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Safety Assessment for the Landfill Disposal of Solidified Cement Wastes

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■ Introduction

- ✓ Various and large amount of radioactive wastes with different characteristics will be generated from the decommissioning of a nuclear power plant (NPP).
- ✓ Therefore, the safe management policy including treatment and disposal of decommissioning wastes should be established.
- ✓ Decommissioning wastes can be disposed of into a surface and landfill disposal facilities depending on the radioactivity level.
- ✓ Among the decommissioning wastes, very low-level wastes (VLLW) such as solidified cement wastes can be disposed of into a landfill site.
- ✓ The purpose of this study is to check the disposal feasibility of solidified cement waste in terms of radiological safety.

■ Solidified cement waste

- ✓ Contaminated concretes are generated from the neutron activation during the operation of a NPP.
- ✓ They can be solidified with MKPC (magnesium potassium phosphate cements) for the immobilization.
- ✓ MKPCs have a high early strength, a high bonding strength, a little drying shrinkage, a low permeability, and a high sulfate resistance.
- ✓ The stable isotopes of cobalt and cesium are added to the solidified waste specimen.

■ Safety assessment tool

- ✓ RESRAD-Onsite code is a computer model to assist in developing cleanup criteria and assessing the dose or risk associated with residual radioactive material.
- ✓ It has been used widely in government agencies, research institutes, and industries in many countries.
- ✓ The important exposure pathways considered in the RESRAD-Onsite code are external exposure, inhalation, and ingestion of contaminated foods.
- ✓ Most input data are derived from the references and the data for the primary contamination zone and the cover are summarized in Table 1.
- ✓ We assumed that the radionuclides of Co and Cs are ^{60}Co and ^{137}Cs, respectively. And we use 1.0 Bq/g for the radioactivity concentration of both ^{60}Co and ^{137}Cs.

Table 1. Input data for the base case

Input variable	Value
Area of contaminated zone (m^2)	14,250
Thickness of contaminated zone (m)	16
Length parallel to aquifer flow (m)	600
Depth of cover (m)	0.5
Density of cover material (g/cm^3)	1.6
Erosion of contaminated zone (m/yr)	0.001
Total porosity of contaminated zone	0.15
Hydraulic conductivity in contaminated zone (m/yr)	100
Evapotranspiration coefficient	0.68
Wind speed (m/sec)	2.1
Precipitation (m/yr)	1.7
Runoff coefficient	0.2
Humidity in air (g/cm^3)	8.0

■ Results and discussion

- ✓ The exposure doses resulting from the landfill disposal of concrete powder wastes solidified by the MKPCs are shown in Fig. 1.
- ✓ As shown in this figure, even at the time of disposal, the total exposure doses do not exceed 0.1 mSv/yr which is the safety goal for the regulation of the low- and intermediate-level radioactive waste repository.
- ✓ Exposure doses decrease with time and they become negligible at the time of 300 years that is the institutional period of a radioactive waste repository in Korea.
- ✓ The contribution of each exposure pathway to the total exposure doses at 30 years are shown Fig. 2. The most important pathway is the ingestion of plants for both ^{60}Co and ^{137}Cs.
- ✓ The second important pathways are the external exposure from the ground for ^{60}Co and the ingestion of meat for ^{137}Cs, respectively.
- ✓ According to the sensitivity analysis results for the cover depth, the total exposure doses and exposure doses for each pathway decreases as the cover depth increases.
- ✓ The total exposure doses increase as the erosion rate of cover material increases because the radionuclides may release to the ground surface due to the fast erosion of cover material.
- ✓ As the density of cover material increases the external exposure dose from the ground surface decreases.

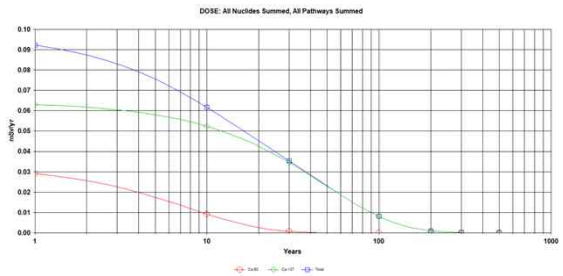

Fig.1. Exposure doses as a function of time

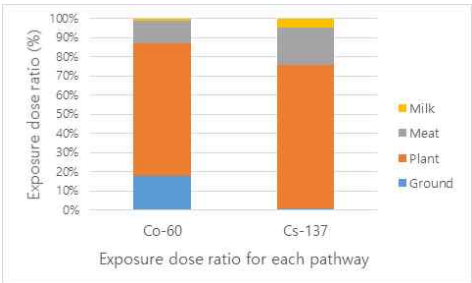

Fig.2. Exposure dose ratio for each exposure pathway for each radionuclide

■ Summary

- ✓ We estimated exposure doses resulting from the landfill disposal of solidified concrete powder wastes with MKPCs to check the disposal feasibility.
- ✓ We found out that total exposure doses are below 0.1 mSv/yr that is the safety goal for the low- and intermediate-level radioactive waste repository.
- ✓ Therefore, the solidified concrete powder wastes with MKPCs containing ^{60}Co and ^{137}Cs can be disposed of into a landfill site safely.