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DETERMINATION OF CALIBRATION FACTORS FOR 223RA FOR 3 DIFFERENT SURFACE CONTAMINATION MONITORING INSTRUMENTS

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BACKGROUND-AIM

^{223}Ra (half-life 11.4 days) decays by the emission of 4 α particles and 2 β- particles via daughter isotopes to stable ^{207}Pb. While the α energy released from the decay of ^{223}Ra to ^{219}Rn is 5.64 MeV, the mean energy associated with the entire decay cascade is 28 MeV (95.3% due to α particles, 3.6% β-, 1.1% gamma and X radiation). The aim of this work is the calibration of 3 different surface contamination monitoring instruments in terms of Bq/cm^2/cps for ^{223}Ra in order to reduce the uncertainty in the evaluation of effective individual dose from skin contamination.

METHODS

Three reference sources were prepared in our laboratory by contaminating Rad-Wipe® Smears with a mean activity of (2.18±0.12) kBq. The activity was evaluated with a spectrometry system equipped with a HPGe detector and multi-channel analyzer based on digital electronics (Areva Canberra, distributed in Italy by TNE, Milan). The spectrometry system was calibrated in the 59-1836 keV range by means of a multi-radionuclide certified reference solution. The activity was uniformly distributed on the 15.2cm^2 surface of the smears. In order to remove the geometry dependence of the measurement due to the self-absorption of the α emission in the contaminated sample, the calibration was based only on ß and α radiation placing the samples in a plastic bag. We investigated the following contamination monitoring instruments: a Berthold LB 124 Scint zinc-sulphide scintillator (windows size 118mmx145mm); an Eberline PRM-6GM "pancake" window GM detector equipped with a HP-210 probe (20cm^2 window); a Tema Sinergie CPS-51 GM detector equipped with a TPG46 probe (15.9cm^2 window). Measurements were performed with each detection probe close to the source placed on a low-Z material surface in order to minimize backscatter effects. For ZnS scintillator pulse count rate was assessed in five different positions of the detector window, while a single position was sufficient for the GM probes as the dimension of the source was comparable with the sensitive area. Measurements (dead time correction negligible) and relative background were repeated five times for each source and the mean value was taken. The final calibration factor was assessed as the average of the factors evaluated for the three different sources. The instruments response was calculated as the ratio between the net counts, the activity of the source at time of measurement and the probe sensitive window. Minimum detectable activity (MDA) for each detector was also evaluated.

RESULTS

Evaluated calibration factors for the probes were (0.013±0.001) Bq/cps/cm^2, (0.09±0.02) Bq/cps/cm^2 and (4.7±0.4) Bq/cps/cm^2 for LB 124 scintillator, GM PRM-6 and CPS-51 respectively. MDA values were 0.3 Bq/cm^2, 0.6 Bq/cm^2 and 30 Bq/cm^2.

CONCLUSION

The described method for sources preparation and calibration factor evaluation allows to characterize different types of surface contamination monitors in a reproducible and simple way. As expected, the ZnS detector shows higher efficiency and lower MDA. Nevertheless, GM detectors may be used for preliminary surface contamination measurements.