Dose evaluation of residents around landfill facilities using recycled concrete solidifying agent

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1. Introduction

When decommissioning a nuclear power plant, a lot of radioactive waste is generated. This volume is expected to be over 80,000 drums, where the volume of one drum is 200 L. And the concrete waste accounts for more than 70% of total waste. The volume of coarse and fine aggregates in concrete generally accounts for more than 60%. Separation of the contaminated part of concrete waste can reduce the cost of waste disposal [1].

When the separated radioactive waste of concrete paste and fine powder is manufactured as a solidifying agent for the waste disposal container, secondary waste is minimized, where, otherwise, most of such a separated radioactive waste should be disposed of as low level radioactive waste. In addition, the amount of general solidifying agent can be greatly reduced and the volume of nuclear power plant concrete waste subject to disposal can be reduced. When radioactive waste is landfilled using this recycled concrete solidifying agent, radiation safety assessment of residents near the landfill facility should be performed. In this study, dose evaluations of residents near the facility where the solidifying agent was used for landfill were evaluated.

2. Methods and Results

This section describes the important assumptions and the result of dose evaluation. The assumptions include the facility condition and the code used for the evaluation of radiological safety of residents in the vicinity of a landfill facility.

2.1 Important Assumptions

The RESRAD code designed at Argonne National Laboratory was used in order to evaluate external and internal exposure of residents near the landfill facility. RESRAD code is a computer code which enables to estimate radiation doses to an individual located on top of radioactively contaminated areas [2]. The radioactivity concentration value in the concrete waste was used as a result of the previous radioactivity evaluation [3]. The considered nuclides are ^{60}Co, ^{152}Eu, and ^{154}Eu. The radioactivity concentration value for ^{60}Co, ^{152}Eu and ^{154}Eu in the concrete waste was 1.620E+3 Bq/g, 1.042E+1 Bq/g, and 2.680E-3 Bq/g, respectively.

The disposal facility reflects the environment of the Gyeongju Low and Intermediate-level radioactive Waste (LILW) disposal facility in Korea. The LILW disposal facility is classified into two types: the first stage of near-surface disposal and the second stage of deep geological disposal.

For a conservative evaluation, this study evaluates the landfill site using the near-surface disposal method. The near-surface disposal is a method of disposing of radioactive waste after digging the surface 1~2 m shallowly, making a disposal shed with concrete. The depth of disposal facility was assumed to be 1 m for conservative evaluation. It was also assumed that radioactive waste was buried in 21 disposal vaults (width 20 m, length 20 m, height 0.6 m) each having an area of 400 m^2. The contaminated zone had 84,000 m^3 which has area of 8400 m^2 and height of 10 m. In this contaminated area, the unsaturated zone is located about 70 m above the aquifer, and the topographical characteristics such as wind speed and precipitation were set based on the 10-year record of Gyeongju. Fig. 1 shows the Gyeongju LILW disposal facility.

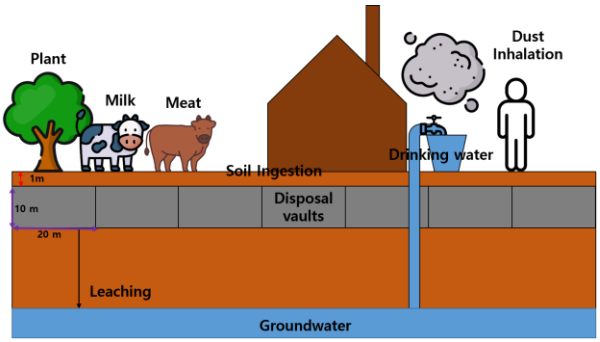

Fig. 1. Schematic diagram of GyeongJU LILW disposal facility for dose evaluation

2.2 Dose evaluation

According to Article 99 (2) of the Enforcement Decree of the Nuclear Safety Act, the post-shutdown management period of radioactive waste disposal facilities using the near-surface disposal method, other than the mined cavity disposal method is up to 300 years [4]. Therefore, the exposure dose of residents after 300 years of the post-shutdown management period was evaluated. The respiratory rate of the occupants after shutdown was assumed to be 7400 m^3/y, which is the average value considering the situation by indoor and outdoor activity level. In addition, the residents were assumed to live on the upper part of the landfill layer after shutdown for conservative evaluation [5]. They

stayed in the building for 1/2 of the year and stayed outside the building for 1/4 of the year [6].

Table I: Residents Exposure Dose (unit : mSv/yr)

	^{60}Co	^{152}Eu	^{154}Eu
External	5.960E-18	2.132E-10	8.670E-16
Inhalation	0.000E+00	0.000E+00	0.000E+00
Plant	2.625E-16	4.820E-10	2.771E-15
Meat	3.552E-17	6.521E-12	3.749E-17
Milk	3.830E-18	1.758E-13	1.011E-18
Soil	0.000E+00	0.000E+00	0.000E+00
Total Dose	7.02E-10		

Table I shows the results of the evaluation of resident exposure dose after 300 years of post-shutdown management period. There was no effect on inhalation and soil ingestion. Also, there was a slight effect on external exposure and plant, meat, and milk ingestion. However, as a result of external and internal exposure to the three considered radionuclides (^{60}Co, ^{152}Eu, and ^{154}Eu), the total exposure dose was 7.02E-10 mSv/yr. It confirms that the residents in the vicinity of a landfill facility were radiologically safe.

3. Conclusions

In this study, external exposure of residents around landfill facilities using recycled concrete solidifying agent was evaluated by using RESRAD code. When the concrete waste is recycled as a solidifying agent and landfilled at the Gyeongju LILW facility, it was confirmed that there is little effect on the radiation safety of the residents in the vicinity of a landfill facility after shutdown. It is necessary to study the evaluation of the safety of the workers of the LILW facility

ACKNOWLEDGMENT

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea (No. 20203210100150).

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