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Development of the Tools and Sampling Method for an Analysis of Radioactive Contaminated Soils in a Storage Facility

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1. Introduction

In the radioactive waste storage facility at the Korea Atomic Energy Research Institute (KAERI), about 3,100 drums of radioactive contaminated soils and concretes have been stored since their generation in 1988. To secure the storage capacity and to reduce a disposal cost and a management cost, these soils and concretes must be treated and reduced in volume.

Before the treatment, the radiological characteristics of the wastes should be confirmed. For that, a package should be unsealed to identify the contents and take a sample.

In this study, tools for a treatment of the contaminated soil and equipment for restricting a contamination were developed. Also, a method to create a representative sample out of 200 liters of soil was suggested. Finally, the representativeness of the sample was verified.

2. Status of contaminated soils

The contaminated soils were generated and have been stored in 200 liter drums in the storage facility since 1988. The radiological characteristics of the soils are not known exactly. Only the contents of each drum and the surface dose rate measured at the generation time are known.

For a convenience, drums with soil, concrete, a soil and concrete mixture or a soil and ash mixture have been managed as a soil drum.

Soil is better than concrete for creating a homogenized representative sample for an analysis and a treatment. So, the objective of this study is limited to the treatment of radioactive soil wastes.

3. Equipment development

3.1. Equipment for restricting a contamination

Unsealing a drum in the storage facility is not allowed because the radioactive material in the drum can spread to contaminate the working place. So some equipment and tools for restricting a contamination during an unsealing of the drum in the storage facility have been developed and applied to the sampling and the classification operation.

First, an airtight working booth with the dimensions of 3,500mm × 2,500mm × 2,500mm was made for limiting a contamination and installed at the storage facility. At the exterior of the booth a ventilation system, a water line and a power line can be connected. For lighting, there are windows at the front side and at the backside of the booth. The bottom board of the booth is strengthened by a steel plate to support the heavy soil drum and the tools used in the booth. The top of the booth can be separated from the body for an easy transfer of the booth and an easy insertion of a material with a large volume into the booth.

The ventilation system has the dimensions of 860mm × 610mm × 610mm. It is composed of a ventilator with a capacity of $20m^3$/min, a pressure gauge, a pre-filter and a HEPA filter. It is attached to the booth and operated during the sampling process. The purposes of the ventilation system are the provision of fresh air to the workers and a reduction of the internal dose to the workers by removing the radioactive dust released from the soil wastes.

3.2. Tools for a sampling

A SUS tray with the dimensions of 1,400mm × 1,400mm × 320mm was manufactured. It was used for holding the soils contained in the package drum. As a hole with a cover is located in the center of the tray, after a sampling, the remaining soils can be discharged to the packaging drum easily.

A 10 × 10 grid is used to create 100 even sections in the homogenized soil. A number is assigned to each section. Soil samples are taken as a total of 30 sections according to the pre-generated random numbers. The 30 samples are mixed to make a 2 liter representative sample for a 200 liter drum.

3.3. Tools for drum handling

Since the soil drum is too heavy to be treated by a worker, a drum lift is used in the working booth. Also, a fork lift is applied to a movement of the tray containing the soil wastes.

4. Management of the working process

For an identification of the radioactivity in the soils, a systematic working process was developed. First, a drum appropriate for the sampling operation was selected. Then, by unsealing it, the contents of the drum were identified. After recording the surface dose rate of the drum, the soils in the drum were poured onto the tray. Following a homogenization of the soil, a sampling was performed. The sample was then transferred to another facility for the analysis. By the result of the measurement, the soil drum was categorized as a radioactive waste or an objective for a regulatory clearance [1]. The diagram for the working process is shown in Figure 1.

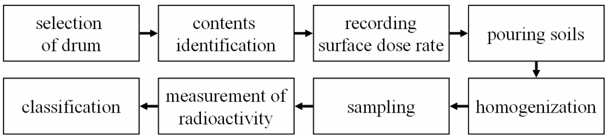

Figure.1 Working procedure for soil sampling and radioactivity measurement

5. Representativeness of a sample

For a verification of the sampling process, 50 1 liter samples were taken from a drum according to the working process described above. The radioactivity concentrations of the 50 samples were analyzed and the results were compared with each other.

The distribution of the total radioactivity concentration is shown in Figure 2. As shown, the difference in the radioactivity concentration is not so large. The difference may be caused by an incomplete homogeneity or measurement error. According to the result, the sampling method suggested in this study has a 1.43% error including a measurement error.

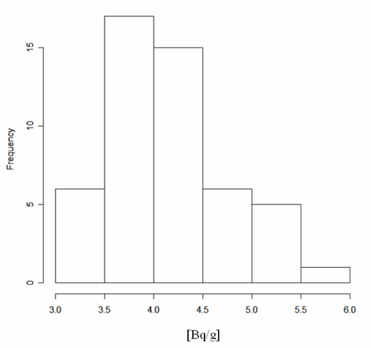

Figure 2. Distribution of total radioactivity concentration [Bq/g]

6. Results

The major radionuclides in the contaminated soils were analyzed as Co-60 and Cs-137. As minor nuclides small amounts of Mn-54, Fe-59, I-131, Cs-134 and Eu-152 were detected in a few soils. Because the soil wastes have been stored for more than 16 years, the radioactivity of the soils has decayed a lot and become much lower than the original activity.

Total radioactivity concentration of the soil is distributed as shown in Figure 3. The distribution is based on the analysis results for 1,545 drums. About 66.4% of the soils show a total radioactivity concentration below 0.1 Bq/g, while the soils with more than 0.4 Bq/g of a radioactivity concentration account for only 5.6% of the total soil drums.

IAEA has recommended regulatory clearance criteria for some radionuclides and that for Co-60 and Cs-137 is 0.1Bq/g respectively [2]. Since about 66.4 % of the soils have a total radioactivity of below 0.1Bq/g, they can be regulatory cleared without any treatment.

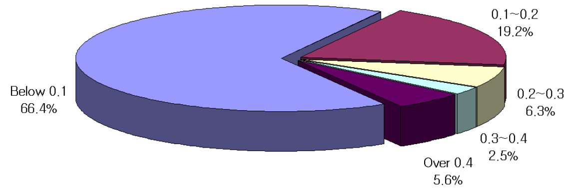

Figure 3. Distribution of radioactivity concentration of soil [Bq/g]

7. Conclusions

It can be concluded that among the radionuclides used at the decommissioned facility, only Co-60 and Cs-137 are left and these nuclides are concentrated as a small portion of the contaminated soil. Also, a radioactive analysis for contaminated soils or concretes should be performed at their generation time to reduce the amount of waste and the storage cost.

Finally, the equipment, tools and working procedure developed in this study can be applied to the treatment of contaminated soils and concrete in a storage facility. Also, the sampling method based on the developed working procedure is applicable to radioactive wastes such as soils, concrete, rock or ashes.

REFERENCES

[1] D. S. Hong, J. S. Shon, T. K. Kim, et al., A Study on the Radioactive Characteristics of Soils in the Storage Facility of KAERI, Transactions of the Korean Nuclear Society Autumn Meeting, Busan, Korea, Oct. 27-28, 2005, (2005)

[2] International Atomic Energy Agency, Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance, Safety Reports Series No. 44, International Atomic Energy Agency (IAEA), (2005).