

Management Status of Disused Sealed Radioactive Sources in Korea

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1. Introduction

Radioactive sources such as sealed and unsealed radioactive sources have been widely used in industry, research, medicine and education. With the various uses of radioactive sources, the accumulation amount of radioactive waste has also been accordingly increased for many years. Due to the upward trend of disused radioactive sources, it becomes an important issue to manage the sources safely from the pre-disposal stage.

Because Low- and Intermediate-Level Radioactive waste (LILW) has been primarily generated from nuclear power plants (NPPs), most R&D studies have focused on the technologies concerning radioactive waste from NPPs. In contrast, the relevant researches associated with Disused Sealed Radioactive Sources (DSRS) and Unsealed Radioactive Sources, which account for about 10% of LILW, are just in early stage. Especially in case of DSRS, it is hard to manage them safely and efficiently due to their long half-lives and high activities. In order to develop the management technology of DSRS, current management status of DSRS was reviewed in terms of number, volume and activity.

2. Current Management Status in Korea

2.1 Management System and Regulatory Framework

The Korean management system for radioisotope (RI) waste is shown in Figure 1. When RI waste is generated from the generator, it is directly delivered or transported by the consigned agency to interim storage facility of Korea Radioactive Waste Agency (KORAD).

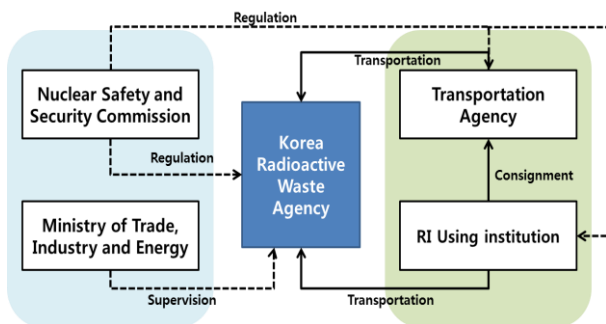


Fig. 1. Management framework of RI waste in Korea

In this acquisition process, the user should pay the costs according to the volume of the waste and submit

the correct information about the source. KORAD reports it to Ministry of Trade, Industry and Energy and Nuclear Safety and Security Commission (NSSC), and these organizations regulate or supervise KORAD for the safe management of DSRS.

The NSSC Notice No. 2014-3 presents the radioactive waste classification system based on the classification scheme of IAEA safety standard series [1]. The Korean system categorizes the radioactive waste into five groups; High-Level radioactive Waste (HLW), Intermediate-Level radioactive Waste (ILW), Low-Level radioactive Waste (LLW), Very Low-Level radioactive Waste (VLLW) and Exempt Waste (EW). The clearance level of EW and concentration limit of LLW in Table I and II are quoted from the NSSC Notice. Among the listed levels of radionuclides in Notice, the levels related with DSRS only are extracted for the purpose of analysis. When the activity of radioactive waste is between the clearance level in Table I and one hundred times of clearance level, it is classified as VLLW. Also, when the activity is between one hundred times of clearance level and concentration limit of low-level waste in Table II, it is classified as LLW [2].

Table I: Clearance level of exempt waste

Radionuclides	Clearance level [Bq/g]
Am-241, Co-60, Cs-134, Cs-137, Eu-152, Na-22	0.1
C-14, Cd-109, Cf-252, Cm-244, Co-57, Ir-192, Se-75, Sr-90, Gd-153	1
H-3, I-125, Ni-63	10
Fe-55, Pm-147	100
	1000

Table II: Concentration limit of low-level waste

Radionuclides	Concentration limit of LLW [Bq/g]
H-3, Cs-137	1.11E+6
C-14	2.22E+5
Co-60	3.70E+7
Ni-63	1.11E+7
Sr-90	7.40E+4
Gross Alpha	3.70E+3

2.2 Inventory of Disused Sealed Radioactive Sources

As shown in Figure 2, the total number of DSRS generated in Korea was 52,176 from 1991 to 2014. Over the past 24 years, 34 radionuclides including mixed sources have been generated from various organizations, and these sources are listed below.

