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IN SITU AND LABORATORY GAMMA SPECTROMETRY MEASUREMENTS IN THE MOSS

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ABSTRACT

The Regional Workshop on Environmental Monitoring was organized in Vilnius, Lithuania, from 7th to 11th of November 2016. During the workshop an exercise on sampling, sample preparation and measurement of ¹³⁷Cs by gamma spectrometry in moss sample was performed. Three teams were formed for the exercise, they used different sampling strategies. In parallel to the sampling in situ measurement were performed on the sampling site. The results of ¹³⁷Cs activity concentration in moss sample measured in laboratory were in good agreement with measured in situ.

1. INTRODUCTION

The International Atomic Energy Agency (IAEA), through its Technical Co-operation Programme, has supported the establishment of many nuclear analytical and complementary laboratories in Member States. This included the development of capabilities for the use of various nuclear analytical techniques, such as alpha, beta and gamma spectrometry; radiochemical analysis; neutron activation analysis; energy dispersive X-ray fluorescence analysis; and total reflection X-ray fluorescence [1].

Since the IAEA seems to be the only international organization that provides technical analytical support to its Member States' end-user laboratories in nuclear and nuclear-related techniques, it is within its mandate that the IAEA initiates these QA/QC projects.

Several Member States in the Europe Region recognize as a priority the need for a systematic approach towards improvement and harmonization of methodologies for the determination and monitoring of selected environmental radionuclides of regional concern. The project RER7008 ***Strengthening Capabilities for Radionuclide Measurement in the Environment and Enhancing QA/QC System for Environmental Radioactivity Monitoring*** addressed some of these needs and several workshops were organized to improve quality control procedures, instrument calibration, determination of corrections, traceability of results, method validation and appropriate assessment of measurement uncertainty [2].

The main outcome of the project is to further develop the capabilities in source and environmental monitoring and to improve quality assurance for the measurements and

monitoring of radioactivity in the environment. In order to assure future metrological comparability of measurement results and to harmonize approaches and procedures at the regional level, in accordance with ISO 17025, workshop in Vilnius, Lithuania was organized from 7th to 11th November 2016 in Radiation Protection Centre (RPC). 22 experienced radioanalytical experts from 16 countries were focused on environmental radioactivity monitoring.

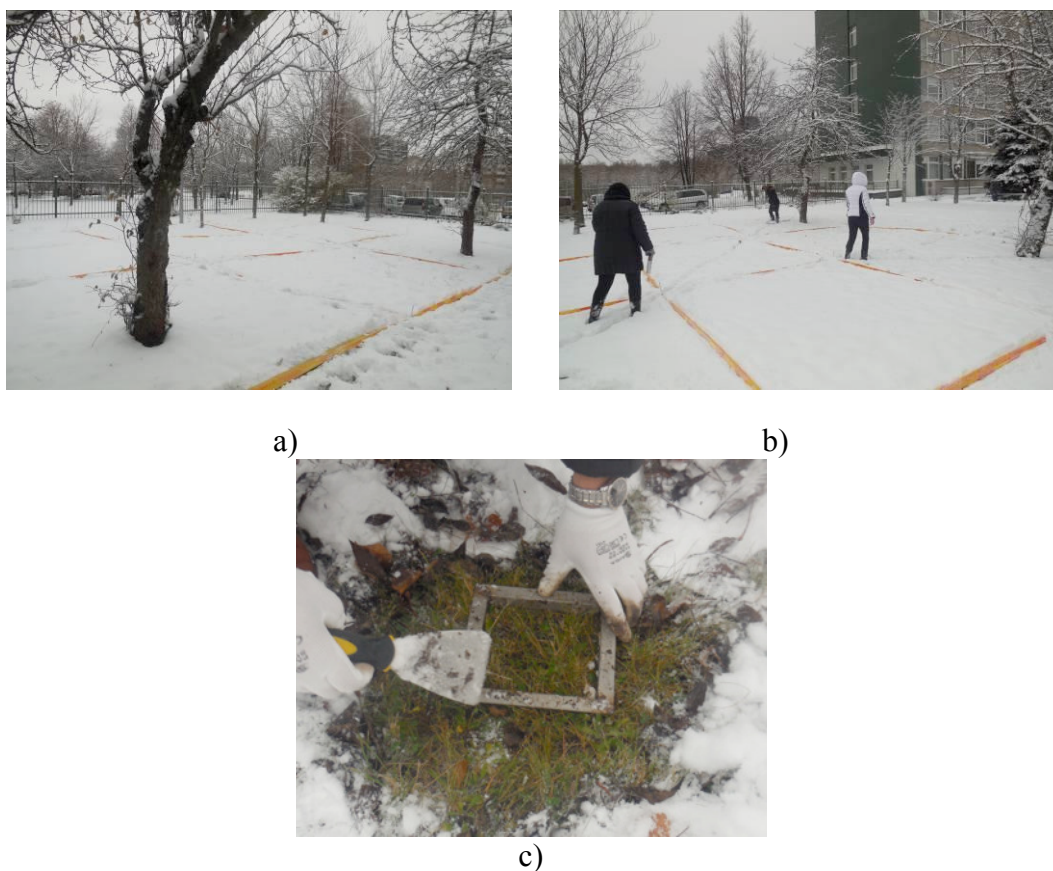
2. METHODS

During the Regional Workshop on Environmental Monitoring one exercise has been performed. It included sampling, sample preparation and measurement of ^{137}Cs by gamma spectrometry in moss sample.

