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Measurement of radioactivity in the environment — Soil —

Part 7: In situ measurement of gamma-emitting radionuclides

Mesurage de la radioactivité dans l'environnement — Sol —

Partie 7: Mesurage in situ des radionucléides émetteurs gamma

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Foreword

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This second edition cancels and replaces the first edition (ISO 18589-7:2013), of which it constitutes a minor revision.

The main changes are as follows:

— B.10: correction of the information related to the activity concentration of ^{40}K;

— E.2 and E.6: correction of Formulae (E.5) and (E.11);

— F.4 : correction of β, according to the numerical values of the example;

— F.6: modify β = 50 g·cm^{-2} into β = 50 kg·m^{-2};

— G.3, Footnote 1 of Table G.3: modify 1 g·cm^{-2} = 10 kg·cm^{-2} into 1 g·cm^{-2} = 10 kg·m^{-2}.

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Introduction

In situ gamma spectrometry is a rapid and accurate technique to assess the activity concentration of gamma-emitting radionuclides present in the top soil layer or deposited onto the soil surface. This method is also used to assess the dose rates of individual radionuclides.

In situ gamma spectrometry is a direct physical measurement of radioactivity that does not need any soil samples, thus reducing the time and cost of laboratory analysis of large number of soil samples.

The quantitative analysis of the recorded line spectra requires a suitable area for the measurement. Furthermore, it is required to know the physicochemical properties of the soil and the vertical distribution in the soil to assess the activity of the radionuclides.

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Measurement of radioactivity in the environment — Soil —

Part 7: In situ measurement of gamma-emitting radionuclides

1 Scope

This document specifies the identification of radionuclides and the measurement of their activity in soil using in situ gamma spectrometry with portable systems equipped with germanium or scintillation detectors.

This document is suitable to rapidly assess the activity of artificial and natural radionuclides deposited on or present in soil layers of large areas of a site under investigation.

This document can be used in connection with radionuclide measurements of soil samples in the laboratory (see ISO 18589-3) in the following cases:

— routine surveillance of the impact of radioactivity released from nuclear installations or of the evolution of radioactivity in the region;

— investigations of accident and incident situations;

— planning and surveillance of remedial action;

— decommissioning of installations or the clearance of materials.

It can also be used for the identification of airborne artificial radionuclides, when assessing the exposure levels inside buildings or during waste disposal operations.

Following a nuclear accident, in situ gamma spectrometry is a powerful method for rapid evaluation of the gamma activity deposited onto the soil surface as well as the surficial contamination of flat objects.

NOTE The method described in this document is not suitable when the spatial distribution of the radionuclides in the environment is not precisely known (influence quantities, unknown distribution in soil) or in situations with very high photon flux. However, the use of small volume detectors with suitable electronics allows measurements to be performed under high photon flux.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11929 (all parts), *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation — Fundamentals and application*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

IEC 61275, *Radiation protection instrumentation — Measurement of discrete radionuclides in the environment — In situ photon spectrometry system using a germanium detector*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
intrinsic efficiency
η_0
cross section of a detector for photons from the direction of the crystal symmetry axis

Note 1 to entry: The intrinsic efficiency depends on the energy of the photon.

3.2
detector efficiency
$\eta_0(E)$
efficiency in the direction of the crystal symmetry axis as a function of the photon energy, E

3.3
detector height
d
distance between the geometrical centre of the crystal and the soil surface

3.4
efficiency per unit of surface area or unit of mass
ε
ratio between the net count rate of an absorption line with energy E and the photon emission rate per unit area or mass

3.5
relative detection efficiency
ratio expressed in percentage, of the count rate in the ^{60}Co 1 333 keV total absorption peak to the one obtained with a 7,62 cm × 7,62 cm (3 in × 3 in) NaI(Tl) scintillator for normal incidence and at 0,25 m from the source

3.6
geometry factor
G
ratio between the flux density without scattered photons measured at the detector location and the photon emission rate per unit area or mass

3.7
aperture angle
ϑ_{col}
characteristic angle for an in situ gamma spectrometer with collimator

3.8
relaxation mass per unit area
β
mathematical parameter describing radionuclide distribution as a function of soil depth

Note 1 to entry: It indicates the soil mass per unit of surface area at which gamma activity decreases to $1/e$ (37 %).

Note 2 to entry: See also Reference [7].

3.9
field-of-view
soil surface area, from which 90 % of the unscattered photons are detected by the detection device

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3.10
distribution model
V
entity of all physical and geometrical parameters to describe the distribution of the radionuclide in the environment as well as the interaction of an emitted photon with soil and air

3.11
angular coefficient
k_m
factor taking into account the angular response of the detector and the angular distribution of the incident flux

3.12
measurement area
area in the soil and/or on the soil surface having radionuclide activity per unit of surface area or unit of mass

3.13
mass per unit area (collimator)
ζ_{col}
product of material density and wall thickness of a collimator

Note 1 to entry: The mass per unit area is reported for a polar angle, ϑ, of 90° in relation to the crystal centre.

Note 2 to entry: See also Reference [7].

3.14
cross section of the detector
ratio of the net rate of the total absorption line at energy E and the flux density of unscattered photons of the energy, E, in the detector

3.15
calibration factor
w
ratio of the activity of surface area or unit of mass of the radionuclide to the net count rate of the total absorption line

4 Symbols

a	Activity of a given radionuclide at the time of measurement a) per unit of surface area b) per unit of mass	 $Bq \cdot m^{-2}$ $Bq \cdot kg^{-1}$
$\hat{a}$	Best estimate of the measurand of the activity of the radionuclide in question a) per unit of surface area b) per unit of mass	 $Bq \cdot m^{-2}$ $Bq \cdot kg^{-1}$
a_K	Activity of the calibration standard at the time of measurement	Bq
a_0	Activity of the radionuclide in question at the soil surface	$Bq \cdot m^{-2}$
$a(\zeta)$	Projected surface activity as a function of mass per unit at the surface of the soil	$Bq \cdot m^{-2}$

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