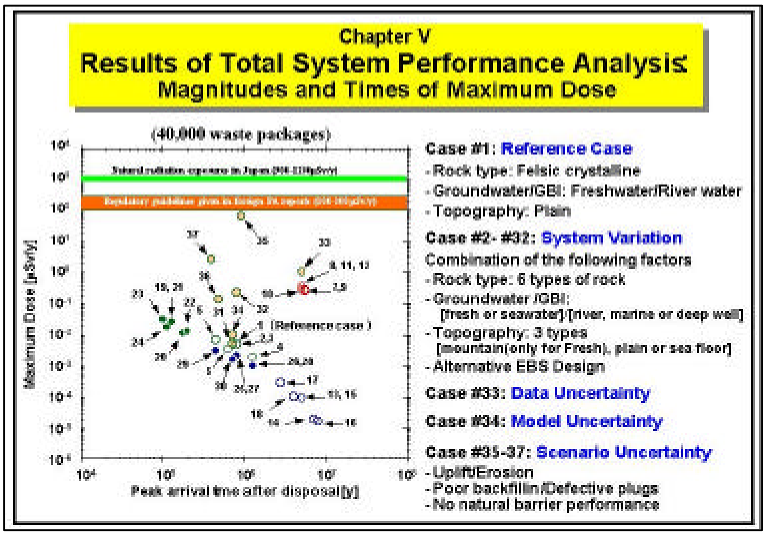

Figure 1. Maxium Doses from Scenario Assessment in H12

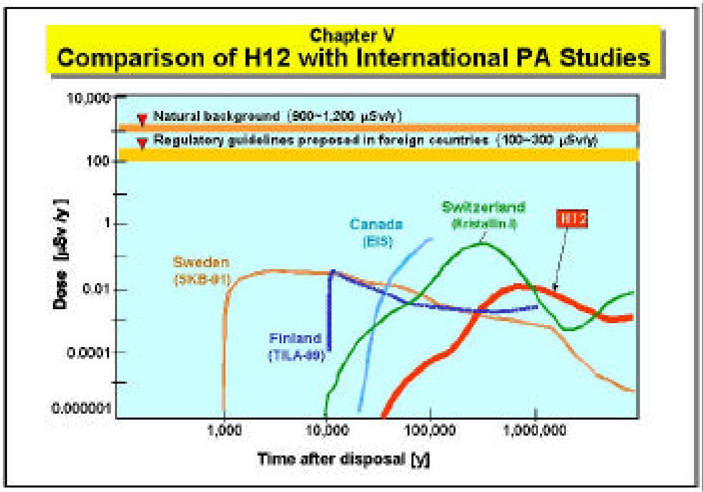

Figure 2. Dose Comparison Among International Studies

2. SCENARIO ASSESSMENT CONTEXT

The arguments on the Base Scenario is quite plausible and a corner stone in the safety assessment of a potential HLW repository in Korea. Under the categories of the Base Scenario, three different scenarios are developed.

(1) Small Well Scenario

The first of is the small well scenario. This is a deterministic case and includes the whole repository. There are two types of spent fuel, PWR and CANDU, which is placed in steel canisters. There are 11,375 PWR canisters and 2,529 CANDU canisters. Each canister is 4.96 m long and has a radius of 0.4 m[KAERI, 1999]. Once the steel container fails, radionuclides statrt to be released. The radionuclide inventory is split into two parts. The “gap” fraction consists of radionuclides that have diffused out of the spent fuel by the time of containment failure. The remainder is released congruently as the fuel dissolves, this process being controlled by the solubility limit of Uranium.

Each canister is surrounded by an annular bentonite buffer, 0.38 m thick. There is also bentonite above and below the canister. The canister and bentonite occupy holes drilled into the floor of the repository tunnels and so the bentonite is in contact with the natural rock. The host rock is a fractured granite. Paths through this granite eventually lead to an aquifer from which water is extracted via a well. The water is used for various purposes that can lead to human doses. Transport through the granite is via fractures with the radionuclides diffusing into the "rock matrix". Biosphere processes are taken to be fully specified by dose conversion factors (Sv/year per Bq/yr leaving the fractures).

(2) Radiolysis Scenario
Differences between the first and this scenarios are summarised as:

1) One percent of the total canister fail at the repository near to a fracture zone after 500 years since emplacement
2) There is a 30 meter fracture and a MWCF(Major Water Conducting Feature), a 800 meter fracture zone in contact with a biosphere.
3) The chemical alteration for the first 5,000 years after the failure of a waste container increases the dissolution rate of a uranium dioxide matrix to 10^{-7} per year and then decreses it to 10^{-8} per year after that.
4) The river biosphere is applied.

(3) Nuturally Discharged Scenario
This scenario is the combination of the near field of the first scenario and the far field and biosphere from the second scenario. Here the waste containment life time is set to be 1,000 years and the length of a fracture is assumed to be 100 meter as used in H12.

3. RESULTS

Figures 3-5 show the annual individual doses from three different scenarios from the AMBER application.

