Experience on a Regulatory Clearance of Spent Steel Drums - 11281

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ABSTRACT

At KAERI(Korea Atomic Energy Research Institute), about 50 tons of spent steel drums have been stored since their generation in 2008. Those were part of drums generated after regulatory clearance of radioactive contents. Some drums emptied after clearance had good integrity and were reused for packing radioactive waste, and only drums with physical damage were remained as a radioactive waste. Once having been used for packaging cleared radioactive wastes, spent steel drums were determined to be cleared in view of treatment. For management, those drums were radiation monitored, cleaned with pressurized water and dried two times respectively, compacted and stored at a designated area. In this study, experience on regulatory clearance of spent drums will be discussed. Before clearance, a clearance scenario was developed with some assumptions and based on that, radiological dose due to clearance was assessed using RESRAD-RECYCLE 3.10. At the assessment, it is assumed that the drums were contaminated by Co-60 with a concentration of 0.08 Bq/g. These assumptions were based on the facts that the contents in the drums were soil and concrete wastes contaminated by Cs-137 and Co-60 with the maximum concentration of 0.08 Bq/g. The assumptions used for the assessment were somewhat conservative in view of that 1) while 0.08 Bq/g was a maximum value of the cleared waste, it is applied as an average value for the spent drum 2) while drums were surface contaminated, volumetric contamination was applied 3) though drums could be contaminated, they were decontaminated two times using water 4) Co-60 which shows higher radiological dose than Cs-137 was assumed to be in the drums. A scenario for recycling of spent steel drums was 'building with rebars scenario' of RESRAD-RECYCLE. The scenario was developed for steel and considers the use of reinforcement bars (rebars) manufactured from recycled steel in the construction of public buildings. In the scenario, processes such as scrap delivery, scrap smelting, product fabrication and product distribution are included. The assessment result shows that radiological dose due to cleared steel drum is the most severe in case of 'Public Product : Building with Rebars' followed by 'Product Distribution: Product Loader' for individual dose and 'Scrap Smelting: Smelter Yard Worker' for collective dose respectively. But the estimated doses were far below the criteria set by Atomic Energy Act of Korea (individual dose <10 micro-Sv/yr and collective dose <1 man-Sv/yr). So it can be concluded that after a license from a regulatory body of Korea, the steel drum can be cleared safely without any limitations.

INTRODUCTION

At 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. Because the wastes had been stored for more than 18 years, some of them with an extremely low level radioactivity were regulatory cleared between 2007 and 2008. The amount of cleared waste was about 2,800 drums (in 200 liter drum) and after the clearance, spent drums remained and have been stored.

After a generation, about 500 spent drums with good physical condition were reused for radioactive waste package. Roughly 2,300 remaining drums were decontaminated, compacted and stored at a designated area.

As the drums had been used as containers for the cleared wastes, the compacted drums were expected to be cleared without any difficulty. So, in this study, experience on the clearance of spent drums was discussed in view of clearance scenario set up and assessment of radiological dose due to clearance.

PROCEDURE FOR THE CLEARANCE

Before the clearance, the drums had been kept in storage in a designated area. Using a recycling scenario applicable to spent drums, radiological doses were estimated. Then, based on the assessment results, clearance would be permitted by the regulatory body and finally the spent drums would be recycled. Fig. 1 shows the procedure for the clearance.

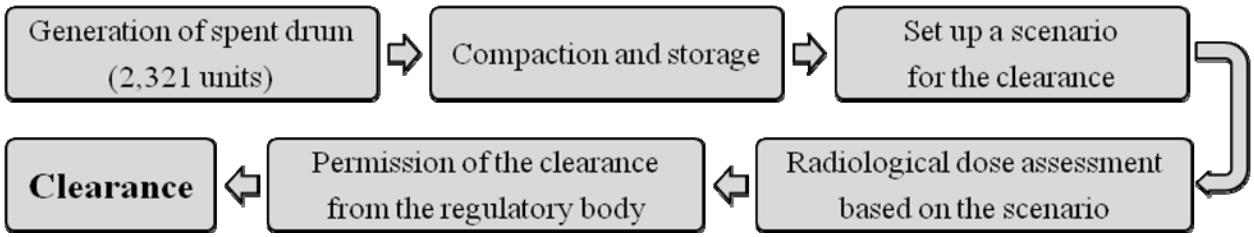

Fig. 1. Procedure for the clearance

Compaction and Storage of Spent Drums

After generation, each drum was radiation monitored for contamination, decontaminated with pressurized water, dried and examined for their integrity. Roughly 2,300 remaining drums were compacted and stored in a designated area for clearance.

