Preliminary Assessment of Radioactive Gas Release in a Near-Surface Disposal Facility

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In order to reasonably assure the post-closure safety of a radioactive waste disposal facility, it is necessary to assess gaseous phase release of radionuclide as well as groundwater release. Radioactive isotopes such as ^{3}H and ^{14}C that might be present in the waste inventory can produce a radioactive component in the generated gas, in particular ^{3}H-containing hydrogen and ^{14}C-containing methane. The principal mechanisms by which these gases will be generated within a low- and intermediate-level waste(LILW) disposal facility are anaerobic metal corrosion and microbial degradation of cellulosic materials, respectively. A further radioactive gas whose release at the surface may pose a hazard is radon. ^{222}Rn could be generated from the decay of ^{226}Ra in the Pu and Cm chains. In this paper, a simple assessment of the potential effects of gas generation on the performance of an engineered vault type LILW disposal facility in Korea is presented. This assessment addresses the immediate release of gases to the air or into a house at the surface of the facility once it is formed, and the potential radiological impact of radioactive gases inhaled by the public.

In the gas release scenario, it is assumed that when active institutional control period, assumed as 100 years after the end of disposal operations, has been completed, those who enter the disposal facility inhale air containing radioactive gas. There could be releases of gaseous species, e.g. ^{3}H, ^{222}Rn and ^{14}C gases, in this period. Following the end of passive institutional control at 300 years after closure, it is assumed that the cover is fully eroded and a house is constructed on the facility site. Effective dose due to inhalation of the gas is calculated by considering the release of gas into a house built on top of the disposal vault and in the air above the disposal facility. A mathematical model is implemented in the AMBER compartment model software application[1]. For ^{3}H and ^{14}C, the associated gas concentrations are derived by taking account of wind on the ground and/or ventilation in the house. For ^{222}Rn, the release rate in gas is evaluated from the model used in the NEA analysis[2].

Figure 1 and Table 1 show the annual individual dose from inhalation of ^{3}H, ^{14}C, and ^{222}Rn from the decay of ^{226}Ra in the ^{238}Pu and ^{242}Cm chains. Doses resulting from ^{3}H and ^{14}C are less than 2E-7 Sv/yr. Radon doses are also less than about 4E-12 Sv/yr up to the end of institutional control period, but when a house is assumed to be constructed, the estimated doses would jump by about two orders of magnitude due to the lower rate of dilution in the house than in the open atmosphere. The resulting doses then continue to rise due to the in-growth of ^{226}Ra. They peak at 200,000 years for ^{222}Rn in-growth from the ^{238}Pu and ^{242}Cm chains with dose values of 2.1E-7 Sv/yr and 1.1E-9 Sv/yr, respectively. Results presented in Table 1 indicate that, for the gas release calculations, the peak dose summed across all radionuclides is far below the dose constraint of 2E-5 Sv/yr. The calculations are highly conservative in that it is assumed that there is no loss of activity from the waste except by decay and gaseous emissions, and after 300 years the cover over the waste is removed by erosion.

Table 1. Timing and magnitude of peak doses for gas release

Radionuclides	Time (yr)	Peak dose (Sv/yr)
^{3}H	10	3.10E-10
^{14}C	300	1.28E-7
^{222}Rn from ^{238}Pu decay chain	200000	2.11E-7
^{222}Rn from ^{242}Cm decay chain	200000	1.13E-9
Total	200000	2.12E-7

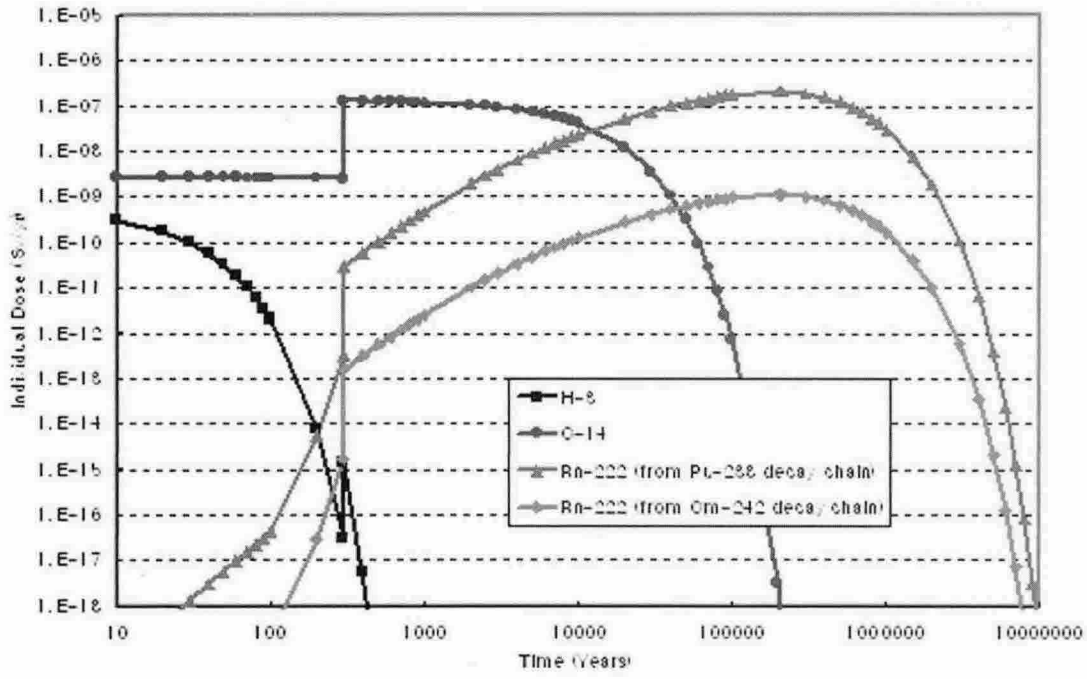

Figure 1. Annual individual doses for gas release

ACKNOWLEDGEMENT

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REFERENCES

[1] Quintessa Limited, "AMBER Version 4.4 Reference Guide, Version 1.01e," Henley-on-Thames, UK, 2003

[2] Nuclear Energy Agency, "Shallow Land Disposal of Radioactive Waste: Reference Levels for the Acceptance of Long-Lived Radionuclides," A Report by an NEA Expert Group, Nuclear Energy Agency, Organisation for Economic Co-operation and Development, Paris, 1987.