

Cost-Benefit Analysis for the Regulatory Clearance of Soil and Concrete Waste at KAERI

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ABSTRACT

At Korea Atomic Energy Research Institute (KAERI) in Daejeon, about 4,800 drums of radioactive soil and concrete waste had been stored since their generation and transport to Daejeon in 1988. The waste had been stored for more than 18 years, so some of it was regularly cleared. For the clearance, since 2005, the radiological characteristics of soil and concretes had been analyzed using 1 liter samples out of 200 liter drum wastes. Based on the analysis result, the environmental impact due to the clearance was estimated in 2007. Finally, about 2,800 drums of waste were regulatory cleared and disposed from 2007 to 2008. The cost for the clearance can be classified as equipment and tools cost, characterization cost, radiological dose assessment cost, transport and disposal cost, material cost, outsourcing cost, and so on. Additionally, about 30 drums of secondary waste were generated. The total cost for the clearance was estimated to be about 0.83 million US dollars. As the disposal cost is estimated to be more than 4,300 US dollars per drum in Korea, the regulatory clearance shows a cost-benefit ratio of more than 14.6, and it can be concluded to be very beneficial work in regard to economic efficiency.

INTRODUCTION

In the radioactive waste storage facility at the Korea Atomic Energy Research Institute (KAERI), about 4,800 drums of radioactive contaminated soil and concrete waste had been stored since their generation in 1988. This waste had been generated during the decommissioning process of a research reactor and its attached facilities in Seoul. Since the waste had been stored for more than 18 years, some of it with an extremely low level radioactivity was regulatory cleared in 2007. The amount of cleared waste was about 2,800 drums (in 200 liter drum).

For the clearance, some equipment for sampling, analyzing, and drum handling was used, and some parts of the drum handling and sampling were outsourced. Based on an assessment result of the environmental impact, the clearance was licensed from the regulatory body. Finally, the cleared waste was transported and disposed. During these activities, secondary waste was collected and treated.

Each clearance activity was costly while a huge amount of disposal cost was saved. In this study, the cost for the clearance and the disposal cost saving were analyzed, and, based on that, the economic efficiency of the regulatory clearance was discussed.

REGULATORY CLEARANCE OF SOIL & CONCRETE

For the regulatory clearance, a sampling and radioactivity analysis was started in 2005. First, a drum with a written surface dose rate below $0.3 \mu\text{Sv/hr}$ was selected for sampling. After unsealing, the contents of the drum were identified and poured into a tray for sampling. If the content was concrete, it was crushed into smaller particles before pouring. Following the homogenization of waste on the tray, a 1 liter sampling out of a 200 liter drum waste was performed. Finally, based on the analysis result of the sample, the waste with a radioactivity concentration of more than 0.4 Bq/g was categorized as radioactive waste unless it was classified as an objective of the regulatory clearance.

Based on the environmental impact assessed using a clearance scenario of objective waste, the regulatory body licensed the regulatory clearance in 2007. After that, the quantity of the waste and the method for regulatory clearance were finally determined.

The cleared waste was amounted to about 2,800 drums and was transported to a public landfill and then disposed from 2007 to 2008. The clearance procedure is shown in Fig. 1.

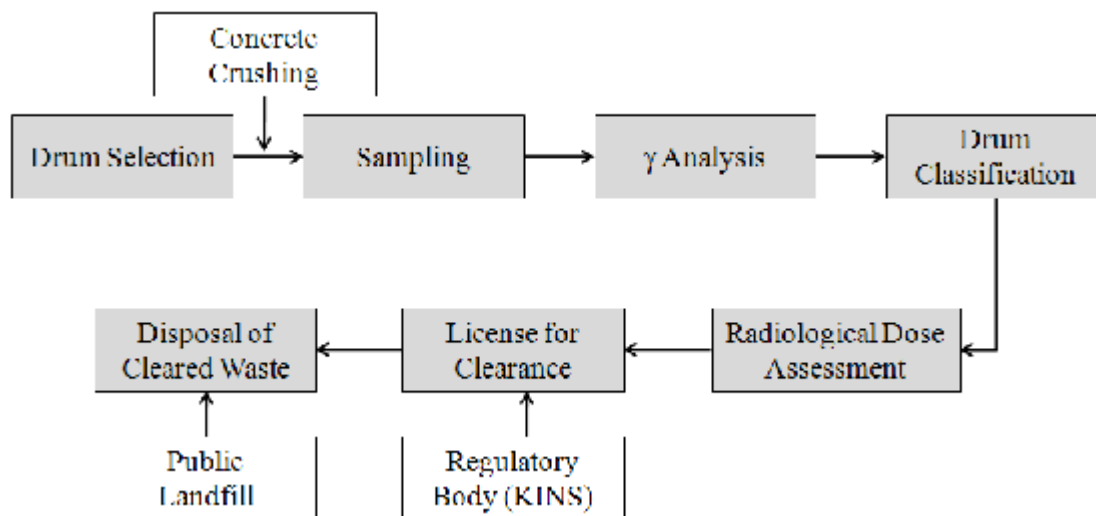


Fig. 1. Procedure of the regulatory clearance

COST TERMS FOR THE CLEARANCE

Equipment

Unsealing a radioactive waste drum in the storage facility is not allowed because the radioactive contents of the drum can spread to contaminate the storage area. However, to transfer the drums from the storage facility to another place for sampling, a considerable amount of time, cost and labor is required. Also, since a soil or concrete drum weighs over 250kg, it can cause a safety problem during a transfer. So, for an effective sampling process, some equipment and tools for restricting contamination were developed and applied to the sampling and analysis.

