Effluent Monitoring System Design for the Proton Accelerator Research Center of PEFP

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1. Introduction

Since host site host site was selected Gyeong-ju city in January, 2006. we need design revision of Proton Accelerator research center to reflect on host site characteristics and several conditions. Also the IAC recommended maximization of space utilization and construction cost saving. After GA(General Arrangement) is made a decision, it is necessary to evaluate the radiation analysis of every controlled area in the proton accelerator research center such as accelerator tunnel, Klystron gallery, beam experimental hall, target rooms and ion beam application building to keep dose rate below the ALARA(As Low As Reasonably achievable) objective. Our staff has reviewed and made a shielding design of them.

In this paper, According to accelerator operation mode and access conditions based on radiation analysis and shielding design, we made the exhaust system configuration of controlled area in the proton accelerator research center. Also, we installed radiation monitor and set its alarm value for each radiation area.

2. Radioactivity Production in Proton Accelerator Research Center of PEFP

Radionuclides in air produced by the accelerator operation consist of H-3, Be-7, C-11, N-13 O-15 and Ar-41. These radionuclides are generated by a spallation reaction during an accelerator operation except for Ar-41; when a linear proton accelerator produces chains up to 100 MeV, its energy is not sufficient for a spallation reaction. Therefore the concentration of Ar-41 is much higher than other radionuclide, because thermal neutron is generated by scattering from the prompt neutron produced by the (p, n) reaction [1].

3. HVAC System Design for the Proton Accelerator Research Center of PEFP

Air inside the accelerator tunnel, klystron gallery area, beam line enclosure in the beam experiment hall can be activated and released to the environment. In such radiation areas, HVAC (Heating, Ventilating and Air Conditioning) system is vital to the radiation protection for workers. Characteristics of the HVAC system are described below.

- During normal and accident conditions, HVAC system minimizes radiation exposure to radiation worker and public by radiation source in air.
- A sufficient amount of air dilution is provided by HVAC to control of radioactivity released in air to protect the environment.
- HEPA filters are designed to filter radioactive contaminants to satisfy regulation of the amount of radioactivities released to the environment.
- Negative pressure ventilation prevents radioactive air in the radiation area from escaping into adjacent area.
- Air in the high radiation area, such as accelerator tunnel, beam line enclosures, and 20/100MeV target rooms, is re-circulated.
- Air suction apparatus is fully spaced apart from exhaust point to prevent activated air from re-entering.

2.1 Radioactivity Released to the Environment through HVAC

To keep negative pressure in high radiation area with Ar-41 produced in Accelerator & Beam Application Research Building of PEFP, ventilation system draws minimum ventilation air volume into the building up to the plenum. Air in each radiation area is re-circulated by AHU.

2.1.1 Accelerator Tunnel HVAC System

Accelerator tunnel HVAC system re-circulates indoor air of accelerator tunnel. Accelerator tunnel is maintained at a slightly negative pressure relative to adjacent interior due to the presence of the exhaust ventilation by klystron gallery exhaust AHU system. During decommissioning and emergency situations, ventilation system draws ventilation air into the building up to the plenum. In the ventilation system, gaseous radiation monitors are installed to monitor radiation level continuously and to alert the operator by continuous monitoring of ventilation air.

2.1.2 Klystron Gallery HVAC System

In HVAC of klystron gallery, a portion of ventilation air supplied is outdoor air and a portion is re-circulated air. Klystron gallery AHU draws air in accelerator tunnel to keep accelerator tunnel in negative pressure. Klystron gallery HVAC system draws ventilation air into the building up to the plenum when mixed-air-plenum satisfies regulations of radioactive discharges. In the ventilation system, gaseous radiation monitors are also installed.

2.1.3 Target Rooms HVAC System

Target rooms HVAC system only operates when target irradiates with proton beams.

During decommissioning and emergency situations, target room ventilation system draws ventilation air into the building up to the plenum when mixed-air-plenum satisfies regulations of radioactive discharges. In the ventilation system, gaseous radiation monitors are installed.

2.2 Accelerator Operation Scenario

According to beam current, target materials, beam irradiation time and operation scenario, each target room has its own operation and access mode as follows :

Assumption

1) 20MeV and 100MeV beam utilities are not allowed to operate simultaneously.

2) In 20MeV beam extraction operation
- TR 21 and TR 25 cannot operate at the same time.
- When TR 21 or TR 25 is in operation, TR 22, TR23 or TR 24 has exclusive operation modes.

3) In 100MeV beam extraction operation
- TR 101 and TR 105 can't operate at the same time.
- When TR 101 or TR 105 is in operation, TR 102, TR103 and TR 104 are not able to operate simultaneously.

Operation Scenario

1) OM020-1 : TR21 in operation
2) OM020-2 : TR22, TR23, TR24 are operating simultaneously.
3) OM020-3 : TR25 in operation
4) OM100-1 : TR101 in operation
5) OM100-2 : TR102, TR103, TR104 are operating simultaneously.
6) OM100-3 : TR105 in operation

Table 1 Ar-41 Concentration of the effluent from mixing box for each operation mode, assuming 50 hours accelerator operation..

Table 1 Ar-41 Concentration of the effluent from mixing box for each operation mode

Operation Mode	Radiation Concentration [Bq/m^3]	Radiation Concentration vs Emission Standard
OM020-1	83	0.16
OM020-2	88	0.17
OM020-3	71	0.14
OM100-1	46	0.09
OM100-2	49	0.09
OM100-3	46	0.09

3. Radiation Monitoring System Design of PEFP

3.1 Alarm Setpoint for the Radiation Monitoring System

In Proton Accelerator Research Center of PEFP, 35 local radiation monitors are installed; 8 for Accelerator Building, 25 for Beam Application Research Building, and 2 for yard. Table 2 describes alarm value for each radiation monitor of PEFP.

Table 2 Alarm Value for each Radiation Monitor of PEFP.

Building	Installation Possition	Alarm Set Value [uSv/hr]
Accelerator Tunnel	Acc. Preparation RM	6.25E+01
	Acc. Tunnel	1.95E+06
	Acc. Assembly Area	1.25E+00
	HVAC RM for Target RM	6.25E+01
	Cooling WTR Tank RM	6.25E+01
	Kly. Gallery Entrance	6.25E+01
Beam Experiment Hall	TR101 Target RM	7.68E+10
	TR102 Target RM	5.78E+08
	TR103 Target RM	1.81E+10
	TR104 Target RM	5.91E+08
	TR105 Target RM	3.51E+11
	100MeV BeamLine Enclosure	7.15E+06
	TR21 Target RM	6.86E+07
	TR22 Target RM	2.04E+07
	TR23 Target RM	1.14E+08
	TR24 Target RM	2.33E+07
	TR25 Target RM	6.46E+07
	20MeV BeamLine Enclosure	1.05E+06

4. Conclusion

In this paper, According to accelerator operation mode and access conditions based on radiation analysis and shielding, we set up the exhaust system configuration of radiation area in the proton accelerator research center. We also designed radiation monitoring system; we set installation position and alarm set value for each radiation monitor.

4. Acknowledgments

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REFERENCES

[1] Yi-Sub Min, Cheol Woo Lee, Kyeong-Jun Mun and Jun Yeon Kim, Off-gas Ventilation System Design for the Shielding Structure of the 100MeV Proton Accelerator of PEFP, Journal of Nuclear Science and Technology, Supplement 5, pp. 112-pp.115, June, 2008