Introduction of the Environmental Sampling Network for the Safeguards in KINAC

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1. Introduction

The Environmental sampling (ES) program is known as the one of the most powerful verification technique for the detection of undeclared nuclear activities. It has grown to be a main investigative tool in the last 15 years since it was approved as a safeguards verification measures [1]. The application of ES usually involves two stages [2] ; (i) baseline sampling and (ii) routine sampling

(i) Baseline sampling is performed to establish a reference 'environmental signature'

(ii) Routine sampling is subsequently performed to obtain data that can be compared for consistency with the established baseline environmental signature and the declared operations.

The KINAC has established the ES program to build 'the baseline of environmental signature' for domestic nuclear facility with the KBSI (Korea) and ITU (Germany).

This paper will describe the current status of ES system of swipe sample at KINAC for the purpose of the safeguards.

2. Methods and Results

2.1 Sample preparation

The particles in cotton swipe sample taken from domestic nuclear facility were attached onto carbon planchet using the pump and vacuum impactor in the clean room (ISO class 5 cleanliness level). All of work is done in a glove bag to minimize the risk of cross-contamination. After deposition step, the planchet was heated to 250 ℃ using a hot plate.

2.2 Screening (SEM-EDS method)

The morphology and elemental composition of particles could be identified by Scanning Electron Microscope (SEM, JEOL JSM-6610LV) and Energy Dispersed Spectrometry (EDS) respectively. Therefore, the deposited planchet was screened to select uranium particles by SEM-EDX. Fig. 1 shows the uranium particles in the planchet by SEM.

Fig. 1. Environmental sampling procedures in ROK.

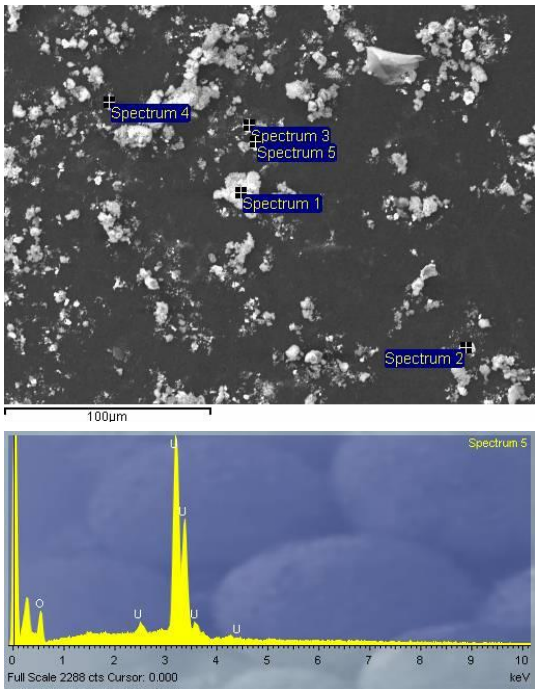
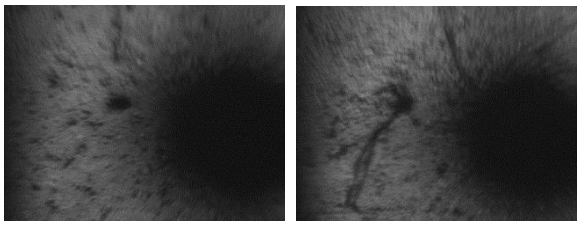


Fig. 2. SEM image of uranium particles.

2.3 Particle analysis (SIMS method)

The SIMS analyze the isotope composition ratio by separating the accelerated particles according to the mass difference. First, UO standard sample measurements were preceded for equipment calibration. And then, the analysis are performed in the order of selected sample (#1) and (#2). Each sample is collected from the pellet manufacturing process point and the conversion process point. And the Beam current was set as weak energy (3μA) in order to prevent the sample from damaging caused by the strong energy beam. The SIMS optical images of samples were shown in Fig. 3.



(a) Sample (#1) (b) Sample (#2)

Fig. 3. Optical image of samples using SIMS.

2.4 Inter-comparison

The accuracy is the mainly required for the particle analysis. As this reason, (#1), (#2) samples were sent to the ITU for cross-analysis. Lastly, the results of KINAC-KBSI joint research and the ITU commissioning analysis are compared in Table 1.

Sample #1 could be interpreted as a scattered material in the process of producing pellets which as nuclear fuel into a heavy water reactor. The samples #2 obtained 4.5wt% enrichment that is the level of concentration of common nuclear fuel materials used in light water reactors.

Table 1. Uranium Enrichment Results

Sample ID	KINAC-KBSI	EC-JRC-ITU
#1	0.7 ~ 0.8wt%	0.7wt%
#2	3.0 ~ 4.5wt%	2.0 ~ 4.5wt%

3. Conclusion

KINAC have been developing the ES program for safeguards since 2010. KINAC keeps discussing on the research initiatives and equipment operating plan with the KBSI, for further improvement. From the above environmental sample analysis network, KINAC will develop analytical capabilities.

REFERENCES

[1] D. M. Fischer 'The Evolution of Environmental Sampling for Safeguards', IAEA-CN-184/138, SGIM-IDS, Vienna, Austria.

[2] IAEA SAFEGUARD GLOSSARY, INTERNATIONAL VERIFICATION SERIES No. 3, 2001 IAEA (VIENNA), 2002.