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Assessment of the gamma-ray spectroscopy laboratory at ETRR-2 based on the results of participation in IAEA-ALMERA proficiency tests

Egypt Second Research Reactor (ETRR-2) has a laboratory for gamma-ray spectroscopy and neutron activation analysis. Beside elemental analysis using neutron activation analysis technique, the laboratory has a broad utilization for radioactivity measurements. Such measurements include low level radioactive waste analysis, radioactivity measurement of irradiated topaz stones, and analysis of naturally occurring radioactive materials (NORM). The laboratory takes part of the AFRA project RAF9056: "Strengthening Education and Training in Radiation Safety and Sustaining Human Resources Development and Nuclear Knowledge Management". Some of the theses accomplished at the laboratory under the umbrella of this project were on NORM managements.

Regularly, the laboratory participates in inter-comparison programs to demonstrate its performance. This paper focused on two proficiency tests organized by the "Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) network". The first proficiency test carried out in 2017 was the IAEA-TEL-2017-04 ALMERA proficiency test on determination of anthropogenic and natural radionuclides in water, milk powder, calcium carbonate, and simulated filter samples. The second one performed in 2019 was the IAEA-TEL-2019-04 ALMERA proficiency test on determination of anthropogenic and natural radionuclides in water, shrimps, and simulated aerosol samples. Our laboratory has been participated in these two proficiency tests using the gamma-ray spectroscopy techniques. The analytes of these samples include Ba-133, Cs-137, Ce-141, Mo-99, Np-239, Ru-103, K-40, Zr-95, Co-60, Eu-152, Cs-134, Ra-238 and Ra-226. Assessment of the laboratory based on these participations regarding the accuracy and precision is discussed in this paper.

As conclusions, the gamma-ray spectroscopy laboratory at ETRR-2 has achieved good accuracy of the analysis in these proficiency tests. Correcting the detector efficiency curve (calibrated with point sources) using Monte Carlo method for volume samples is validated by these results. Measurement of Ra-228 activity can be carried out using the daughter Ac-238 with high accuracy. The accuracy of the Ra-226 activity using Pb-214 and Bi-214 resulted in high underestimation values except this measured from the 1674 keV energy line of Bi-214 which gives good accuracy. This may be due to the complicated decay schemes of these radioisotopes which need accurate corrections of true-coincidence. Evaluation of the measurements precision showed that the evaluated uncertainties are underestimation or overestimation for some nuclides that need more precautions in the uncertainty estimations.

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