Radiation Shielding Evaluation for Existing Transport Container Containing Decommissioning Waste of KORI Unit 1

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1. Introduction

For safe and economic transportation of radioactive wastes generated during decommissioning in the NPP, not only their radiological characteristics but also transportation and conditions of disposal site should be considered. Since most of decommissioning wastes are classified as LLW or VLLW, they can be transported using IP-2 type transport container operating in the NPP. In Korea, radioactive wastes generated from nuclear power plants are mainly packed in 200 or 320 liters drums and then transported to disposal facilities using IP-2 type transport containers. IP-2 type container has the ability to carry eight drums at the same time.

The purpose of this study is to evaluate the feasibility of existing IP-2 container with minor modification for efficient transportation of decommissioning wastes.

2. Shielding Evaluation of IP-2 container

2.1 Dose Rates Criteria

There are several regulations related to radioactive waste transport in the domestic and international laws. Under the Normal transport condition, the dose rate at the surface of the IP-2 transport container is limited to 2 mSv/hr and one at any point 2 m away from the container is limited to 0.1 mSv/hr.

2.2 Source Terms

According to previous evaluation for radioactive nuclide inventory of RV/RVI of the KORI unit 1, LLW/VLLW accounts for about 65% of the activated RV/RVI radioactive waste [1].

The radioactive waste with the highest radioactivity among the low-level wastes generated during decommissioning is the upper core plate of RV/RVI. For conservative evaluation, the upper core plate of RVI is assumed to be the contents of the existing IP-2 type transport container. Since the expected maximum allowable weight of the package used for transportation of decommissioning wastes is 35 tons and the weight of the existing IP-2 container is 3.6 tons, the maximum allowable weight of the contents is 31.4 tons. The calculated radioactivity of the contents in the IP-2 type transport container is shown in Table 1.

Table 1. Radioactivity of Upper Core plate

Nuclides	Specific Activity [TBq/g]	Activity [Bq]
Fe-55	1.91E-06	6.00E+13
Co-60	7.51E-09	2.36E+11
Ni-59	1.78E-08	5.59E+11
Ni-63	1.88E-06	5.90E+13

2.3 LLW Package

External dimensions of the existing IP-2 transport container are 1.6 m (W) × 3.4 m (L) × 1.2 m (H) and thickness of it is 0.012 m. The upper core plate used as the radiation source is assumed to be uniformly distributed inside the transport container. Fig. 1 shows the model of IP-2 transport container with LLW such as upper core plate of RVI for shielding evaluation. The volume inside the transport container is 6.26 m^3 and the upper core plate is made of stainless steel with a density of 8.03 g/cm^3, so the volume corresponding to 31.4 tons is 3.91 m^3. Therefore, 62.5% of the inside of the container is filled as the contents.

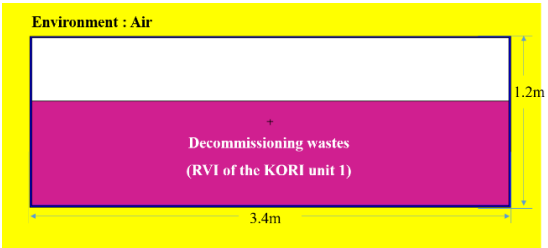


Fig. 1. Shielding Evaluation Model.

2.4 Shielding Evaluation

MCNP5 computer code using the three-dimensional Monte Carlo method has been used to calculate dose rates at the various desired locations of the IP-2 type transport container [2]. The flux-to-dose conversion factor was added to the input data so that it could be expressed as the dose rate at the locations of interest. The dose conversion factors used in this calculation was taken from ICRP-74 (1996) [3].

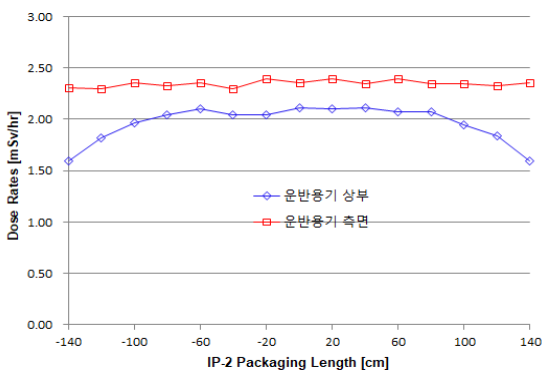
3. Shielding Evaluation Results

In this MCNP calculation, 15 detectors were placed at the external surface and 2 m position of the IP-2 transport container, respectively. Table 2 shows the maximum dose rates at all positions and Fig. 2 shows dose rates at calculated points for the top and side of the IP-2 transport container. Relative errors of these detectors were 0.01~0.02.

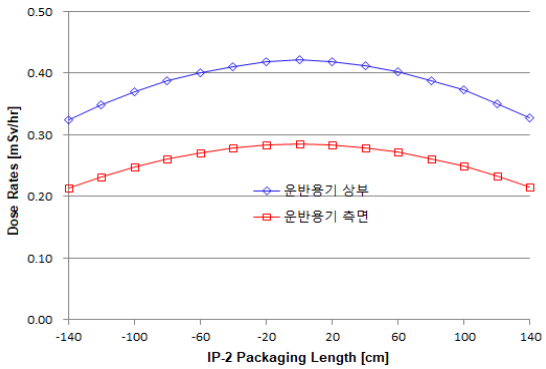
Table 2. Dose Rates Results for IP-2 Container

[Unit : mSv/hr]

Cal. Point	External Surface		2 m from the Surface	
	Results	Limit	Results	Limit
Top	2.113	2.0	0.422	0.1
Side	2.396		0.285	



(a) Dose rates at External Surface



(b) Dose rates at 2 m form the Surface

Fig. 2. Results of Shielding Evaluation.

4. Conclusion

Radiation shielding evaluations for existing IP-2 transport container containing LLW such as RVI of KORI unit 1 were performed. Existing IP-2 transport container containing the upper plates among RVI didn't satisfy the radiation dose limits under normal transport condition. Therefore, in order to use existing containers for efficient transport of bulk decommissioning waste, additional shielding and/or conditioning such as solidification should be reflected.

ACKNOWLEDGEMENT

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