Experiences on a Regulatory Clearance of the Radioactive Wastes at KAERI - 8323

D.S. Hong, Y. Y. Ji, J. S. Shon, S. B. Hong
Korea Atomic Energy Research Institute
1045 Daedeokdaero, Yuseong, Daejeon, Korea

ABSTRACT

At the Korea Atomic Energy Research Institute (KAERI) in Daejeon, about 4,500 drums of old radioactive soil and concrete wastes have been stored since their generation and transport to Daejeon in 1988. The wastes have been stored for more than 18 years. So, according to the analysis result for their radioactivity, some of them can be regularly cleared. In addition to that, about 2,200 tonnes of decommissioning wastes were generated during the dismantling of Korean research reactors #1 and #2 (KRR-1 and KRR-2) from 1997 to 2005. Among those, only 13% were classified as radioactive wastes and part of remains were cleared. In this paper, the experiences on a regulatory clearance of radioactive wastes at KAERI were discussed. First, for the old wastes, a working procedure for representative sampling of each drum and an analysis was developed. Also, as these old wastes are already in a storage facility, some equipment and tools for easy sampling and restricting a contamination of a storage facility were developed and applied. Following the working procedure, the old wastes with a surface dose rate less than 0.3 μSv/hr were selected for an analysis. Based on the analysis results of a sample, the waste with a radioactivity concentration less than 0.4 Bq/g was classified as an object for regulatory clearance. According to the radiological dose assessment result and the dose criteria regulated by Atomic Energy Act of Korea (individual dose<10 μSv/yr, collective dose<1 man·Sv/yr), about 2,800 drums of wastes were determined for a clearance and they are under process for a license. After a clearance, it is scheduled for the wastes to be disposed of at a public dumping ground. Second, for the recently generated decommissioning wastes, the analysis for their radioactive characteristics was simpler than that for the old wastes. The distribution of a radioactivity levels, a gross alpha/beta contamination and a surface dose rate was measured to assess the radiological dose for the biological shielding concrete. According to the radiological dose assessment result, about 800 tonnes of the concrete will be disposed of conventionally by a recycling or landfill disposal after approval of the clearance plan by the regulatory authority.

INTRODUCTION

In KAERI, radioactive wastes are generated from the HANARO Research Reactor, nuclear fuel cycle facilities and research laboratories. All these wastes are collected, treated and stored in the RWTF. The RWTF is located within KAERI and is composed of a treatment facility, a solar evaporation facility and storage facilities.

In the storage facilities, there are about 13,000 drums of solid wastes. These wastes should be treated and sent to a disposal facility in the future. As a disposal site for the low and intermediate level radioactive waste was determined in 2005 and will be operated at the end of 2009 in

GyeongJu, Korea, the RWTF is preparing to treat these radioactive wastes before sending them to the disposal facility safely.

To save on a disposal cost of the radioactive waste, and to secure a storage capacity, KAERI is considering a regulatory clearance of the very low radioactive solid waste for a reduction of the waste volume. Among about 13,000 drums of the wastes, soil and concrete wastes that were generated in 1988 during a decommissioning process take up about 28 % of the storage capacity. Also, during the decommissioning process of dismantling of a research reactor which began in 2005, large volume biological shielding of concrete wastes has been generated. Based on the radioactivity concentration of the wastes and the dose estimation results of a clearance scenario, some of those wastes were cleared per regulatory criteria.

In this study, the processes for a regulatory clearance of wastes in storage and recently generated wastes will be discussed.

CLEARANCE OF WASTES IN STORAGE

The subject wastes were generated during the decommissioning process of the attached facility to the research reactor in Seoul and were transported to Daejeon in 1988. It is known that the major radionuclides were Co-60 and Cs-137 and that for most of the wastes, their radioactivity concentrations were low. At present about 4,500 drums of wastes are stored and managed at the storage facility in 200 liter drums and they take up about 28% of the storage capacity. The radioactive characteristics of the soils are not managed but their surface dose rates are measured for their safe management. For a convenience, drums with a soil, a concrete, a soil and concrete mixture, and a soil and ash mixture have been managed as a soil drum [1].

