Improvement of Radiation Safety for Radioisotopes Producing Facility

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1. Introduction

KOMAC of Korea Atomic Energy Research Institute (KAERI) conducts research in various fields, including Surface modification, Nano-chemistry, and Aerospace, and so on, using 100MeV Proton Accelerator. Additionally, it provides opportunities for various industries to utilize proton beams as well.

When proton beams are irradiated into target, radioisotopes are highly likely to be generated, and specific radioisotopes can be produced depending on target materials. KOMAC recently obtained a Radioisotope Production Permit for a few radionuclides from NSSC (Nuclear Safety and Security Commission) and now is planning to begin producing them this year. However, produced radioisotopes are not sealed, which have a risk of radioactive contamination during handling.

Therefore, KOMAC tried to ensure the radiation safety of researchers by improving the contamination monitoring environment of the facility. This paper aims to discuss the improvement of safety of radiation workplace for KOMAC's radioisotopes producing Facility, by analyzing the weakness of the radiation workplace and by correcting it.

2. Analysis and Improvement

2.1 Radioisotopes Production Procedure

The facility was constructed entirely of concrete material, and proton beams are irradiated into target which is placed in a sealed area called as "Target Room." The irradiated target material is then transferred to a Target Room Hot Cell, which is directly connected to the Target Room through the hole. Researchers use a manipulator to place the target into a shielded transport container. This container is then moved by a forklift to a Fume Hood or Refining Hot Cell for handling. The total distance of the forklift is approximately 10 meters.

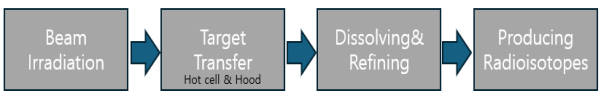

Fig.1. Simple procedure for Radioisotopes production

Ultimately, in the Fume Hood or Hot Cell, target undergoes separation and refinement processes. After processing, the radioisotope remains in a liquid state. Researchers can transport it to another laboratory for use, store it in the production facility, or dispose of it.

2.2 Setting up Measurement Points for Surface Contamination

Most of facilities where utilize radioactive sources conduct contamination measurement. In other words, contamination measurement is commonly conducted not only in industrial facilities but also in hospitals. [1]

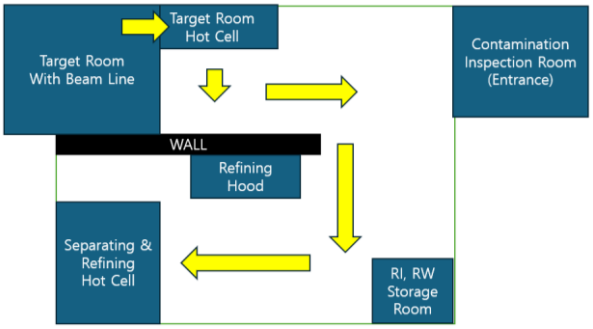

Fig. 2. Target Transfer Route (Yellow Arrow)

Figure 2 shows the structure of facility with moving line of targets from Target Room to Refining Hot Cell or Fume Hood. The Yellow Arrow indicates the transport route using a forklift. However, Researchers can directly handle targets in the Fume Hood in case of low-radioactivity, and they can also store some residual materials or radioisotopes in Storage Room after refinement process. Also, researchers did not measure contamination during experiments. They only monitored the radiation levels in the vicinity of their working area.

Therefore, Surface contamination measurement points were selected near the Fume Hood and Radioisotopes Storage Room, considering situations where researchers handle target materials directly. Smear method was used for measurement, as it is less influenced by ambient contamination compared to surveymeter method.

Meanwhile, there is a buffer zone between the production facility and general Radiation Controlled Area (outside of the facility), called as "Contamination Inspection Room." All the researchers must pass through this room for entrance. Especially before leaving, researchers should take a measurement from Whole Body Surface Contamination Monitor. To monitor the potential diffusion beyond the facility, the

Contamination Inspection Room was also included as a measurement point. Consequently, 3 points of total are set to be measured. Also, researchers in the facility are going to check the levels of Surface contamination of their workplaces by themselves, using surveymeters during work.

