Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 26-27, 2023

Self-disposal of metal duct wastes from the radiological controlled area of the Radiochemical Analysis Facility at KAERI

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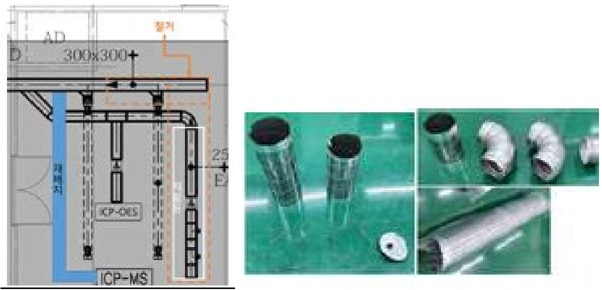
1. Introduction

In the domestic legislative context, the term “regulatory release” pertaining to radioactive waste is commonly referred to as “self-disposal.” Regulatory release entails the exclusion of previously regulated radiation sources or activities from the ambit of regulatory control, thereby effectively removing such control. “Self-disposal” is precisely defined in the Atomic Energy Safety Act`s application as per the Nuclear Safety Commission`s official notification, titled “Regulations on Classification and Criteria for Self-Disposal of Radioactive Waste (No. 2020-06).” According to this definition, once it is established that the concentration of radionuclides in the radioactive waste falls below the prescribed permissible concentration for self-disposal, the waste is thereafter managed through means such as incineration, burial, or recycling, treating it as non-radioactive waste. Within the operations of the Korea Atomic Energy Research Institute(KAERI)`s nuclear facilities and radiation testing facilities, a diverse array of radioactive waste is generated. The self-disposal methods for radioactive waste can be categorized into volumetrically contaminated waste and surface-contaminated waste, based on factors such as the physical form of wastes and degree of contamination.

This study aims to present a case of self-disposal initiative concerning the metal duct generated within the mass analysis laboratory of the Radiochemical Analysis Facility. Firstly, comprehensive measurements were conducted on the entire target waste, encompassing surface area, weight, and surface contamination. The obtained measurement results yielded values below the background (BKG) level. It is noteworthy that all equipment utilized in this process underwent calibration by accredited institutions. The surface contamination for beta-emitting radionuclides was determined to be below < 2.04E-04 Bq/cm^2, with the evaluated maximum radioactivity concentration recorded as <2.04E-04 Bq/g. Furthermore, a gamma spectrometry analysis was performed on the target waste, resulting in the absence of detectable radioactive isotopes. This particular case has successfully obtained the final approval for self-disposal from the Korea Institute of Nuclear Safety Technology and is presently under temporary storage within a dedicated self-disposal storage facility located within the premises of the KAERI. The research findings hold promise in assisting future endeavors pertaining to the processing and disposal of self-disposal waste that may potentially arise during the facility`s operational activities.

2. History of self-disposal waste generation

The site of waste generation was the mass analysis laboratory within the Radiochemical Analysis Facility, where the need for replacement of pertinent equipment arose to improve performance. Consequently, during the process of internal fan replacement and reconfiguration of existing connections to facilitate the operation of the testing equipment, an approximate quantity of 20.7 kg of metallic waste was generated, as depicted in Fig 1.



(a) (b)

Fig 1(a). The schematic diagram for the repositioning of the air conditioning system, (b) the obsolete equipment generated subsequent to the reconfiguration process.

3. Sample collection and radiological characterization

Firstly, measurements of the background radiation levels were conducted within the radiation control area. Subsequently, surface radiation dose rates were measured for the entire surface area of the target waste. The procedural steps for obtaining the measurement values are illustrated in Fig 2.

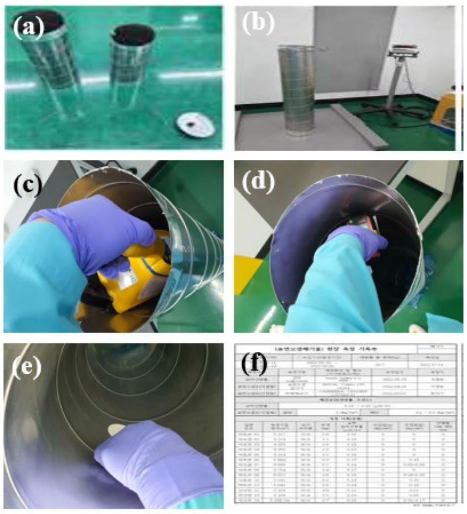


Fig 2 (a) surface area, (b) weight. (c) surface contamination (direct method), (d) surface radiation dose rate, (e) surface contamination (indirect method), (f) measurement record.

Although the waste, being a facility equipment, did not exhibit any contamination due to the absence of direct contact with radioactive materials, a conservative approach was taken to estimate the radioactivity concentration of the waste. This involved assuming a scenario where beta-emitting radionuclides are uniformly distributed throughout the object. To perform the estimation, five specific radionuclides (C-14, Fe-55, Ni-63, Sr-90, I-129) were selected from the licensed isotopes used within the laboratory where the waste originated. The formula utilized for the estimation is presented below.

$$Concentration\left(\frac{Bq}{g}\right) = \frac{\mathrm{a}}{b \times c} \times \left(\frac{d}{e}\right)$$

Here, a is the activity (Bq), b is the specific area (cm^2), c is the transmittance (=0.5), d is the surface (cm^2), and e is the mass (g). The surface radiation dose rate measurement results for the metal duct have been summarized in Table 1. In summary, the surface contamination for beta-emitting radionuclides was determined to be below <2.04E-04 Bq/cm^2, and the maximum evaluated radioactivity concentration was found to be below <2.04E-04 Bq/g. Furthermore, gamma spectrometry analysis was performed on the target waste, and no detectable radioactive isotopes were observed. Consequently, based on the aforementioned analytical results, it can be conclusively inferred that the waste remains uncontaminated by gamma and beta-emitting radionuclides. Table 1 presents the results of the waste contamination measurements.

Table 1. Results of waste contamination measurements

Contents					
Type	Gamma (μSv/h)		Surface contamination		
	γ	BKG	Direct measurement (cps)		Indirect measurement (Bq/cm^2)
			β	BKG	β
Metals	< BKG	0.19	< BKG	22.0	< MDA (2.04E-04)

4. Final approval of self-disposal and temporary storage

In this study, radiation dose and surface contamination measurements were conducted using direct and indirect methods of the entire surface area of the waste intended for self-disposal. Based on the measurement results and obtaining approval from the regulatory authority, it was determined that there was no contamination from the primary licensed radioactive sources in the facility, thereby finalizing the disposal process. It is anticipated that similar wastes will be generated in numerous other nuclear facilities and radiation testing facilities in the future, and the findings of this study can serve as a valuable reference for promoting self-disposal of such wastes. Considering the significant cost reduction achieved by self-disposal in terms of radioactive waste disposal costs, there are plans to continue conducting research on specific guidelines for the treatment of self-disposal wastes

5. Acknowledgement

This work was supported by the KAERI Institutional Program(Project No. 521320-23)

6. References

[1] Korea Institute of Nuclear Safety Regulatory Guidelines 2015, Safety Evaluation of Self-disposal of Radioactive Waste, KINS/RG-N12.08.

[2] Korea Institute of Nuclear Safety Guidelines for the Review of Self-disposal Plans for Radioactive Waste from Nuclear Fuel Cycle Facilities, KINS/GE-W004.

[3] Atomic Energy Safety Commission Announcement 2000, No. 2020-06, Regulations on Classification and Self-disposal Criteria for Radioactive Waste.