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SWEDISH STANDARDS INSTITUTE

Mätning av radioaktivitet i omgivningen – Mark – Del 7: Mätning av gammautsändande radionuklider på plats (ISO 18589-7:2013, IDT)

Measurement of radioactivity in the environment – Soil – Part 7: In situ measurement of gamma-emitting radionuclides (ISO 18589-7:2013, IDT)

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Den internationella standarden ISO 18589-7:2013 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av ISO 18589-7:2013.

The International Standard ISO 18589-7:2013 has the status of a Swedish Standard. This document contains the official version of ISO 18589-7:2013.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för Kärnenergi, SIS/TK 405.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

ISO 18589 consists of the following parts, under the general title *Measurement of the radioactivity in the environment — Soil*:

— *Part 1: General guidelines and definitions*

— *Part 2: Guidance for the selection of the sampling strategy, sampling and pre-treatment of samples*

— *Part 3: Measurements of gamma-emitting radionuclides*

— *Part 4: Measurement of plutonium isotopes (plutonium 238 and plutonium 239 + 240) by alpha spectrometry*

— *Part 5: Measurement of strontium 90*

— *Part 6: Measurement of gross alpha and gross beta activities*

— *Part 7: In situ measurement of gamma-emitting radionuclides*

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.

Measurement of radioactivity in the environment — Soil —

Part 7: In situ measurement of gamma-emitting radionuclides

1 Scope

This part of 18589 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 part of ISO 18589 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 part of ISO 18589 can be used in connection with radionuclide measurements of soil samples in the laboratory (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 part of ISO 18589 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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*

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

3 Terms, definitions, symbols, and units

3.1 Terms and definitions

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

3.1.1
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.

3.1.2
detector efficiency
$\eta_0(E)$
detector efficiency in the direction of the crystal symmetry axis as a function of the photon energy E

3.1.3
detector height
d
distance between the geometrical centre of the crystal and the soil surface

3.1.4
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

3.1.5
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 3 x 3 inch NaI(Tl) scintillator for normal incidence and at 0,25 m from the source

3.1.6
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

3.1.7
aperture angle of collimator
ϑ_{col}
characteristic angle for an *in situ* gamma spectrometer with collimator

3.1.8
relaxation mass per unit area[7]
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 %).

3.1.9
field-of-view of a detector
soil surface area, from which 90 % of the unscattered detected photons originate

3.1.10
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

3.1.11
angular coefficient
k_m
factor taking into account the angular response of the detector and the angular distribution of the incident flux

3.1.12
measurement area
area in the soil and/or on the soil surface having radionuclide activity per unit of surface area or unit of mass

3.1.13
mass per unit area (collimator)[7]
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.

3.1.14
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

3.1.15
calibration factor per unit of surface area or unit of mass
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

3.2 Symbols and units

For the purposes of this part of ISO 18589, the symbols and units defined in ISO 11929 and given in Table 1 apply.

Table 1 — Symbols

Symbols	Designation	Unit
a	Activity of a given radionuclide at the time of measurement	
	a) per unit of surface area	$Bq \cdot m^{-2}$
	b) per unit of mass	$Bq \cdot kg^{-1}$
$\hat{a}$	Best estimate of the measurand of the activity of the radionuclide in question	
	a) per unit of surface area	$Bq \cdot m^{-2}$
	b) per unit of mass	$Bq \cdot kg^{-1}$
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	$Bq \cdot m^{-2}$
a^*	Decision threshold of the measurand of the radionuclide in question at the time of measurement	
	a) per unit of surface area	$Bq \cdot m^{-2}$
	b) per unit of mass	$Bq \cdot kg^{-1}$
$a^\#$	Detection limit of the measurand of the radionuclide in question at the time of measurement	
	a) per unit of surface area	$Bq \cdot m^{-2}$