Development of Contamination Evaluation and Classification System for Radioactive Soil and Concrete Waste from NPP Decommissioning

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1. Introduction

Concrete waste accounts for more than 70% of the waste generated during the dismantling of nuclear facilities, and in the case of commercial nuclear power plants, it is expected that approximately 500,000 to 550,000 tons of concrete waste will be generated. Therefore, it is necessary to improve dismantling waste management by facilitating classification, storage, determination of final disposal plan and generation history at the generation site.

In this study, in order to minimize the amount of radioactive waste generated and optimize its management, we made modularized LTS (Linear Transfer System) conveyor system for waste classification and its performance was tested using radioactive materials. And the results are described.

2. Methods and Results

Typical radionuclides detected in radioactive concrete waste from nuclear facility are ^{60}Co, ^{137}Cs, ^{152}Eu and ^{154}Eu, and detected in soil waste are ^{60}Co, ^{137}Cs and ^{152}Eu[1-5]. So, we selected ^{60}Co and ^{137}Cs, which are detected simultaneously in concrete and soil, as the nuclides of interest, and used low level and very low level RM (Reference Material) radiation sources, respectively, to evaluate the performance of the contamination assessment module of the classification system. The RM sources used for the test evaluation were made and used with simulated concrete and soil sources. In the test, the sources were placed in each equally divided section in an acrylic box for radioactivity assessment. The classification system cannot distinguish between the weight of the acrylic and the RM sources. Therefore, the radioactivity concentration was calculated including the weight of the acrylic box(15 kg).

The temperature during the test was 29.4 ℃ to 34.9 ℃, and the humidity was 74 % to 96.6 %.

2.1 Background Measurement and Energy Calibration

After moving and setting up the HPGe for performance testing, the first work was background radiation measurement and energy calibration. Background radiation measurement was taken using an empty measurement container. The energy calibration work was performed by dividing the measurement container into 9 sections and placing 1 liter of CRM source in each divided section.

2.2 LL(Low Level) RM source measurements

LL simulated concrete and soil sources were measured for 10 minutes after placing 2 kg of sources in each 9 sections. Table 1 explains specification of simulated concrete and soil sources. Figure 1 shows the measurement rate of CRM, and simulated concrete and soil sources.

Table 1. Specification of simulated concrete and soil low-level RM sources

	Simulated Concrete		Simulated Soil	
	^{60}Co	^{137}Cs	^{60}Co	^{137}Cs
Weight	2,029.1 g		2,025.9 g	
Concentration (Bq/g)	0.1291	0.1231	0.1400	0.1327
Average Measurement Rate (%)	52.86	53.51	53.75	57.83

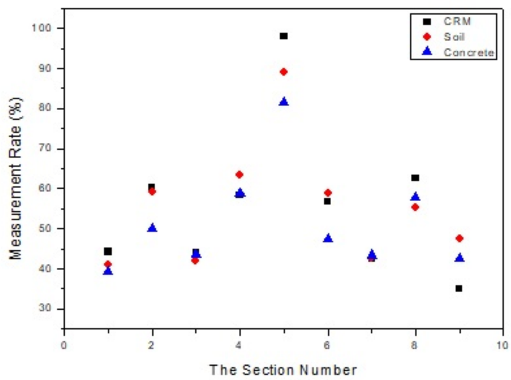

Fig. 1. Measurement rate of simulated Soil and Concrete RM and CRM sources

2.3 VLL(Very Low Level) RM source measurements

VLL soil and concrete source had an extremely low radioactive concentration, and it was difficult to detect the energy peak if measured in the same way as low -level measurement. Therefore, the VLL sources were measured with a linear arrangement of sources. Table 2 shows the specification of the VLL sources, and Fig. 2 shows the arrangement and procedure for measurement. Fig. 3 shows the measurement rate of VLL simulated concrete and soil source.

Table 2. Specification of VLL simulated concrete and soil RM sources

	Simulated concrete		Simulated soil	
	^{60}Co	^{137}Cs	^{60}Co	^{137}Cs
Weight	2,029.1 g		2,025.9 g	
Concentration (Bq/g)	0.0803	0.0754	0.124	0.119
Average Measurement Rate (%)	68.87	57.46	55.84	61.60

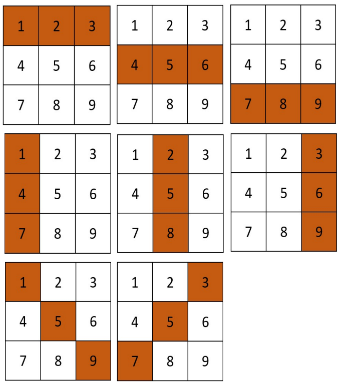

Fig. 2. The measurement arrangement and procedure of VLL simulated soil and concrete RM sources

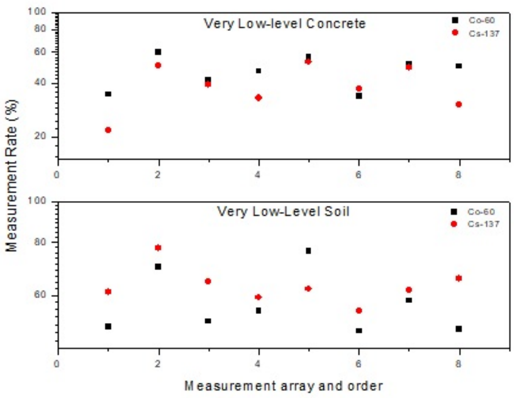

Fig. 3. Measurement rate of VLL simulated soil and concrete RM sources

We confirmed that the contamination assessment module works well in an environment with relatively high temperature of 34.9 °C and humidity of 96.6 %. Section 5 of Figure 1 means the radiation source placed right below the HPGe. The measurement rate of CRM was 98% in the section 5, which is the center of the measuring container.

In case of VLL RM sources, it was measured for 60% in the middle of the walls of the measuring container (2, 4, 6, 8) and 43% in the corners (1, 3, 7, 9) as shown in Figure 2. As a result, it can be confirmed that the measurement results of the RM radiation sources also showed the same tendency depending on the arrangement of sources.

Finally, we confirmed that the measurement rate decreases as the radiation source moves away from HPGe. In order to improve the situation, we plan to adjust the distance between the measurement container and the HPGe and install an auxiliary detector at the contamination assessment module.

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