# Periodic airborne contamination measurement of air in KOMAC

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## 1. Introduction

The 100-MeV high-power accelerator operated in Korea multi-purpose accelerator complex (KOMAC) could offer an optimum proton beam for the experimental user. These proton beams with the energy 100MeV would interact with a nucleus of the target installed by the user and made many radioactivity by-product such as neutrons, protons, photons, α particles and β particles. The radiation worker and experiment users worked in the radiation controlled area can be exposed to the risk of inhaling the airborne alpha and beta particulates, generated by this proton linac. Fig. 1 shows that the working space in the accelerator building is classified into the general public area and the radiation controlled area, which divided into the radiation worker area and the high-level radiation area.

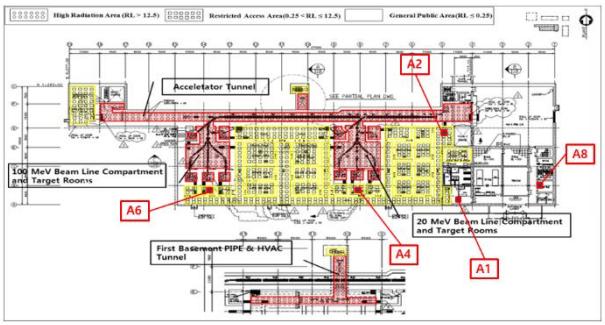


Fig. 1 Radiation controlled area defined in the first floor of the accelerator building. The red area and yellow mean the high-level radiation area with the main proton linac and the radiation worker area, respectively. The five points have shown places to have the airborne contamination measurement.

The air concentrations of target rooms and the tunnel with the 100-MeV proton linear accelerator, as defined in the high-level radiation area of Fig. 1, have been monitored by the radiation monitoring system (RMS). For the safety of the experimental user, the potable beta air monitor is operated near the shielding door for the experiment. In order to manage systematically the radioactivity of the airborne alpha and beta particulates, the airborne contamination measurement [1] should be performed at least once a month at designated five places as shown in Fig. 1. The five places are composed of three places in front of the shielding door of the tunnel and target rooms (A2, A4, A6), the entrance of the radiation controlled area (A1), and one place of the general public area (A8), as shown in Fig. 1. In this research, the procedure and its measurement result to have the airborne contamination measurement would be described.

## 2. The air contamination measurement in KOMAC

For the airborne contamination measurement in KOMAC, two equipment are needed as shown in Fig. 2. The first equipment is the air-sampler to capture the airborne radioactivity in the air near the designated place and the low alpha-beta counter is needed to measure the total activity of the filter installed in the air-sampler [2]. The equation to calculate the airborne concentration, C is given as the following: [1]

$$C = \frac{A_0}{F \cdot t_0 (1 - e^{-\lambda \cdot t_0})} \quad (1)$$

where the parameter F is the flow rate of the air-sampler. The parameter λ is the decay constant of the unknown radioactivity measured on the filter installed in air-sampler. First of all, in order to calculate the decay constant λ, the sample filter should be measured several times over time. This value can be calculated by fitting the data measured [1]. The parameter $A_0$ is the radioactivity measured immediately using the low alpha-beta counter as soon as the air sampling is completed. Actually, there are the time gap, $t_g$ between the time after finishing the air sampling and the time to start measuring the radioactivity of the filter. The parameter $A_0$ has been corrected using the time gap $t_g$ and the radioactivity to measure on the filter first. And the parameter $t_o$ is the air sampling time. For the airborne contamination measurement in KOMAC, the air is collected during an hour with the flow rate, 60 lpm.

Fig. 2 The air-sampler (left) used to collect the air near the entrance of the radiation controlled area (A1) and the low alpha-beta counter (right) used to measure the radioactivity of the filter installed in the air-sampler.