Development of the Equipment

Unsealing a radioactive waste drum in the storage facility is prohibited to protect the facility from a radioactive contamination. But a transfer of all the drums from storage to another building for a sampling is a time, labor and cost consuming work. So, some equipment has been developed and applied for the sampling of the radioactive waste in the storage facility [2].

First, a movable airtight working booth with a detachable ventilation system was made to limit a contamination and it was installed at the storage facility. For a convenience, a water line and a power line can be connected to the exterior of the working booth. Also, there are windows at the front side and the backside of the booth for a lighting and supervision. The bottom board of the booth was strengthened by a steel plate to support a heavy soil drum and the heavy tools used in the booth. In addition to that, 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 dimension into the booth. The ventilation system is for the provision of fresh air to the workers in the working booth and a filtration of the radioactive dusts generated during the sampling process. **Fig. 1** shows the airtight working booth connected with the ventilation system and **Fig. 2** shows the ventilation system on a cart.

Fig. 1. Airtight working booth

Fig. 2. Ventilation system

Second, a tray and a grid for easy sampling were developed. On the tray, a hole with a cover is located in the center for an easy discharge of the remaining soil after a sampling. Also, the grid has 100 sections for the division of a soil in the tray into 100 even sections. Each section has its own number and the soil samples are taken from 30 sections according to the pre-generated random numbers. **Fig. 3** shows the tray with soil poured out of a drum. **Fig. 4** shows the 10 × 10 grid placed on the soil in the tray.

Fig. 3. SUS tray

Fig. 4. 10 × 10 grid

Working Process

For efficient sampling, a systematic working process was developed. A surface dose rate of below 0.3 μSv/hr was applied for selecting the drums for sampling. After an identification of the contents of each drum, the soils are poured onto the tray for a homogenization and sampling. During sampling, the equipment discussed above is applied. A 2 liter sample was taken out of 200 liters of waste and 1 liter was used for an analysis while the other 1 liter was saved for verification. The sample is then transferred to another facility for a γ-analysis. Based on the analytical result for a sample, the waste with a radioactivity concentration less than 0.4 Bq/g was classified as waste for a regulatory clearance, otherwise it was classified as a radioactive waste. **Fig. 5** represents the working process [2].

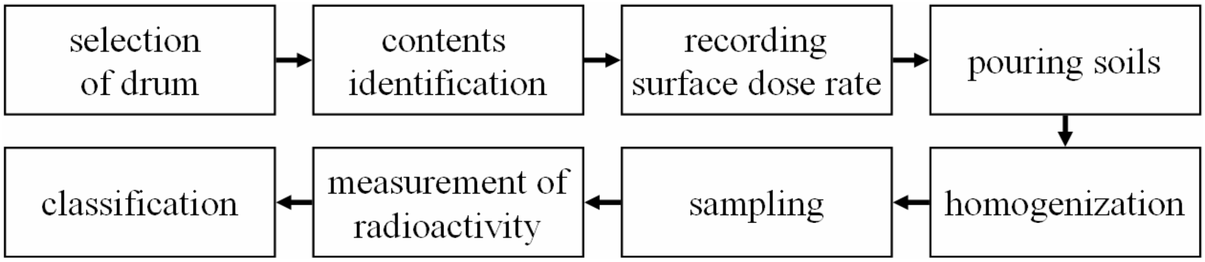

Fig. 5. Working process for sampling and waste classification

Analysis Result

Major radionuclides found in the soil and concrete wastes were Co-60 and Cs-137. Also minor nuclides such as Mn-54, Fe-59, I-131, Cs-134 and Eu-152 were detected as small amounts in the samples with a relatively high radioactivity concentration. As the wastes have been stored for more than 18 years, the radioactivity of the soils has decayed a lot and become much lower than their original activity. Total radioactivity concentration of the wastes is distributed as shown in **Fig. 6**. About 68 % of the wastes 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 11.2 % of the total number of waste drums.