Fig. 2 shows the management processes that is (a) decontamination (b) compaction (c) storage (d) monitoring of the spent drum for clearance.

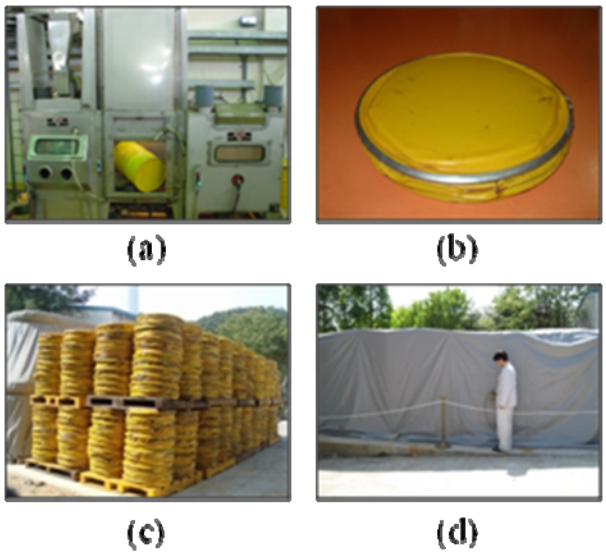

Fig. 2. Management of spent drum at KAERI

Drum Smelting and Product Manufacturing

After the clearance, the spent drums will be treated as scrap metal and KAERI will commit the treatment. For recycling, the scrap metal is considered to be made into reinforcing bars for building construction. As shown in Fig. 3, the recycling is composed of a steel making process and a rolling mill process.

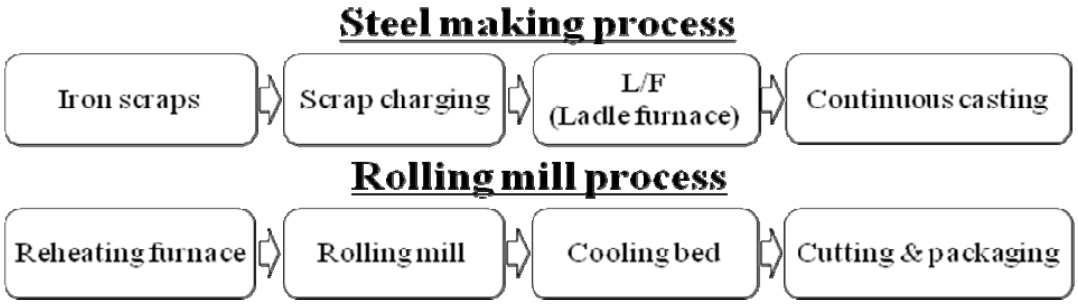

Fig. 3. Processes for manufacturing recycling product

The steel making process produces half-finished products called billets. In the rolling process, these billets are manufactured to required shapes and sizes. Each step of the processes is shortly described.

Iron scraps : the first stage of steel making requires putting iron scraps into the electric arc furnace.

Electric arc furnace : the selected iron scraps are heated to create molten iron.

Ladle furnace (L/F) : the L/F is a smelting furnace in which molten iron in the ladle (a large vessel that contains molten iron) is heated and additional smelting is performed to ensure the material has basic ingredients. The temperature of the molten iron is maintained at 1540 ~ 1560 ºC to improve stability and productivity in the continuous casting process that follows.

Continuous casting : molten iron that has remained in a liquid state until the L/F process finally takes a solid shape in the continuous casting process. In continuous casting, the molten iron which went through second phase tempering in the L/F is made into billets for the rolling mill process.

Reheating furnace : the billets are placed in the reheating furnace and reheated up to about 800 ºC. This reheating process softens the billets, better preparing them for the next stage of rolling where they are extended into the thickness and length required by customers.

