Radiation Safety Design for the Target Rooms of the Beam Application Research Building of PEFP

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1. Introduction

Proton Engineering Frontier Project (PEFP) has been developing a 100 MeV proton linear accelerator. Also, PEFP has been designing the Proton Accelerator Research Center in Gyeong ju.

In Accelerator Tunnel & Beam Experiment Hall in Proton Accelerator Research Center, 5 target rooms for the 20 & 100 MeV beamline facilities exist in the Beam Experiment Hall, respectively. For the 100MeV target rooms during 100MeV proton beam extraction, a number of high energy neutrons, ranging up to 100MeV, are produced.

For the radiation safety, we designed the radiation shield scheme and HVAC system for the target room and personal safety & interlock system [1]. Proposed radiation shield design and HVAC system satisfy the radiation safety design criteria.

2. Radiation Shielding Design for the Target Room

In Accelerator Tunnel & Beam Experiment Hall of PEFP, 5 target rooms for 20 MeV and 100 MeV exist to utilize proton beam. Layout of the 20MeV and 100MeV target room is illustrated in Fig. 1.

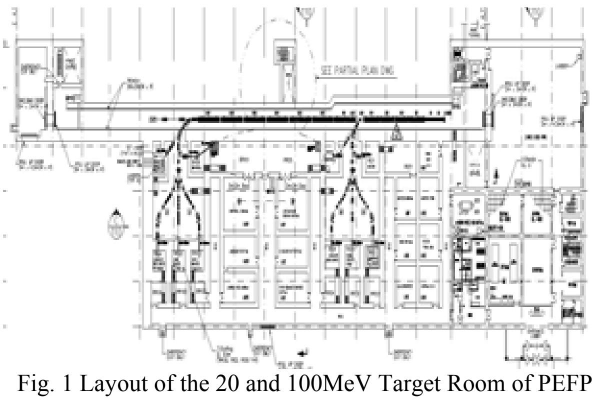

Fig. 1 Layout of the 20 and 100MeV Target Room of PEFP

For the 20 MeV target rooms under normal operating conditions, because dose limit is satisfied with concrete wall thickness determined by structural design analysis, radiation shielding design of 20MeV target rooms is unnecessary. For the 100 MeV beam utilization, PEFP designed the 5 target rooms (TR101, TR102, TR103, TR104 and TR105) for the 100MeV beamlines in the Beam Experiment Hall. Fig. 2 describes 100MeV target rooms in the beam experiment hall of PEFP.

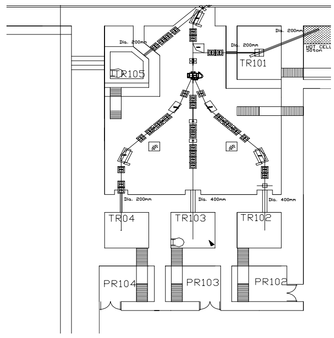

Fig. 2 100 MeV Target Rooms in Beam Experiment Hall

For the optimal shielding design of the 100MeV target rooms of PEFP, permanent and removal local shield structure was adopted. Iron and concrete were employed as a permanent shield structure. Lead and high density polyethylene (HDPE) were employed as a local shield structure. Shield wall thickness by permanent shield structure for the 100MeV target rooms are described in Table 1.

Table 1 Permanent Shield Wall Thickness and Radiation Level for 100MeV Target Rooms

Target Room	Shield Wall Component	Radiation Level [uSv/hr]	Beam Direction
TR101	Concrete-Iron-Concrete Max Thick. : 270cm	≤12.5 (Front Wall Outside) ≤ 0.25 (others)	Horizontal Beam
TR102	Concrete-iron-concrete Max Thick. : 270cm	≤ 0.25 (roof outside) ≤ 12.5 (others)	Horizontal Beam
TR103	Concrete-iron-concrete Max Thick. : 270cm	≤ 0.25 (roof outside) ≤ 12.5 (others)	Horizontal Beam
TR104	Concrete-iron-concrete Max Thick. : 300cm	≤ 0.25 (roof and Left Side Wall outside) ≤ 12.5 (others)	Horizontal Beam
TR105	Concrete-iron-concrete Max Thick. : 300cm	≤ 0.25	Vertical Beam

At the end of the beamline, rear wall of each target room is located. When a target room is not in operation, radiation from other beamlines or target rooms should be shielded to keep its radiation doses below 12.5uSv/hr (radiation worker area). Also, when beamlines are not in use, they are filled with water to protect radioactivation.

