The Installation and Operation Status of Environmental Sample Analysis System at KOMAC

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1. Introduction

Korea multi-purpose accelerator complex (KOMAC), which belongs to the Korea Atomic Energy Research Institute (KAERI), has started the performance test operation in the second half of 2013 and currently operates one 20MeV beamline and three 100MeV beamlines. And a radiation monitoring system (RMS) is installed in facilities and sites to monitor radiation of each section in real time. In addition, to analyze the environmental radioactivity of the surrounding area, an environmental sample analysis system has been installed and operated in the first half of this year. Figure 1 shows the view of KOMAC's site.

Figure 1.View of KOMAC's site

Currently, environmental samples are periodically measured for water samples such as rainwater, drinking water and reservoir water and the radiation safety team of KOMAC plans to expand the range of samples and analysis targets through setting up a step-by-step. When measuring tritium in water sample using LSC, the water sample required pretreated in the method such as distillation to minimize the effect of quenching. However, this experiment focuses on checking the operation status of the equipment so omits the pre-treatment procedure of the sample and tried to compare relative value rather than absolute values. The pre-treatment equipment and nuclide analysis equipment, in order to measure environmental samples such as soil and plants required the chemical pre-treatment, are also prepared. The radiation safety team of KOMAC intends to provide the sample data analyzed by the environmental sample analysis system as experimental research data and to improve the efficiency of radiation safety management work by conducting more systematic monitoring of radiation activity in the surrounding environment.

2. Methods and Results

For the Environmental Sample analysis system of KOMAC, LSC and portable LSC and Low background alpha and beta counter are currently installed to analyze rainwater, drinking water or the other one in the KOMAC site.

An alpha-spectrometer is also recently installed in order to analyze alpha-nuclides of substances in natural materials such as soils and plants, that is, the sample analysis range will be expended from the water sample to the variety materials. Now the sample pretreatment equipment such as a combustion device and an evaporation device has currently being prepared. Figure 2 shows the analysis equipment installed currently for the environmental sample analysis system in KOMAC.

Figure 2.Analysis equipment installed currently for the environmental sample analysis system

In addition, HPGe detectors for gamma nuclide analysis of samples are also considered for this environmental sample analysis system. The HPGe detector considered currently should satisfy several conditions. First, the energy range measured of the natural radionuclide such as U-238 and Th-232 decay branch should be covered in this equipment. Second, the peak of interest in the medium and low energy range of the fixed measurement time has also the good resolution [1]. Currently, water samples in the KOMAC site are measured once every quarter to determine whether or not the cooling water is activated by the accelerator installed in KOMAC and also the test measured were conducted for general

purpose in the public area of the KOMAC for second quarter. The liquid sample used for the analysis was quantitatively mixed with 2 ml of the sample and 10 ml of the cocktail solution using a micropipette. After samples were stabilized for 18 hour, these are measured in the LSC. When the target nuclide of samples is tritium, the measurement time will be set to 30 minutes and average values are calculated after repeating the measurement five times. MDA was calculated through (1) and definition of each parameter is T_b: background measurement time, T_s: sample measurement time and R_b: background count rate in cpm.

$$\mathrm{MDA} = \frac{2.71 + 3.29\sqrt{R_b \times T_s \times (1 + \frac{T_s}{T_b})}}{eff \times V \times T_s} \quad ----(1)$$

The efficiency of the LSC was determined from the external standard source (^{133}Ba) method. As a result of above equation, the MDA value of the equipment was 39Bq/L. According to a notification from the NSSC (Nuclear Safety and Security Commission), the MDA of tritium for environmental radioactivity analysis is 5Bq/L. Because of the MDA depends on the amount of sample and the measurement time, so plan to increase the amount of sample and the measurement time to comply with the NSSC's requirement. Table 1 summarizes the measurement values and minimum detectable activity (MDA) of the LSC obtained by converting the measurement results into the Becquerel per cubic meter (Bq/m^3) and figure 3 shows a comparison between the measurement results of the samples and effluents control limit.

Table 1.Measurement results of two samples such as drinking water and rain water in the unit Bq and Bq/m^3 for second quarter

Sample	[1)] Value [Bq/m^3]	MDA [Bq/m^3]	Effluents control limit [Bq/m^3]
Drinking water	< MDA	3.92E+04	4E+07
Rain water	< MDA	3.97E+04	

*[1)] Value does reflect background subtraction

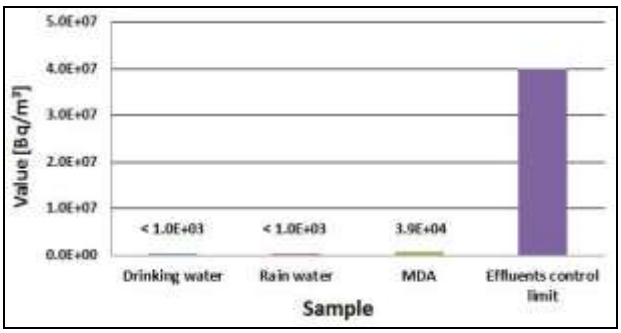

Figure 3.Comparison of measurement result of samples and emission control value

From the measurement results, the rainwater and drinking water were similar to each other and it can be confirmed that the measured value is significantly lower than the effluents control limit of water in tritium-bound state.

3. Conclusion

KOMAC's environmental samples analysis system measures the radioactivity of several water samples in the KOMAC site after the test operation period has passed. As a result of measurement with the rainwater and drinking water samples collected from the general area of the KOMAC site, it was confirmed that the measured value is much lower than the effluents control limit. The future operation plan of the environmental sample analysis system is to measure and analyze the environmental radioactivity of the soil or the plant by expending the range of the measurement target sample and analysis. Therefore, sample pretreatment equipment is prepared for this process and for gamma nuclide analysis, searching for the HPGe detector type to satisfy the experimental conditions. Also the radiation safety team of KOMAC plans has been preparing to establish an analytical procedure according to sample types, such as confirmation of CRM standardization procedure and reflection of uncertainty for measured values.[2][3] KOMAC's environmental sample analysis system operation goal is to build a more systematic sample analysis process and utilize the results of environmental sample analysis as experimental research data and to improve the efficiency of radiation safety management work by monitoring the radiation around the center environment.

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