Low Current Irradiation Facility at KOMAC

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1. Introduction

Korea Multi-purpose Accelerator Complex (KOMAC) is branched off from Korea Atomic Energy Research Institute (KAERI). The 100 MeV linear proton accelerator as well as the various types of the ion accelerator have been operated and developed in KOMAC. The operation of these accelerators included in the KOMAC site should be approved by Nuclear Safety & Security Committee (NSSC). To aims at the operation in 2017, a research facility to irradiate low current beam has been prepared. We will change the structure of the shielding and the operation program about the radiation safety. So, the radiation safety analysis was performed again to adopt with the change. As a result of these changes, an easy access into the facility will be got to. This paper introduces the activity in terms of the radiation safety for these accelerator operations.

2. Evaluation of Radiation Safety

The proton irradiation facilities in KOMAC were already designed and constructed by performing a radiation transport analysis according to criteria design limits. The previous heavy shielding door should be demolished for the low current irradiation facility and the door concept should be changed to easily access. There are the aspects evaluated. Those are a design of new shielding door at the changed position, an evaluation of radiation exposure caused by the activated concrete and a calculation of the leakage radiation through new penetration for electric cables.

2.1 Shielding Calculation

Table 2.1 shows the results of calculation about the radiation dose rate at new shielding door according to several positions. Those positions are shown in figure 2.1. This calculation is used a computational simulation code, MCNPX. [1]

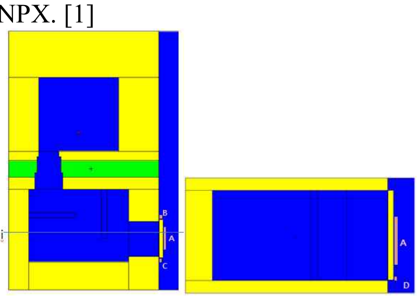

Fig. 2.1 Calcuation Model for MCNPX 2.6.0

Table 2.1 Dose Rate according to the Evaluation Position

Po si on	Neutron		Gamma		Total	
	Dose rate (μSv/h)	Rel. Err. (%)	Dose rate (μSv/h)	Rel. Err. (%)	Dose rate (μSv/h)	Rel. Err. (%)
A	4.88	5.49	0.78	3.08	**5.66**	4.75
B	2.28	7.73	0.58	3.35	2.86	6.20
C	2.32	7.03	0.64	3.45	2.96	5.56
D	3.90	4.39	1.07	2.06	4.97	3.47

2.2 Evaluation of induced Gamma-ray from the Concrete Wall

The radio-nuclide which is generated in the concrete wall was evaluated using a computational simulation code, PHIT. After that, an exposure evaluation from the gamma ray caused by these radio nuclides is performed. Gamma ray that affects on the exposure comes from activated impurities in the concrete. Impurities information in concrete was referred in nureg-3474. This evaluation is assuming that the facility have operated for 30 years.

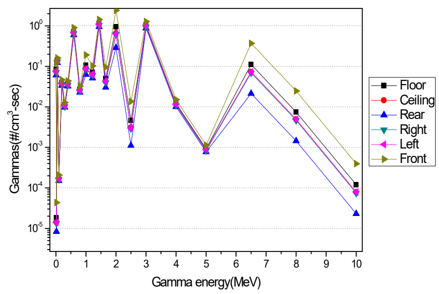

Fig. 2.2 Intensity of Gamma from each Wall

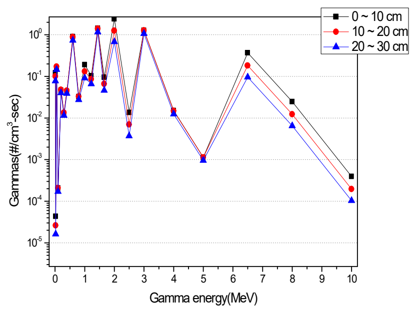

Fig. 2.3 Intensity of Gamma according to the Depth for the Concrete Wall

Table 2.2 Dose Rate caused by the activated concrete wall

Group	Position of Gamma source	Dose Rate (μSv/h)	Rel. Err.
A	Surface to 10 cm	1.03	0.9%
B	10 cm to 20 cm	0.18	1.6%
C	20 cm to 30 cm	0.05	2.7%
Total		**1.26**	1.0%