The sampling was performed in the yard in the front of RPC. The sampling location was divided in 12 rectangles (Picture 1. a).

For the exercise three teams were formed. Each team has to collect samples by using different sampling strategy. The authors of this paper were members of team No 1.

The first team collected the samples from the center of all 12 rectangles. It was very easy to draw the diagonals on snow (Picture 1. b), which covered sampling site and to collect sample in their crossing points (Picture 1. c). The samples were collected with special tool, which ensured that all samples were taken from the same area (0.01 m^2). After collecting 12 samples were put in the same plastic bag for preparation of bulk sample.



Picture 1. a) Sampling location divided in 12 rectangles, b) center of rectangle determination, c) Moss sampling

In the laboratory moss sample was cleaned manually (without washing), adhering particles of soil and other impurities were removed. After sample was dried at a temperature of 105°C, then the sample was cut, milled and homogenized. Sample was put into 500 ml type Marinelli beaker. The size of sample was 0.105 kg d.w.

The ^{137}Cs activity concentration was measured on low background high resolution gamma spectrometry system with high purity broad energy germanium HPGe detector, Producer CANBERRA PACKARD Central Europe. Gamma spectrometer included the following main components:

- high purity broad energy germanium HPGe detector (detector model BE3825/S):
 - o active diameter 70 mm, active area 3800 mm²
 - o thickness 25 mm,
 - o distance from window 4.5 mm,
 - o window thickness 0.5 mm,
 - o window material Carbon Epoxy,
 - o relative efficiency 27.3%,
 - o recommended bias voltage +3500 V,
 - o FWHM 1.794 keV at 1332 keV,
- lead shielding model IGS3: Pb=100 mm, Cd=1 mm, Cu=1 mm),
- cryostat model 7500SL,
- digital spectrum analyzer DSA-1000.

In paralel with the sampling in situ measurement was performed on the sampling site (Picture 2). Mobile spectrometer with GENIE 2000 software (CANBERRA) was used.



Picture 2. In situ gamma spectrometry measurement

3. RESULTS

The ^{137}Cs activity concentration in moss was calculated using spectroscopy software Canberra Genie™ 2000 V3.3, 2013. Mathematical calibration by Monte Carlo calculation has been performed with software ISOCS/LabSOCS.

For in situ measurements efficiency calibration was done by Monte Carlo calculation, using ISOCS software. Detector was fully characterised and characterisation verified by producer.

The results of measurement are presented in Table 1.

Table 1. ^{137}Cs activity concentration in moss sample

Measurement method	^{137}Cs activity concentration (Bq/kg)	^{137}Cs activity surface contamination (Bq/m ²)
Laboratory, team No 1	1.6 ± 0.7	370
In situ	1.7 ± 0.3	344

It can be observed from Table 1, that both results are in very good agreement, considering that the sample was collected in 12 points (snow removed) and that in situ measurement was in the center of the field which was covered by snow.

Team No 2 and team No 3 used different sampling technologies for collection of samples. Team No 3 collected samples randomly in the rectangles (not in the center) and team No 2 collected samples randomly from all field. The samples were prepared and measured in the same way as the sample from the first team. The ^{137}Cs activity concentrations in moss samples for team No 2 and team No 3 are presented in Table 2.

Table 2. ^{137}Cs activity concentrations in moss samples (team No 2 and team No 3)

Measurement method	^{137}Cs activity concentration (Bq/kg)
Laboratory, team No 2	0.7 ± 0.5
Laboratory, team No 3	0.9 ± 0.3

The ^{137}Cs activity concentrations in moss samples obtained by team No 2 and 3 were in very good agreement and could be comparable within measurement uncertainties with result of the first team.

4. DISCUSSION AND CONCLUSION

The ^{137}Cs activity concentrations in moss measured in laboratory by the first team and measured in situ were in good agreement. The laboratory measurements in moss samples taken by different strategies showed the agreement within measurement uncertainties for ^{137}Cs activity concentrations in all moss samples.

The project has contributed to comparability of monitoring results across countries by introducing up to date techniques for sampling, sample preparation and rapid measurement of vegetation.

5. ACKNOWLEDGMENT

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IN SITU I LABORATORIJSKO GAMASPEKTROMETRIJSKO MERENJE U MAHOVINI

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SADRŽAJ

Od 7. do 11. novembra 2016. godine u Viljnusu, Litvanija, je organizovana regionalna radionica posvećena monitoringu životne sredine u toku koje je organizovana vežba koja je uključivala uzorkovanje, pripremu uzorka i gamaspektrometrijsko merenje uzorka mahovine. Formirana su tri tima od učesnika radionice koji su prikupljali uzorke na različite načine. Istovremeno sa uzorkovanje vršeno je in situ merenje na istoj lokaciji. Rezultati merenja aktivnosti ¹³⁷Cs u mahoviniu laboratoriji i merenja in situ pokazali su dobro slaganje.