Environmental Gamma Spectrometry for Polish Nuclear Power Plant
Preliminary Considerations

K. Szewczak [1*], K. Ciupek [1], S. Jednorog [2]

[1] **Central Laboratory for Radiological Protection,** Konwaliowa 7, 03-194 Warsaw, Poland
[2] **Institute of Plasma Physics and Laser Microfusion, Association EURATOM,** Hery 23, 01-497 Warsaw, Poland
* Coresponding author: szewczak@clor.waw.pl

Introduction

Two gamma spectrometric systems with two different detectors are taken into consideration as the future source of information regarding any radioactive releases from soon constructed Polish nuclear power plant. First of them is a spectrometric system with HPGe detector while the second is equipped with LaBr probe.
The aim of this work is to compare the above mentioned gamma spectrometric system for their further implementation for environmental gamma spectrometry.

Comparison of gamma spectrometry systems

Lowest Limit of Detection (LLD) can be understood as the lowest signal reliably exceeds N time the background standard deviation. N is typically chosen 3-5. Assuming Poisson distribution, the standard deviation is equal to square root of the collected counts. Where: AFEPE(E_i) – Absolute Full Energy Peak Efficiency at energy E_i, t – counting time [min]

$$LLD(DPM) = \frac{N}{AFEPE(E_i)} \cdot \frac{\sqrt{Bg(CPM)}}{t}$$

Relative Minimum Detectable Activity (MDA$_r$) is proportional to the square root of the background area divided by the efficiency at the specified energy. Where: FWMH(Ei) – Resolution at energy Ei, AFEPE(Ei) – Absolute Full Energy Peak Efficiency at energy Ei, Bg(Ei) – total bacground at energy Ei.

$$MDA_r = \frac{\sqrt{FWMH(E_i)Bg(E_i)}}{AFEPE(E_i)}$$

Measurements

The stainless disc (d=51, h=3 mm) was activated by Am-Be source with strange $1.5 \cdot 10^7$ n/s. After cooling the sample was measured on both spectrometric systems and ^{58}Co, ^{60}Co, ^{51}Cr, ^{59}Fe, ^{54}Mn were detected. The quantitative analyzes obtained with precalibrated HPGe detector system was the background for cross calibration of the LaBr probe.

Results

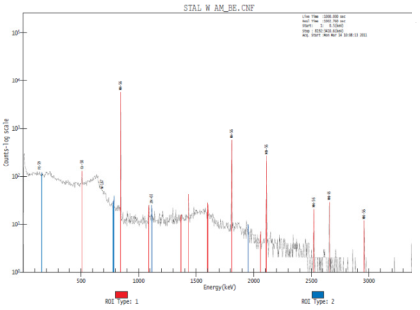

Fig. 1 Gamma-rays spectrum obtained during mockup experiment with HPGe

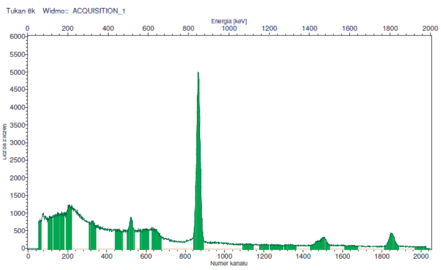

Fig. 2 Gamma-rays spectrum obtained during mockup experiment with LaBr

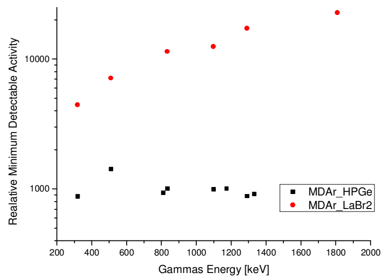

Fig. 3 Relative Minimum of Detectable Activity for LaBr probe and HPGe detector

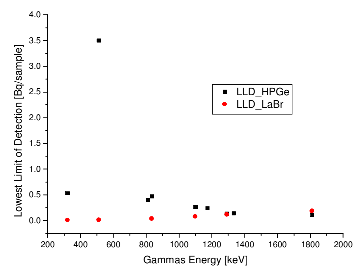

Fig. 4 Lowest Limit of Detection for both spectrometric systems. The lowest LLD the better system is.

Conclusions

- Photons with energy ranging from 320 keV to 1332 keV and several other belonging to the above diapason were registered.
- the most frequently photons emitted from ^{133}I have energy 364 keV while energy 662 keV relates to photons released from ^{137}Cs therefore mockup experiment can represents contamination of the ground layer.
- MDAr of LaBr probe is higher than respective values for HPGe detector due to the higher efficiency of the scintillation probe.
- LLD is smaller for LaBr scintillate probe. This means that the scintillate probe can distinguish lower concentrations of radionuclides, however, some difficulty in identifying them might appear due to the lower resolution of the probe in comparison to the HPGe detector resolution.
- The LaBr scintillation probe is suitable for environmental gamma spectrometry.
- Assessment of different spectrometric systems can be performed during mockup experiment with activated stainless sample.