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CALIBRATION FOR GAS CONTAINERS IN GAMMA-RAY SPECTROMETRY

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ABSTRACT
To meet the need for rapid monitoring of gas activity in Kr-85, Xe-127, Xe-133 and Rn-222, two gamma-ray spectrometers of LNHB have been specifically calibrated with two types of reference containers with respective volumes 500 cm^3 and 100 cm^3. Two standardization methods were used depending on the radionuclide of interest. For Kr-85, Xe-133 and Xe-127, the reference values were measured by the method of three length-compensated proportional counters, with a relative standard combined uncertainties of about 1.1 % and the reference activity of Rn-222 was obtained from the solid angle measurement of a cryogenic source, with 0.35 % relative standard combined uncertainty. The spectrometers consist of high-purity germanium detectors coupled to conventional electronic modules. The calibration was performed for two container–to-detector distances. Different precautions were taken to process the spectra correctly. For example, the 514-keV peak area of 85Kr may be affected by a significant uncertainty due to the possible interference with the annihilation peak at 511 keV. There is no difficulty in measuring high activities, but for low activities (a few tens of Bq), the case of the 511-514 doublet is more delicate and inappropriate treatment can lead to significant deviations. Spectrometry measurements on 133Xe were performed in two steps. A first step allowed the quantification of the impurities (Xw-131m and Xe-133m), and relevant calibration factors for these xenon impurities were established by computing efficiency transfer factors. These impurities consequently induce corrective factors for the reference activity. In a second step, the calibration factors for Xe133 were established with 10 containers filled with the reference gas. The spectrum of 127Xe shows three main peaks at 172.1 keV, 202.9 keV and 375.0 keV. Three calibration coefficients could be established for each of these main lines. The calibration factors are obtained with a relative standard combined uncertainties of about 1.4 %, 1.1% and 1.1 %, respectively for Kr-85 (514 keV), Xe-133 (79.6 keV-81.0-keV) and the three lines of Xe-127. In the Rn-222 spectra, we observe peaks due to Rn-222 and its progenies (mainly Bi-214 and Pb-214). The only photon emission corresponding to Rn-222 has an energy of 510 keV, interfering with the annihilation peak, with a low emission intensity (0.076%). It, therefore, has two disadvantages. However, it is the only reliable information related to the volume distribution of the gaseous radionuclide, as the progeny in solid form tends to deposit on the walls of the container. The calibration coefficient has been measured, but with a relative standard combined uncertainties of about 5 %. This calibration work for gas containers is directly established with the radionuclides of interest, allowing the activity of containers of the same type to be determined routinely, simply by applying the calibration factors thus established.

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