The airborne concentration C could be defined as the activity per unit volume. In the denominator of the

equation (1), the part $F \cdot t_0$ means the volume of the air collected by the air-sampler and the part $\frac{1}{1-e^{-\lambda \cdot t_0}}$ of the equation (1) is approximately 1.44. That is, the radioactivity used to calculate the air concentration C is 44 % larger than the activity measured as soon as the air sampling is completed since the radioactivity of the airborne particulates should be decayed continuously. The alpha radioactivity measured first from the filter sampled at the general public area (A1) is 3.59 Bq. The decay constant λ for the alpha calculated from the fitting data measured at the entrance (A1) is 1.19. When the time gap, $t_g$ is 3 minutes, the radioactivity $A_0$ calculated is 3.81 Bq. The airborne concentration C for the alpha calculated is 1.52 Bq/$m^3$ and its uncertainty is 0.30 Bq/$m^3$ [1].

### 3. The nuclide analysis of the sample

In the filter sampled during an hour, there should be unknown radionuclides detected although its airborne concentration is small. In order to identify these unknown radionuclides, the alpha spectrometer should be used. Specifically, two air-samplers are installed at the designated place and we assume that two air-sampler has collected the same amount and kind radioactivity at the same time. After finishing the sampling, the radioactivity of one filter is measured on the low alpha-beta counter. Another filter is installed in the alpha spectrometer to identify the radioactivity on the filter. The nuclide analysis of the radioactivity would be operated during one day using the alpha spectrometer.

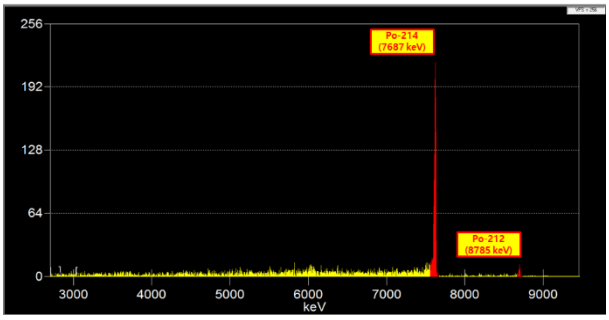


Fig. 3 The result of analyzing the nuclide of the filter as soon as the air sampling is completed at the general public area (A1).

Fig. 3 shows the result of the nuclide analysis measured during a day and two main peaks are identified from the nuclide analysis of the alpha spectrometer. The first peak identified with the energy 7687keV is Po-214 and the second peak identified with the 8785keV is Po-212. The energy peak of Po-214 is 7616.7keV and its half-life is 1,64E-4 sec. Po-214 is decayed from Radon(Rn-222), shown in Fig. 4. The energy peak of Po-212 is 8687.6keV and its half-life is 0.3E-6 sec. Po-214 is decayed from Radon (Rn-222), shown in Fig. 4. Actually, Radon and thoron contribute to a large portion of the natural background radiation dose affecting humans [3]. That is, they have emanated from rocks and soils distributed around us. Especially, in confined spaces such as basements or building, they are accumulated as the high levels. The radioactivity of the airborne concentration C measured on the filter can be seen from the radon and thoron. The purpose to measure the airborne concentration at designated five places as shown in Fig. 1 is to find the artificial radionuclide produced from the proton linear accelerator, not the natural radionuclide. Thus, the filters installed in the air-sampler keep for three days and then, their radioactivity data are measured using the low alpha-beta counter to remove the effect of the natural radioactivity.

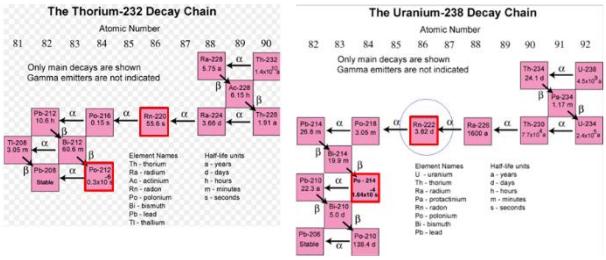


Fig. 4 The decay chain for the thorium-232 and uranium-238.

### 4. Conclusions

In order to check the airborne radioactivity effect of the proton linear accelerator in KOMAC, the airborne contamination measurement are operated periodically at designated five places as shown in Fig. 1. By the nuclide analysis using the alpha spectrometer, the radioactivity measured on the filter of the air-sampler is from the natural radionuclide, radon and thoron. Thus, in order to remove the effect the natural radionuclide, the real data used to the report are measured using the low alpha-beta counter after keeping for three days.

### REFERENCES

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