2.3 Improvement for Air Contamination Monitoring

This facility handles unsealed radioactive sources, which can induce air contamination. Air contamination of the facility is monitored and measured at Rooftop exhaust area. Monitoring devices are installed in this area to detect air contamination. Refining Hot Cell and Fume Hood are connected to the exhaust system respectively. If radioactivity levels reach a certain value, the exhaust fan automatically shuts down. The issue here is that researchers can't check air contamination levels in real-time and must rely on monitoring devices connected to the exhaust system during experiments. In other words, researchers cannot check whether the contamination levels remain relatively high compared to normal conditions. Also, to check the contamination levels, they need to go to the Rooftop, which is impractical. In addition, unlike Hot Cell, the Fume Hood is not fully sealed. Leakage of radioisotopes from Fume Hood is probable while researchers handle samples in this area. For these reasons, a Continuous Air Contamination Monitoring Device (FHT-58SI, Thermo) recently has been installed near the Fume Hood. This device continuously collects the air and displays real-time radioactivity levels, allowing researchers to monitor air contamination levels frequently. From now on, they can check the levels and take appropriate actions on their own. Additionally, the device has a filter-based air collection mode, which allows for periodic filter collection and another radioactivity measurement from using this filter. The Filter is collected at every specific time-cycle and analyzed using a Low-Alpha and Beta Proportional Counter (5XLB, Canberra) to monitor air contamination levels in the facility.

Fig. 3. Continuous Air Contamination Monitoring Device (Before and after installation)

In case of Air monitoring, for tasks which have a high risk of diffusion of contamination, a portable air sampler (Hi-Q) will be used to collect air samples before and after the task to measure changes in contamination levels. This device can also rapidly be used for accidental leakage of radioactive sources from target sample or unexpected incidents.

2.4 Radioactive Waste Management

KOMAC's Radioisotopes production facility is located within Proton Accelerator facility. The radioactive waste generated from radioisotopes production process includes Liquid, Glassware, and Residual by-products from separation and refinement processes, which mainly contain Na-22. (Half life: 2.6 years)

Compared to the waste that comes from Proton Accelerator, the type, form, radio-nuclide composition of the waste differs significantly from each other. Therefore, radioactive waste of production facility will be stored and managed separately within this facility. After reducing the radioactivity concentration by natural decay, the waste will be disposed of by self-disposal in accordance with regulatory procedures.

3. Conclusion and Future Work

The radioisotope production activities are going to begin this year. There were some insufficiencies in terms of radiation safety in KOMAC's radioisotopes production facility, and we tried to improve them. Surface Contamination measurement locations were selected considering the areas where researchers directly handle radioisotopes and the paths of moving radioactive sources within the production facility. Additionally, by installing Air monitoring equipment that allows them to check air contamination levels in real-time during experiments, their concerns of exposure have been alleviated, making them take preventive actions if necessary.

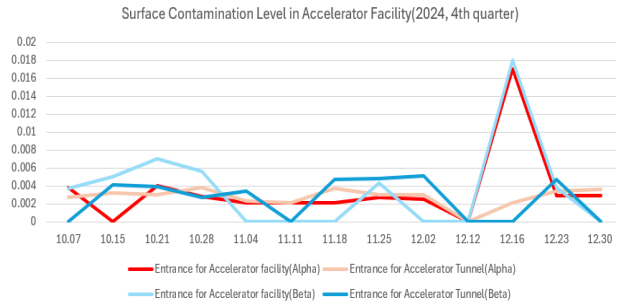

Fig. 4. Surface Contamination Level in Accelerator Facility in unit Bq/cm^2 (4th Quarter, 2024)

Meanwhile, Proton Accelerator facility is being monitored continuously. Figure 4 shows the surface contamination level measured from specific place in this facility. KOMAC will monitor whether researchers' radioisotopes production activities impact the contamination levels of the accelerator facility and analyze influenceability and correlation of them.

Furthermore, we will identify specific tasks in the production facility that may cause contamination continuously. This will allow us to ensure more effective radiation protection management when researchers conduct similar tasks or experiments in the future.

REFERENCES

[1] Sang-Hyun Han, Measurement of Radioactive Surface Contamination of the Restroom in the Hospital, Journal of the Korea Convergence Society, Vol. 11, No. 8, pp. 71-76, 2020.