- 23 radionuclides whose half-lives are lower than 30 years; Bi-210, I-125, Sb-Be, Ir-192, Se-75, Po-210, Gd-153, Ge-68, Co-57, Cd-109, Cs-134, Na-22, Pm-147, Cf-252, Fe-55, Co-60, Ba-133, Kr-85, H-3, Eu-152, Cm-244, Sr-90, Sr-90/Y-90
- 9 radionuclides whose half-lives are higher than 30 years; Cs-137, Ni-63, Am-241, Am-241/Be, Ra-226, Ra-226/Be, C-14, U-235, U-238
- 2 mixed sources including Co-60 and Sr-90, respectively

The whole activity of DSRS was estimated as much as $4.2E+14$ Bq or more. In addition, the DSRS volume including the transport container was about 41,600 L. In these disused sources, the long-lived radionuclides whose half-lives were longer than 30 year took about 9% of total number and about 62% of total activity. In terms of DSRS volume including the transport container, Co-60 accounted for the biggest part of total volume, and long-lived radionuclides took about 30% of total volume.

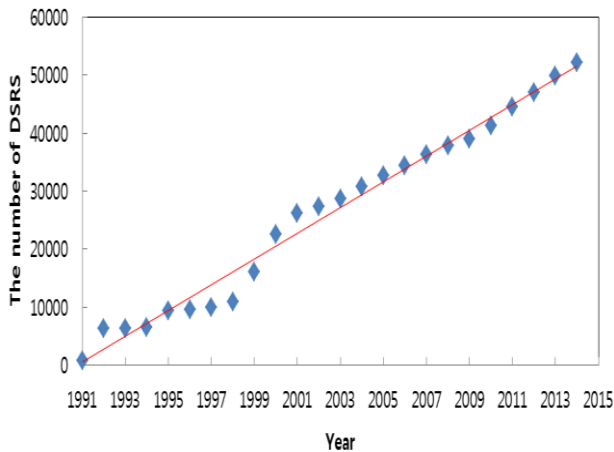


Fig. 2. The cumulative trend of DSRS

2.3 Classification of Disused Sealed Radioactive Sources

The generated DSRS until 2014 was classified as shown in Table III. Although the clearance levels of EW and concentration limit of LLW were applied to each radionuclide based on the Table I and II, if there were no corresponding levels to arbitrary radionuclide, they couldn't be sorted out and were distinguished as 'Unclassified'. As a result, most DSRS were determined as EW and took about 58% of total number. With regard to specific activity, the ILW accounted for the biggest portion of total activity (97.5%).

Table III: The classification of DSRS

Category	Number (%)	Activity (%)
EW	57.86	2.90E-07
VLLW	5.42	1.03E-05
LLW	2.25	0.01
ILW	20.10	97.51
Unclassified	14.37	2.48
Total	100	100

3. Conclusion

According to the increasing usage of sealed sources in Korea, the necessity of best management practices of DSRS have been raised. Moreover, the development of safe and efficient treatment and disposal technology has become an important issue.

Until 2014, DSRS of 52,176 have been stored at temporary RI waste storage facility, and long-lived DSRS whose half-lives are more than 30 years took about 62% of total radioactivity. This study reviewed the current status of DSRS and analyzed it based on recent classification standard of NSSC Notice. It resulted that more than half of the number of DSRS were defined as EW, and most of activity were fallen under the category of ILW. The results of this study can be used as basic data to draw up a long-term management plan of DSRS.

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- [1] International Atomic Energy Agency, Classification of Radioactive Waste, IAEA Safety Standards Series GSG-1, 2009.
- [2] Nuclear Safety and Security Commission, Notice No. 2014-3, 2014