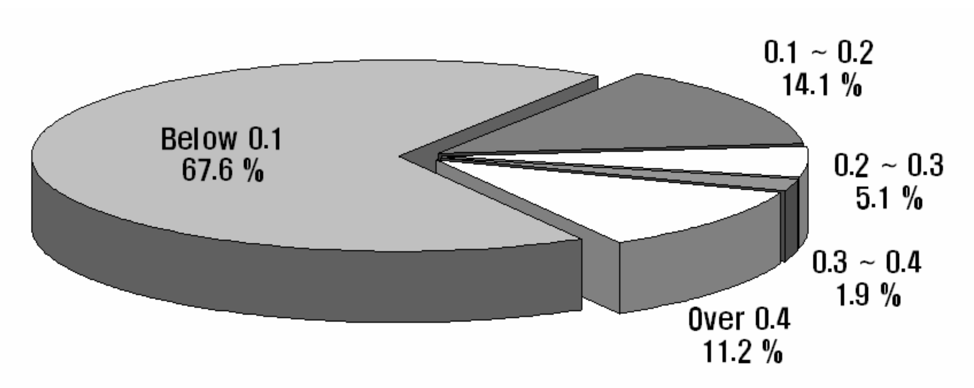

Fig. 6. Distribution of the radioactivity concentration of the soils and concretes in storage

Regulatory Clearance

For a regulatory clearance, a radiological dose assessment is required by the Atomic Energy Act (AEA) of Korea. So, based on the analytical results for the radioactivity concentration, a radiological dose due to the clearance of the wastes was estimated. As a method for a disposal of the cleared waste, transfer to a public dumping ground was considered. For the dose assessment, RESRAD code was used. The criteria for the clearance required by AEA are an individual dose of <10 μSv/yr and a collective dose of <1 man·Sv/yr. In addition to that, IAEA recommended clearance criteria of 0.1 Bq/g for each of Co-60 and Cs-137 and for both [3]. Finally, considering a public acceptance, we decided to clear the radioactive wastes with a total γ radioactivity concentration below 0.08 Bq/g. So, the amounts of wastes cleared totaled about 2,800 drums.

CLEARANCE OF THE RECENTLY GENERATED WASTES

A large amount of radioactively contaminated and activated materials was generated from the decommissioning and decontamination of KRR-1 and KRR-2, most of which may be slightly contaminated or activated. Total amount of decommissioning solid waste is about 2,197 tonnes, but 13% of the wastes were classified as radioactive waste at the end of 2006. All the solid waste from the decommissioning project was categorized into three groups based on their radioactivity; radioactive, restricted releasable and not-contaminated waste. The radioactive waste has a higher radioactivity than 0.4 Bq/g for beta/gamma emitting nuclides. The restricted releasable waste will be treated according to a pre-determined route. In the near future, a study on a local disposal or long term storage of this waste at the KAERI site will be carried out. The radioactivity level of the not-contaminated waste is less than MDA, which was estimated as 0.013 Bq/g for the beta/gamma emitting nuclides. The not-contaminated concrete waste from the biological shielding concrete was recycled as a road basement after authorized from the regulatory body[4].

Analysis of the Radioactivity

A variety of radionuclides has been generated in the biological shield concrete by a neutron reaction during the operation of the reactor, including ^{3}H, ^{14}C, ^{55}Fe, ^{60}Co, ^{63}Ni, ^{134}Cs, ^{137}Cs, ^{152}Eu and ^{154}Eu. The radioactivities of ^{3}H and ^{14}C were determined by an oxidation combustion method and a liquid scintillation counter, ^{55}Fe and ^{63}Ni by a combined method of an extraction chromatography method and liquid scintillation analysis and other radionuclides by a gamma spectrometry method. To ensure the homogeneity of a sample, the decommissioned biological shielding concretes was divided into 100 cm $\times$ 100 cm sectors and samples were taken from each surface of the decommissioned concrete blocks. 10% of a concrete sample was taken and mixed homogenously for a radioactivity analysis from the total sampling amount of the concrete blocks. The radioactivity level of the not-contaminated waste is less than MDA, which was evaluated as 0.013 Bq/g for the beta/gamma emitting nuclides. **Fig. 7** describes the sampling from the decommissioned biological shielding concretes.