2.2 Radiation Streaming Calculation

There are many penetrations and the thin air filled in clearance gaps of the accelerator facility, such as a cable, a cooling water pipe or an air conditioning duct as well as an air gap of between the wall and the shielding door. The estimation of the radiation streaming through these penetrations or the air filled in gaps is one of the most difficult parts in shielding design. The Shin's semi-empirical formula describing energy-space distributions of neutrons and gamma-rays streaming in ducts or labyrinths is very useful for application to accelerator facility.[2] A streaming calculation code DUCT-III is based on the Shin's formula with the albedo data up to 3GeV.[3]

The source term was calculated by MCNPX and the radiation streaming through the air gap by DUCT-III. The ambient dose conversion coefficient of ICRP 74 was regeneration with the neutron energy group band width of DUCT-III by MCNPX. Table 2.3 and Fig. 2.5 are shown the source term and the calculation result, respectively.

Table 2.3 Source Term Calculated by MCNPX for DUCT-III input

Energy [MeV]	100 MeV	
	Flux [#/cm^2/primary]	Intensity [#/sec]
4.14E-07	0.00E+00	0.00E+00
5.04E-06	0.00E+00	0.00E+00
1.01E-04	3.42E-14	2.68E+02
3.35E-03	5.35E-12	4.20E+04
8.65E-02	6.16E-10	4.83E+06
1.35E+00	1.92E-08	1.50E+08
2.00E+01	1.36E-07	1.07E+09
1.00E+02	6.12E-08	4.80E+08
4.00E+02	0.00E+00	0.00E+00
8.00E+02	0.00E+00	0.00E+00
1.50E+03	0.00E+00	0.00E+00
3.00E+03	0.00E+00	0.00E+00
total	2.17E-07	1.70E+09

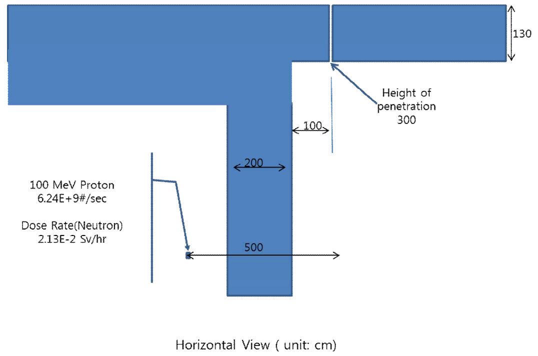

Fig. 2.4 Calculation Model for using DUCT-III

The simulation geometry model for using DUCT-III is shown in Fig. 2.4.

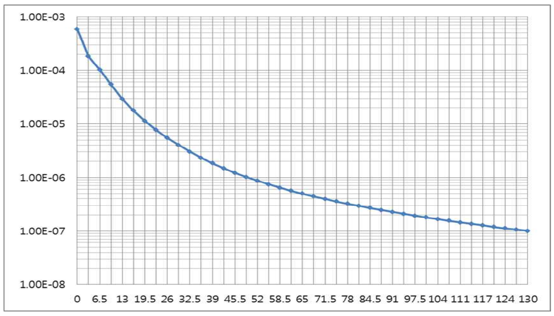

Fig. 2.5 Leckage Dose Rate according to the Penetration Depth

3. Conclusions

Radiation analysis was performed depending on the planned changes, and it was confirmed that there is no effect by the changes. This facility is expected to be made the best use at a field which could be irradiated with proton beam which has an energy up to 100 MeV and current up to 10 nA.

REFERENCES

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