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Method Validation of In-Situ Gamma Spectroscopy for quantification of Naturally Occurring Radioactive Materials (NORM) K-40, Th-232 and U-238 in Soil

In this research Canberra HPGe in-situ gamma spectroscopy systems calibration is validated with respect to the accuracy of radiation measurement and quantification of radionuclides in the soil. The most important aspect of in-situ gamma spectroscopy investigated in this research is its efficiency calibration that is essential in the process of radionuclide quantification specifically NORM such as K-40, Th-232, U-238 in radiologically hazardous areas in Sri Lanka. The two methods used primarily for in-situ system efficiency calibration, source-based calibration and Monte-Carlo simulation-based source less calibration using Canberra ISOCS was practiced and investigated. It was found that the two methods bring nearly close calibration curves for efficiency-energy relationship. Then the calibration of the system with respect to radionuclide quantification was compared by three methods 1) validation with comparison of dosimetry results of dosimeter and in-situ system Saphymo AD6181, 2) Inter comparison with other portable gamma spectroscopy systems RS-125 by TerraPlus and 3) Comparing with laboratory-based gamma spectroscopy for activity concentration. Real measurements of radionuclides for soil at 14 different places in Sri Lanka where environmental radiation from natural radionuclides was found to be considerably higher than average background where used. The measurements were taken simultaneously from the three methods were performed and the results obtained were compared to find the accuracy of the in-situ system. The main radionuclides in soil quantified in this research were K-40, U-238 and Th-232. The comparison of dosimetry results of the in-situ and the conventional dosimeter Saphymo AD6181, shows a mean percentage deviation of 16.6% and good correlation of 0.98, a good result as per ICRU recommendations for in-situ measurement. The activity concentration deviation between in-situ and laboratory gamma spectroscopy were 72.4%, 106.7% and 46.6% for K-40, U-238 and Th-232 respectively, meaning large deviations of the two systems. Inter-comparison of radionuclide activity concentration between portable system RS-125 and in-situ brought conclusion that the two were highly correlated and the two values can be mapped for converting from RS-125 to in-situ values by coefficients 0.73 for K-40, 0.17 for U-238 and 0.86 for Th-232

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