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Computation of full energy peak efficiency for voluminous radioactive atmospheric sources using remote scintillation gamma-ray spectrometry

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A method for computation of full energy peak registration efficiency for voluminous atmospheric gamma radiation sources (emission of nuclear power plant) using collimated scintillation detector has been developed. The method is based on preliminary experiments on calibration of detector response as a function of distance and angle relatively detector axis with further mathematical extension of the obtained calibration for significantly larger distances.

In the experimental part a quite intensive source of ^{226}Ra has been used. This radionuclide is suitable for calibration purposes because it escapes gamma-rays lying in a wide energy range. The measurements were carried out at the distance of 3-5 meters from detector and $0-90^\circ$ angular range from detector axis. The obtained discrete results has been mathematically processed that results in obtaining of a set of smooth dependences describing the efficiency values as function of distance and angle. The obtained set of dependences has been extended beyond the experimental region and used for efficiency computation for arbitrary points lying in the aperture scope of the collimator used.

The formulated task is needed for resolving more general problem concerning continuous control of radioactivity which releases in atmosphere by nuclear power plants (NPP). At small distances from NPP radioactive emission is a gas stream which may be mathematically described by normal distribution whose parameters depends on the atmosphere state.

Computation of full energy peak efficiency for voluminous figure of gas stream escaping from ventilation pipe of NPP lying in the detector's aperture is carried out by means of Monte-Carlo modelling. The developed model takes into account the radiation absorption in the air depending on the weather conditions (temperature, atmospheric pressure, humidity). The model of the emitted radioactive stream implies different options of radioactivity distributions inside the stream: uniform, triangular and normal one.

The height of the radioactive stream axis over the ground is one of the key parameters controlling the results accuracy. To determine the stream height the following steps are used. At the first step the height in question equated to height of the ventilation pipe. At the second step the minimization of residuals of isotope identification procedure is used as a criterion for computing the actual height value of the stream.

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