Rolling mill : the rolling mill molds the products into the size and shape ordered by customers.

Cooling bed : the products are cooled.

Cutting and packaging : products from the rolling mill line are cut into lengths ordered by the customer, counted by the automated counter and packaged into bundles.

SETUP SCENARIO FOR DOSE ASSESSMENT

For the clearance, radiological doses should be assessed based on a clearance scenario. At the scenario, in addition to ‘drum smelting and product manufacturing’ process, more processes such as delivery, loading & unloading and treatment of drum and recycling product should be considered.

In this study, based on the scenario suggested by RESRAD-RECYCLE 3.10, a scenario for radiological dose due to recycling was developed.

As shown in Table 1, the scenario is composed of ‘transport and process of spent drum’, ‘scrap smelting’, ‘rolling mill’, ‘product distribution’ and ‘recycling’. Each process can be divided into some scenarios set up using drum smelting and product manufacturing processes.

DOSE ASSESSMENT RESULT

Using this scenario, radiological doses due to recycling of spent drum was assessed using RESRAD-RECYCLE 3.10. In the assessment, while some scenarios not covered by the computer code were assessed using similar scenarios or conditions, parameters of RESRAD-RECYCLE were used for the assessment.

For the radioactivity, for a conservative approach, it is assumed that drums have an average radioactivity of 0.08 Bq/g which was the maximum radioactivity of the cleared soil and concrete waste once contained in the drum. In addition to that, Co-60 was considered as a radionuclide in drum. The assessment result is shown in Table 1.

TABLE 1. Scenario for Radiological Dose Assessment and Assessment Result

Processes	Scenario	Workers	Dose Assessment	
			Individual [μSv/yr]	Collective [man·Sv/hr]
Transport and process of spent drum	spent drum loader	4	3.31E-03	6.63E-09
	spent drum truck driver	3	2.91E-03	8.72E-09
	scrap processor (cutting and compacting)	2	2.32E-03	4.65E-09
	scrap loader	2	3.31E-03	3.32E-09
	scrap truck driver	2	2.91E-03	5.81E-09
Scrap smelting	scrap processor	3	2.37E-03	7.12E-09
	smelter yard worker	10	2.15E-02	2.15E-07
	smelter loader	5	3.98E-03	1.99E-08
	electric furnace operator	3	1.42E-02	4.27E-08
	baghouse processor	1	6.33E-04	6.33E-10
	refinery worker	3	1.56E-02	4.69E-08
	billet worker	2	7.80E-03	1.56E-08
	slag worker	1	0.00E+00	0.00E+00
Rolling mill	reheating furnace loader	5	3.98E-03	1.99E-08
	reheating furnace operator	3	1.42E-02	4.27E-08
	rolling mill	15	5.34E-04	8.01E-09
	cutting and packaging	20	5.35E-04	1.07E-08
Product distribution	product loader	2	4.21E-02	8.41E-08
	product truck driver	5	1.49E-02	7.45E-08
	product assembler	20	1.06E-02	2.12E-07
Recycling	building with rebars	164	1.13E+00	1.85E-04

CONCLUSIONS

The assessment result shows that the maximum individual dose and collective dose due to recycling of cleared spent drums were 1.13 μSv/yr and 1.85E-04 respectively for the case of ‘Recycling : building with rebars’.

Because Korean nuclear law regulated dose criteria for the clearance as below 10 μSv/yr for individual dose and below 1 man·Sv/yr for collective dose, the assessment result in this study shows that about 49 tons of steel drums can be regulatory-cleared without any limiting condition.

REFERENCES

1. J. J. Cheng, B. Kassas, C. Yu, D. Lepoire, J. Arnish, E. S. Dovel, S. Y. Chen, W. A. Williams, A. Wallo, and H. Peterson, RESRAD-RECYCLE: A COMPUTER MODEL FOR ANALYZING THE RADIOLOGICAL DOSES AND RISKS RESULTING FROM THE RECYCLING OF RADIOACTIVE SCRAP METAL AND THE REUSE OF SURFACE-CONTAMINATED MATERIAL AND EQUIPMENT, AND/EAD-3, Environmental Assessment Division, Argonne National Laboratory, 2000