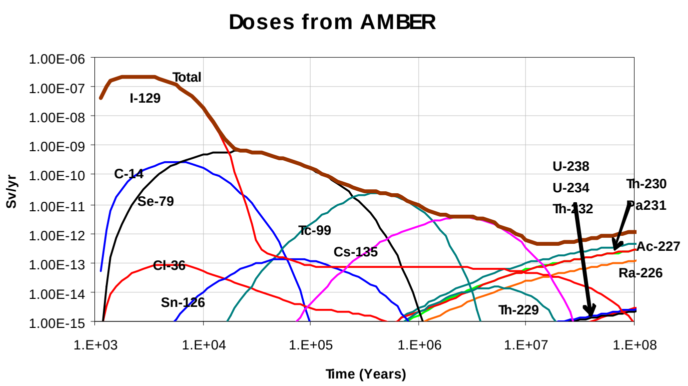

Figure 3. Annual Individual Dose for a Small Well Scenario

Figure 3 shows the annual individual dose as a function of time since emplacement. As shown the so called gap nuclides such as I-129, C-14, Se-79 etc result in higher peaks at earlier times than congruently released ones. Results from this study are compared with those from international studies as well as that by the application of the MASCOT-K. The peaks predicted by the AMBER and MASCOT-K are almost identical and likely to other studies, the dominant nuclide is turned out to be I-129. The peak value from the AMBER application well suits in the range of values from other studies.

Table 1. Comparison of Peak Doses in International Programs

Study	**Peak Dose Rate (Sv/yr)**	**Dominant Nuclide**	**Number of Canisters**
H12	$5.0 \cdot 10^{-9}$	Cs135	40 000
SR97	$5.0 \cdot 10^{-8}$	I129	4 000
SPA – ENRESA	$1.4 \cdot 10^{-6}$	I129	3 600
SPA – GRS	$1.0 \cdot 10^{-5}$	I129	15 600
SPA – IPSN	$1.5 \cdot 10^{-6}$	Ra226	14 400
SPA – VTT	$2.7 \cdot 10^{-7}$	I129	1 400
MASCOT-K KAERI	$2.6 \cdot 10^{-7}$	I129	13 900
AMBER KAERI	$2.3 \cdot 10^{-7}$	I129	13 900
PICNIC/STMAN	$2.5 \cdot 10^{-7}$	I129	13 900

Figure 4 illustrates the doses from the radiolysis scenario. The maximum dose mainly contributed by I-129 in this scenario is similar to that from the first scenario. However, the contribution of other nuclides for overall doses becomes more significant than the first scenario.

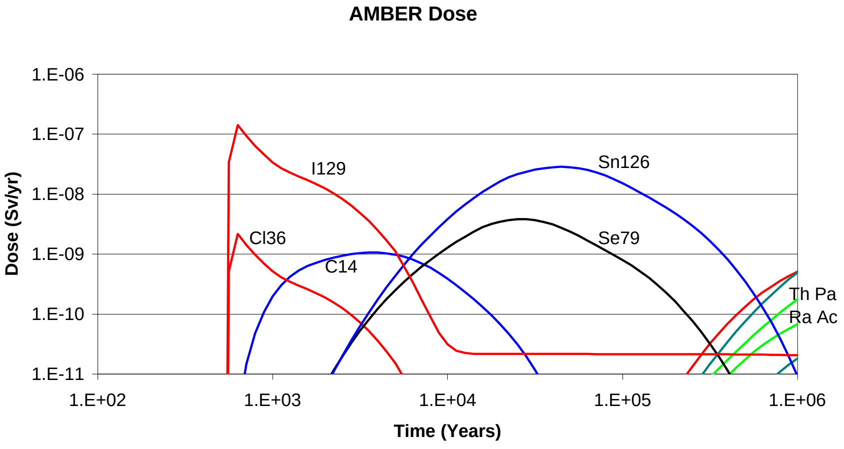

Figure 4. Annual Individual Dose for a Radiolysis Scenario

Figure 5 illustrates the annual individual doses from the naturally discharged scenario. The maximum dose mainly contributed by I-129 is significantly reduced due to the capacity of natural barriers to hold nuclides in both a fracture and a fracture zone.

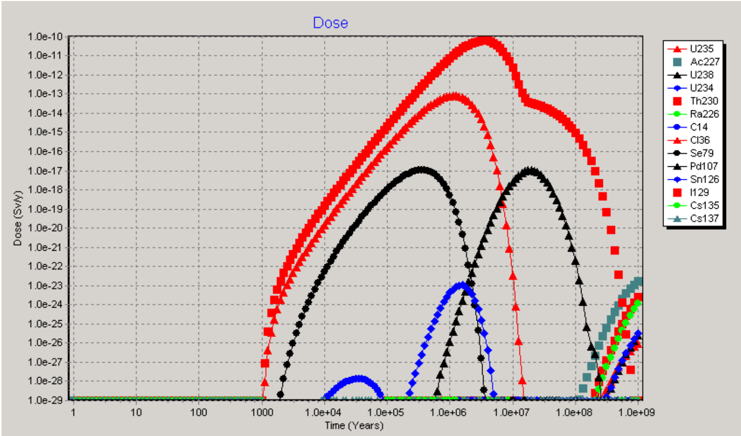

Figure 5. Annual Individual Dose for a Naturally Discharged Scenario

CONCLUSIONS

For outlines of assessment context on the Korean Base Scenario, three different scenarios are developed. For each scenario, annual individual doses are estimated by the AMBER code. Results from the first scenario, a small well one agrees well with those from international studies. The so called gap nuclides turn out to be significant. The doses from second and the third scenarios also show that they are below the limit of 2mRem/yr.

In this analysis only the uncertainties in the scenarios are studied. Currently in KAERI, uncertainties in the model as well as the data are under investigation.

ACKNOWLEDGEMENT

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