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Status of RI handling facility in KOMAC

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1. Introduction

Korea Multi-purpose accelerator complex, the branch of Korea atomic energy research institute, has the 100 MeV linear proton accelerator and plans a total of 10 beamlines. And the research to produce radioactive isotopes using one of the 10 beamlines has been underway [1]. We have established the facility to handle some radioisotopes for self-procurement and for the development of labeled compounds. In this facility, the biological effects of the commercialized radioisotopes also can be tested. Recently, we have been expanding our research field into the development of beta cell battery, and will have been changing the facilities for this purpose. Since the facility is to handle the unsealed radioisotope, the consideration and evaluation of facilities in terms of internal exposure and external exposures have been made again.

2. Evaluation for external and internal exposure dose

2.1 Type and amounts of radioisotopes

The types and amounts of radio-isotopes used in KOMAC are shown in Table 1. On the list of radioisotopes shown on Table 1, Ni-63, additional use of a nuclide, is planned to study the beta cell battery and some amounts of the nuclides licensed previously will be updated to increase their usage. Among these nuclides, Cu-64, Cu-67 and Sr-82 are planned to be procured by beam irradiation of the proton linear accelerator.

Table 1: Radio-isotope Types and Annual Use Amount

Type of Source	Isotope	Annual amount(MBq)	Daily Use amount(MBq)	
Unshielded Source (6 types)	Sr-82	74	3.7	-
	Cu-67	185-->11,100	18.5-->370	
	H-3	37	3.7	
	Cu-64	370-->11,100	37-->370	
	P-32	37-->370	3.7-->37	
	Ni-63	11,100	555	

2.2 Shielding change of the storage box and surface dose calculation

The storage of radioisotopes is planned to be locally shielded with lead bricks (50mm) in the storage box with 5mm thickness lead wall as shown in Figure 1. Table 2 shows the results of evaluating the gamma emission nuclides using Equation 1 under the assumption that the maximum storage amount of stored nuclides is a point source. At the distance of 1m from the source, the dose rate evaluated is lower than the background level as shown in table 3.

Table 2: Shielding Thickness of the radio-isotope storage box

Before change the license	After
Lead 5 mm	lead 55 mm (Lead 5 mm + Lead Bricks)

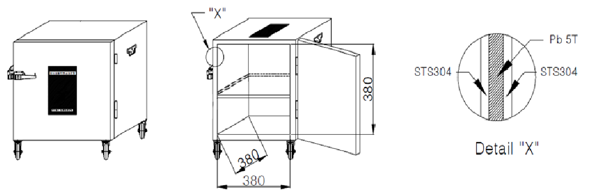

Fig. 1. Shielding Storage Box

Table 3: Evaluated Dose Rate for each Radio-isotope

Radio Isotopes	Maximum Load	Gamma Coefficient (mSv/Hr/MBq at 1m)	at 10 cm (uSv/hr)	at 1m (uSv/hr)
Sr-82	74 MBq	2.08E-4	0.79	4.7E-2
Cu-67	740 MBq	2.36E-5	5.8E-15	3.5E-16
Cu-64	740 MBq	3.51E-5	0.53	3.79E-2
Sum			1.3	78.9E-2

$$D = \Gamma \cdot \frac{A}{r2} \cdot e^{-\ln 2 \left(\frac{t}{\mu}\right)} \qquad (1)$$

D : Dose Rate (mSv/hr)
Γ : Γ Coefficient $(mSv/hr/MBq@1m)$
A : Maximum Storage Amount of RI (MBq)
r : Distance between the source and the evlauated point (m)
μ : Half value layer (mm)
t : Shield thickness $(Pb)(mm)$

2.3 Evaluation of internal and external radiation dose

Under the assumption that the total number of handling per year was 200 times for each type of nuclides and the evaluation method was the same as before [2], the estimated exposure dose according to the expected handling time and radioactivity during handling has described in Table 4 with comparison with previous evaluation results. The handling amounts of radioactivity for Cu-64 and 67 have increased at 30-60 times, so that the dose of external exposure was also increased linearity. However, the internal dose was increased by 10 times since it was evaluated by applying the internal ventilation rate which was not considered in the previous evaluation.

Table 4: Estimated dose comparison with previous evaluation results

	Before change the license	After
Annual external exposure dose rate	5.07 μSv	16.5 mSv
Annual external exposure dose rate per one person	about 2 μSv	about 6 mSv
Annual internal exposure dose rate	0.56 mSv	6.55 mSv
Annual internal exposure dose rate per one person	about 0.2 mSv	about 2 mSv

In the case of handling unsealed sources, internal exposure can be occurred due to the inhalation of air pollution at the facility and the ingestion caused by body contamination during handling. However, in order to evaluate the internal exposure through ingestion, the uncertainty of the evaluation is very high according to the dose evaluation models, and it is not easy to predict the degree of ingestion according to the exposure pathway. Therefore, only the evaluation of the exposure caused by inhalation process due to air pollution would be considered in this paper.

Inside the hume hood, 10% of the total daily amount was assumed to be the source of exposure as leaked to evaluation point. The dispersion factor depends on the status correction factor and handling correction factor for each group. The total annual usage of the raio-isotope to be used is 3,811 MBq, and the monthly working time is assumed to be maximum 144 hours, and the daily usage to be maximum 1,339 MBq. The dispersion factor is adoptted to 10^{-4}, the correction factor for the status condition is 1, and the correction factor for the handling method is 10 [2]. The indoor air contamination amount is 7,860 Bq/day. The average air contamination concentration is evaluated conservatively as assume to be zero for half-life of each RI. The daily average air contamination concentration is estimated to be 1.57 kBq/m^3 when the laboratory ventilation rate is 1200 CMH and the laboratory inside volume is 50 m^3. Assuming that all five radionuclides are included in the calculation of the average daily air contamination concentration, the evaluation ratio is 0.328 to compare with amount induced air concentration of unknown radioactive materials in the domestic law [3]. The expected annual internal exposure dose is 6.56 mSv since the concentration in the induced air is derived based on the 20 mSv dose per year.

3. Conclusions

External and internal exposure doses on the use of unsealed source were evaluated. Under the assumption that the main factors affecting the evaluation results are dispersion rate, indoor inflow rate, handling time, and handling frequency, etc and the calculation has used their conservative values, the annual dose is might be negligible.

REFERENCES

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