First, for limiting contamination, an airtight working booth with a ventilation system was made. The booth had dimensions of 3,500 mm × 2,500 mm × 2,500 mm, and the bottom of the booth was strengthened to withstand the weight of the waste drum and the equipment for drum handling. At the exterior of the booth, a ventilation system was attached and operated during the sampling process.

Second, for easy sampling, a stainless steel tray and a 10 × 10 sampling grid were made. The tray had dimensions of 1,400 mm × 1,400 mm × 320 mm. It was used for holding the soils and concretes poured out of the package drum. The sampling grid was used to create 100 even sections in the homogenized waste on the tray. Additionally, a concrete jaw crusher and a soil sampling tool were installed for representative sampling.

Finally, for handling a heavy drum or a tray with waste, a fork lift and a drum lift were used. As those were for use in the working booth, some parts were modified to fit in the working booth. The equipment and tools are showed in Fig. 2.



Fig. 2. Equipment and tools for the regulatory clearance

Characterization

As major radionuclides in waste were known as Co-60 and Cs-137, for the radioactivity analysis of the waste, 1 set of an HPGe γ -spectrometer was installed and operated. Additionally, as complete enumeration was applied for the waste, some of the samples were analyzed at the radioactive waste treatment facility (RWTF), and the remains were analyzed at the another facility.

In order to identify that there was no α - or β - emitter or chemical content in the waste, some samples were additionally analyzed. It proved that there were only γ radionuclides in the soil and concrete waste.

Radiological Dose Assessment (2)

For a clearance scenario, it was assumed that the cleared waste is disposed in a publically reclaimed landfill. Therefore, only radiation workers were considered for the exposure dose estimation during a working hour by the disposed waste. In the estimation, no dose due to ingestion was considered, but an inhalation pathway and an external dose were considered. Also, it was assumed that all the cleared waste will be disposed homogeneously in a facility.

Two criteria of Table 1 were applied for a determination of the range of waste for a regulatory clearance. One was the radioactivity concentration criteria recommended by the IAEA. Another was the dose criteria regulated by Korean nuclear law.

Table 1. Criteria for Regulatory Clearance (3, 4)

Criteria	
IAEA	$(C_{Co-60} + C_{Cs-137}) / 0.1 < 1$
Korean regulation	Individual dose $< 10 \mu\text{Sv/yr}$
	Collective dose $< 1 \text{man}\cdot\text{Sv/yr}$

where, C_{Co-60} : radioactivity concentration of Co-60,
 C_{Cs-137} : radioactivity concentration of Cs-137

License

According to the estimation result, individual and collective doses were $4.55\text{E}+0 \mu\text{Sv/yr}$ and $1.37\text{E}-5 \text{man}\cdot\text{Sv/yr}$ for the disposal work, and $1.00\text{E}-2 \mu\text{Sv/yr}$ and $3.00\text{E}-7 \text{man}\cdot\text{Sv/yr}$ for the workers at the reclaimed landfill after a disposal. The amount of waste for clearance was determined by the regulatory body to be about 2,800 drums.

Transport & Disposal

From 2007 to 2008, after the clearance license, the waste was transported to the publically reclaimed landfill and disposed there. The interval between the transports was required by the landfill facility for the safe disposal of the cleared waste. All the waste was transported by trucks, and a radiation monitor followed the truck in case of an emergency situation.

COST-BENEFIT ANALYSIS

Cost Estimation

Until now, all the activities for the regulatory clearance were described. These activities were accompanied with time, labor, and costs. Some parts of the activities were outsourced. In addition to those activities, about 30 drums of secondary waste such as spent filter and protective wear was generated.

In total, the regulatory clearance costs about 0.83 million US dollars and spans four years (assumed exchange rate : 1US dollar = 1,200 Korean Won). Because a discount rate is not applied in the cost estimation, the present value is somewhat underestimated.

Among the several cost terms, the labor cost due to outsourcing accounts for about 48.5 %, and secondary waste accounts for about 14.0 %.

Benefit Estimation

In Korea, the final disposal of low and intermediate level radioactive waste costs about 4,300 US dollars. So, due to the regulatory clearance, a disposal cost of about 12 million US dollars for about 2,800 drums was saved. This is based on the assumption that soil and concrete waste can be disposed in the original waste form. If soil and concrete is considered as particle waste and fixation is required, the disposal cost can be doubled.

After the clearance, about 2,800 spent drums remained. Among them, about 400 drums in their integrity were reused and others were stored for clearance later. As a result about 0.03 million US dollars were saved by the reuse of drums.

CONCLUSION

Among the soil and concrete waste generated in 1988, some with extremely low level radioactivity was regulatory cleared in 2007. For the clearance, sampling and a radioactivity analysis were started in 2005. Based on the radiological dose assessment using the analysis result, a clearance of about 2,800 drums of waste was licensed. After that, the waste was disposed at a publically reclaimed landfill for 2 years.

During the clearance, some equipment for limiting contamination, easy sampling, and handling a heavy drum or a tray was used. Aside from that, some parts of the activities were outsourced, and secondary waste was generated. All these activities were accompanied with costs.

A cost-benefit analysis result shows that the regulatory clearance costs about 0.83 million US dollars while saving about 12.10 million US dollars. Among the clearance activities, outsourced labor cost account for about 48.5% of the total cost.

The equipment for the soil and concrete clearance can be reused for the clearance of other waste. Therefore, it can be concluded that the regulatory clearance of 2,800 drums of soil and concrete waste shows a cost-benefit ratio more than 14.6.

Since the regulatory clearance is an economically efficient activity, in the future, KAERI will try to clear waste such as a spent drum, a spent filter frame, and DAW (dry active waste) based on the radioactivity analysis result of each kind of waste.

REFERENCE

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