Fig. 7. Sampling from the biological shielding concretes

Management the of Waste

The major solid wastes generated during the decommissioning process were metal and concrete and those were classified and managed as radioactive waste, restricted releasable waste and non-radioactive waste. The radioactive wastes were packaged in 4 m^3 containers or 200 liter drums and temporarily stored. While the restricted releasable waste and non-radioactive wastes were packaged in containers and managed separately from the radioactive wastes. The type and amount of wastes are shown in Table I.

Table I. Status of decommissioning wastes (until 2006) [unit : tonne]

Type of wastes	Radioactive wastes	Restricted releasablewaste	Non-radioactive wastes
Metal	17.3	33.2	104.1
Concrete	260.0	33.3	1,710.9
Etc.	12.0	15.5	10.8
Total	289.3	82.0	1,825.8

Regulatory Clearance

Radiological dose assessment for a recycling road basement or a landfill disposal of selected scenarios was evaluated based on the measured results of the concentration levels of the radionuclides in the biological shielding concrete of KRR-2. The individual dose and collective dose for each scenario were evaluated by using an appropriate mathematical modeling of the NUREG-1640, MCNP4C and RESRAD codes. A basis of the selection for the input parameter was conservatively chosen for each scenario by reflecting the industrial conditions in Korea and comparing them with other countries as a reference. Based on the estimation result, about 800 tonnes of concrete were regulatory cleared and recycled as a road basement.

CONCLUSION

KAERI has been storing more than 13,000 drums of radioactive wastes. In addition to that, during the operation of the facilities, research and decommissioning processes, approximately 420 drums of radioactive wastes are being generated per year. The storage capacity will be reached in 2014 if there is no volume reduction. Additionally, as a disposal site for the low and intermediate level radioactive waste was determined in 2005 and will begin operation from 2009 in GyeongJu, Korea, the RWTF of KAERI is preparing to treat radioactive wastes before sending them to the disposal facility.

For a regulatory clearance of the wastes in storage, some equipment for radiation work in the storage facility and a working procedure for a systematic sampling were developed. About 4,500 drums of soil and concrete wastes were analyzed. Finally, about 2,800 drums of wastes were cleared and are scheduled to be dumped at a public dumping ground.

For a regulatory clearance of the recently generated wastes, biological shielding concrete blocks were decommissioned and samples from the wastes were analyzed. The assessment of a potential radiation exposure in the case of a concrete recycling and a landfill disposal was evaluated for a clearance about 800 tonnes of concrete waste. Radiological dose assessment method and measurement method were established for the gamma and beta emitting nuclides in the activated concrete.

As a result of a regulatory clearance, the saturation of the storage capacity will be delayed about 6~7 years to around 2020. In addition to the delay of the saturation year, a disposal cost of around 2,500 billion Won (2.6 billion US dollar) can be saved. Also, management cost for the radioactive waste can also be reduced.

Radioactively contaminated soils and concretes can be generated during the decommissioning of nuclear facilities. So, the result of this study can be applied to the clearance of those wastes either in storage or in generation.

REFERENCES

1. KAERI, 2006, *Operation of Radioactive Waste Treatment Facility*, KAERI/MR-438/2005.
2. D. S. Hong, Y. Y. Ji, I. S. Kang and J. S. Shon (2007), *Development of the Tools and a Sampling Method for Radioactive Soils in a Storage Facility*, International Symposium on Radiation Safety Management, Daejeon, Korea.
3. IAEA, 2005, *Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance*, Safety Reports Series No. 44.
4. KAERI, 2006, *The Results of the Assessment for Clearance of Dismantling the Concrete Waste from the Research Reactor Facilities*, KAERI/TR-3176/2005.