Evaluation of the Shielding Performance for the Hot-cell built in 100-MeV Isotope Beam-line of KOMAC

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1. Introduction

Korea multi-purpose accelerator complex (KOMAC) is currently operating 20-MeV and 100-MeV beam-line one by on. Additional 100-MeV beam-line and target room (TR101) are planned for the purpose of the radioisotope production in this year. The initial goal of the radioisotope production is to produce the radioactive isotopes, Sr-82 [1] or Cu-67 [2], used widely for the diagnosis and treatment of the cancer. In order to produce these radioisotopes mentioned, the proton beam with the energy between 70-MeV and 100-MeV at a beam current of 300 μA is irradiated into a solid target made of ZnO or RbCl. After the irradiation of the proton beam during approximately 100 hours, the radioisotope Sr-82 with the radioactivity amount of about 3.8 Ci or the Cu-67 with the amount of about 2.7 Ci will be produced. Radioisotopes produced though this process should be conveyed from the TR101 target room to the PR101 processing room and then in order to be delivered into the place for the next process step, a hot-cell is necessary. This study describes the structure of the hot-cell constructed in KOMAC for radioisotope production and evaluates the shielding performance for the hot-cell via the radiation shielding ability test.

Fig. 1 Current status of the hot-cell

2. Methods and Results

Hot-cell is constructed as the cube shape which consists of lead shielding material (150mm) with iron casing wall (3mm) and divided into three parts (the left side of the hot-cell, the right side of the hot-cell, and the transport device for container). The shielding performance test is carried out through the internal source method. That is, the outer wall of the left side of the hot-cell is divided into the nine parts as the measurement areas and the outside of the right side is divided into the eight parts, shown in Fig. 2.

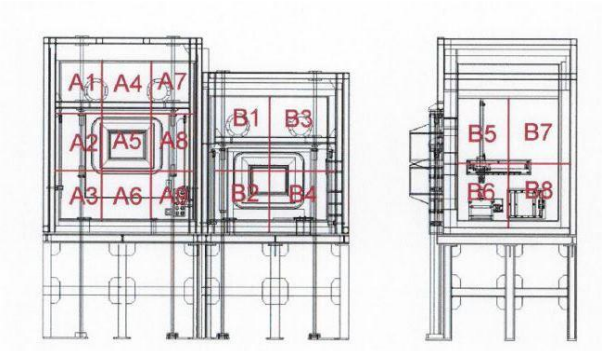

Fig. 2 Measurement area at the left side and the right side of the hot-cell for the shielding performance test

The radioisotope Co-60 with the radioactivity amounts of about 30 Ci is used for the shielding performance test. In order to calculate the maximum value of the dose rate, it is assumed that the source is irradiated on the center of the measurement area of the hot-cell and the radiation dose is measured in contact with outer wall. The maximum value of the dose rates measured on each zone at point of 5cm apart from the measurement area of the shielding surface is selected during the shielding performance test. The representative value on the lead glass windows protruded from the hot cell shielding wall are obtained by measuring the dose rate from the front and side direction of the lead shielding window. After repeating this process three times, the highest point value of three measurement values taken on each zone selected is decided as the final value of the dose rate.

The dose rate decided as the final value at the measurement area will be compared with the dose rate value calculated by the eq1.

$$A = \frac{\Gamma \times A_0}{r^2} \cdot e^{-0.693 \times \frac{thick}{HVL}} \quad \text{----------eq1.}$$

The source activity of Co-60, A_0 is 30 Ci and measured distance, r is 206 mm from the source. This is the distance contained between source and shielding materials (Pb, Fe) surface plus 50 mm away from there. The gamma factor for the Co-60, Γ is defined as the 1.32R· m^2/Ci·hr. The shielding thickness is the sum of 150 mm of the lead and 3 mm of the iron materials. The half value layer (HVL) for the Co-60 is 12 mm (Pb) and 20 mm (Fe). Table 1 shows equation constants used in the equation 1.

Table 1: Equation constants used in the equation 1.

Measurement distance	206 mm
Thickness of shielding material	150 mm(Pb), 3 mm(Fe)
HVL of Co-60	12 mm(Pb), 20 mm(Fe)
Gamma Factor(Co-60)	1.32R· m^2/Ci· hr
Activity (Co-60)	30 Ci

Shielding performance evaluation was carried out by comparing the measured value with calculated value. The dose rate calculated using equation 1 is 1263 μSv/hr. If the measured value was less than the calculated dose rate in each zone, the result was satisfied with the shielding performance requirements. As a measurement results, dose rates were satisfied with the requirements at all points except the zones near the lead glass window of the left and right-side hot cell (A5 and B4). In the case of the zones near the lead glass windows, there is plan to meet the requirements of the shielding performance through the reinforcement using a lead shielding material based on the distance from the source point to the window surface, shown in Fig 3.

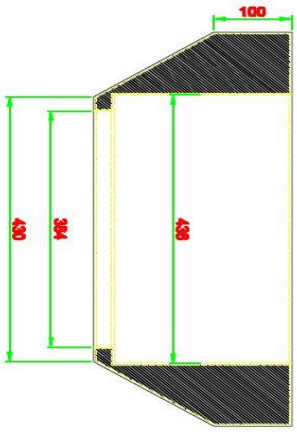

Fig. 3 Reinforcement using the lead shielding material near the glass window.

Fig. 3 shows the side of lead glass window with the shielding reinforcing structure, shown as hatched part. In this reinforced structure, the value of the dose rate measured at the side of the lead glass has the similar value with dose rate measured in front of the lead glass window and is satisfied with the condition of shielding performance.

3. Conclusion

Result of the shielding performance evaluation of the hot-cell for producing radioisotopes shows the necessity of the shield reinforcement using lead material at side of the lead glass window. Except these parts, the shielding performance evaluation was satisfied with all areas of the hot-cell.

REFERENCES

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