3. HVAC System Design for the Target Room

3.1 Target Room Operation Scenario

To design the HVAC system for the target room appropriately, we should know the operation scenario and accessibility.

For the 20MeV target rooms, access in one of the 20MeV target room is permitted after beam shut-down. For the 100MeV target rooms, access to TR102, TR103 and TR104 can be permitted after beam shut down. Although its beam shut down, access to TR101, TR105 and beamline enclosure is restricted when one of the 100MeV beams is in operation.

3.2 HVAC System Design for Each Target Room

During target room operation, to prevent the migration of the airborne radioactivity to accessible area, HVAC (Heating, Ventilating and Air conditioning) system exhaust radioactive gas from the target room for ventilation. The air then goes to a mixing box, where it is mixed with a controlled quantity of outside air. Fig. 3 describes the HVAC system for the 20/100MeV target rooms of PEFP.

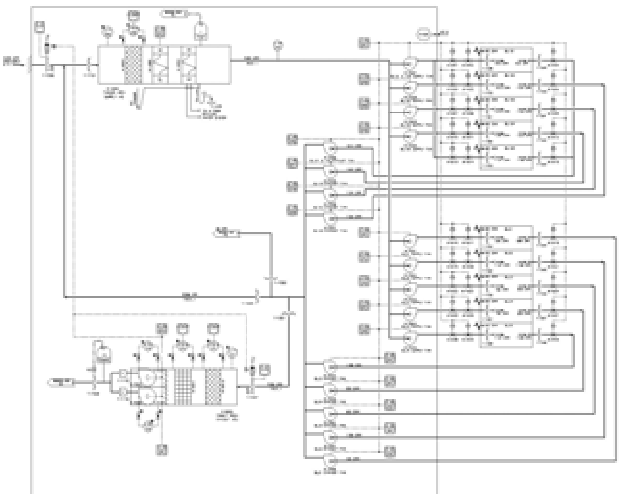

Fig. 3 HVAC System for the 20/100MeV Target Room

At the same time, HVAC draws out some of the inside air and blowing it into the ACU. Radiation monitor is attached to the ventilation tube to check if it satisfies the radiation limit. Fig. 4 describes radiation monitor for the target room.

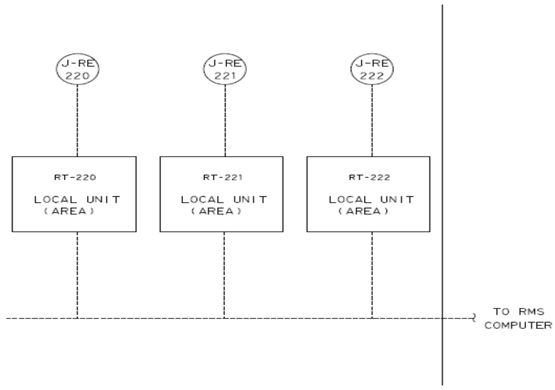

Fig. 4 Radiation Monitoring System for the Target Room of PEFP

4. Conclusions

In this paper, we designed radiation shielding and HVAC system according to the radiation shield scheme for the radiation safety.

We proposed shielding scheme to keep its radiation doses below 12.5uSv/hr (radiation worker area). To prevent the migration of the airborne radioactivity to accessible area, HVAC system draws air from outside for the target room ventilation. The air then goes to a mixing box, which satisfy the radiation safety design criteria.

ACKNOWLEDGEMENT

This work was supported by the Ministry of Education, Science and Technology (MOST) of the Republic of Korea through the Proton Engineering Frontier Project.

REFERENCES

[1] “Radiation Protection for Particle Accelerator Facilities,” NCRP Report No. 144, published by National Council on Radiation Protection and Measurements, 2003.