

## Review of Radiological Criteria for Type-IP package

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### 1. Introduction

In June 2017, Kori Unit 1 was permanently shut-down. Decommissioning is proceeding after the permanent shut-down of the Kori Unit 1. The amount of radioactive waste to be disposed after decommissioning was aimed at 14,500 drums and 67% of the generated radioactive waste was estimated to be very low level radioactive waste [1]. Most of the very low level radioactive waste will be transported by using Type-IP package and a large amount of disposal waste is expected to be transported by using Type-IP package. It is necessary to investigate the technical criteria for domestic Type-IP package and confirm appropriateness of the dose criteria in the situation where the transportation of Type-IP package is expected to be frequent.

The objective of this study was to analyze the current status and rationales of the dose criteria for Type-IP package in Korea. To achieve this goal, technical criteria for the IAEA, U.S. and Japan were investigated. In addition, the rationales for setting the Type-IP package dose criteria set by international organizations were analyzed.

### 2. Type-IP package dose criteria

Radiation dose criteria for the Type-IP package and packaging were specified in Nuclear Safety and Security Commission (NSSC) Notice 2017-56. For Type-IP package, packaging criteria and contents quantity limitation provision is applied. Table 1 shows radiation dose criteria for Type-IP package in the Korean regulation.

Table 1: Dose criteria for Type-IP package

Classification	Condition	Distance	Dose rate
Dose criteria	External radiation level (general)	Surface	2 mSv/h
	External radiation level (general)	Apart 1 m from surface	0.1 mSv/h
	External radiation level (exclusive use)	Surface	10 mSv/h
Contents quantity limitation	External radiation level from the unshielded material or object	Apart 3 m from surface	10 mSv/h

### 2.1 General transportation

The regulations specified the radiation dose criteria as technical criteria for packaging regarding the Type-IP package. The dose criteria for the Type-IP package in the regulation in Korea and other countries have been regulated at the same level by adopting the IAEA guidelines. Table 2 compares the domestic and overseas criteria for dose criteria for Type-IP package.

Table 2: Radiation dose criteria (general) [2]

Country	Condition	Dose rate
Korea	Surface radiation level	2 mSv/h
	External radiation level at 1 m <sup>a)</sup>	0.1 mSv/h
IAEA	Surface radiation level	2 mSv/h
	External radiation level at 1 m <sup>a)</sup>	0.1 mSv/h
U.S.	Surface radiation level	2 mSv/h
	External radiation level at 1 m <sup>a)</sup>	0.1 mSv/h
Japan	Surface radiation level	2 mSv/h
	External radiation level at 1 m <sup>a)</sup>	0.1 mSv/h

a) converted criteria from regulation which shall not exceed Transport Index 10

The rationales of the radiation dose criteria for radioactive material transportation was proposed by the IAEA. The dose criteria of 2 mSv/h on the external surface, which is the general criteria of the package, was derived from the results of the IAEA's assessment of the radiological effects of radioactive material transport carried out in 1985. When IAEA derived the dose criteria, IAEA considered that it was permissible to receive a dose of 1 mSv during 8 hours working day and the survey which resulted transport workers stayed near package for 30 minutes in a day [3].

Dose criteria of 0.1 mSv/h at a distance of 1 m was derived to prevent fogging of the X-ray film after development. Research of X-ray film conducted in 1947 showed that fogging would occur at an exposure of 0.15 mSv. Therefore, the limit was set in the 1961 edition of the regulations of 0.1 mSv linked to a nominal maximum exposure time of 24 hours. The dose of 0.1 mSv was derived by taking into account 0.1 mSv per 24 hours and the distance between parcels containing radium and the normal parcels, 4.5 m [3].

## 2.2 Exclusive use

Exclusive use means single shipper uses a carrier, tank, or cargo container exclusively. Therefore, loading and unloading works are carried out with the order of the shipper or consignee. At the time of transport, the criteria of Type-IP package for domestic and international dedicated transport was regulated to the same level by adopting IAEA guidelines. Table 3 compares the domestic and overseas dose criteria for Type-IP package in exclusive use.

Table 3: Radiation dose criteria (exclusive use) [2]

Country	Condition	Dose rate
Korea	Surface radiation level	10 mSv/h
IAEA	Surface radiation level	10 mSv/h
U.S.	Surface radiation level	10 mSv/h
Japan	Surface radiation level	10 mSv/h

The dose criteria of 10 mSv/h on the external surface was derived from the requirement that it shall not exceed 0.1 mSv/h at the point 1 m above. Domestic law specified 10 cm from the actual surface as the surface dose rate. The dose rate in this point was derived by considering distance.

### 3. Contents quantity limitation criteria for LSA material and SCO

Contents quantity limitation criteria have been established for low specific activity (LSA) material and surface contaminated object (SCO) in IP-type packages. As similar with the other criteria, the limits of the Type-IP package for domestic and foreign countries were regulated at the same level by adopting the IAEA guidelines. Table 4 compares the domestic and overseas criteria for the contents quantity limitation of Type-IP package.

Table 4: Contents quantity limitation criteria [2]

Country	Condition	Dose rate
Korea	External radiation level at 3 m from the unshielded material or object	10 mSv/h
IAEA	External radiation level at 3 m from the unshielded material or object	10 mSv/h
U.S.	External radiation level at 3 m from the unshielded material or object	10 mSv/h
Japan	External radiation level at 3 m from the unshielded material or object	10 mSv/h

The dose rate of 10 mSv/h at the 3 m point, which is the contents quantity limitation criteria of the Type-IP package, was set to ensure that the potential external dose

was consistent with the potential consequences of severe accidents involving Type-IP package [3].

IAEA advisory group (AG-144) noted that imposing the impact and crush tests required for Type-A packaging for Type-IP packaging is occurring loss of shielding. It was believed that an external dose criteria be added rather than requiring special testing.

After AG-144 mentioned, technical committee meeting was held. The meeting considered the need to ensure adequate shielding was retained for these materials to limit the external radiation dose rates following an accident, and the specific activity might be increased to unsafe levels following an accident. It was decided that the limit of external dose rate shall not exceed the radiation dose rate of 1 rem/h (10 mSv/h) at a distance of 3 m of the package [4].

## 4. Conclusions

In this study, the current status and rationales of the dose criteria for Type-IP package in Korea was analyzed. Radiation dose criteria and contents quantity limitation criteria for the LSA material and SCO of domestic Type-IP package were the same level as the overseas criteria. The dose criteria were set to prevent the radiological impact and fogging of X-ray films. Contents quantity limitation criteria for the LSA material and the SCO were set to ensure that the potential external dose is consistent with the potential consequences of severe accidents. This study is expected to contribute to confirm the appropriateness of dose criteria for domestic radioactive material transport.

## ACKNOWLEDGEMENTS

This work was supported by the Nuclear Safety Research Program through the Korea Foundation Of Nuclear Safety(KoFONS) using the financial resource granted by the Nuclear Safety and Security Commission(NSSC) of the Republic of Korea. (No. 1805016).

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