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International Standard

ISO/FDIS 9697

Water quality — Gross beta activity — Test method using thick source

Qualité de l'eau — Activité bêta globale — Méthode d'essai par source épaisse

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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 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 3, *Radioactivity measurements,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 230, *Water analysis*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fifth edition cancels and replaces the fourth edition (ISO 9697:2018), which has been technically revised.

The main changes are as follows:

— the normative references have been updated;

— additional symbols for the coverage interval and uncertainty calculations have been added.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Radionuclides are present throughout the environment; thus, water bodies (e.g. surface waters, ground waters, sea waters) contain radionuclides, which can be of either natural or anthropogenic origin:

— Naturally-occurring radionuclides, including ^{3}H, ^{14}C, ^{40}K and those originating from the thorium and uranium decay series, in particular ^{210}Pb, ^{210}Po, ^{222}Rn, ^{226}Ra, ^{228}Ra, ^{227}Ac, ^{232}Th, ^{231}Pa, ^{234}U, and ^{238}U, can be found in water bodies due to either natural processes (e.g. desorption from the soil and runoff by rainwater) or from technological processes involving naturally occurring radioactive materials (e.g. mining, mineral processing, oil, gas and coal production, water treatment, production and use of phosphate fertilisers).

— Anthropogenic radionuclides such as ^{55}Fe, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{99}Tc, transuranic elements (e.g. Np, Pu, Am, Cm) and some gamma emitting radionuclides such as ^{60}Co and ^{137}Cs can also be found in natural waters. Small quantities of anthropogenic radionuclides can be discharged from nuclear facilities to the environment as a result of authorized routine releases. The radionuclides present in liquid effluents are usually controlled before being discharged to the environment[1] and water bodies. Anthropogenic radionuclides used for medical and industrial applications can be released to the environment after use. Anthropogenic radionuclides are also found in waters due to contamination from fallout resulting from above-ground nuclear detonations and accidents such as those that have occurred at the Chernobyl and Fukushima nuclear facilities.

Radionuclide activity concentrations in water bodies can vary according to local geological characteristics and climatic conditions and can be locally and temporally enhanced by releases from nuclear facilities during planned, existing and emergency exposure situations.[2][3] Some drinking water sources can thus contain radionuclides at activity concentrations that can present a human health risk. The World Health Organization (WHO) recommends to routinely monitor radioactivity in drinking waters[4] and to take proper actions when needed to minimize the health risk.

National regulations usually specify the activity concentration limits that are authorized in drinking waters, water bodies and liquid effluents to be discharged to the environment. These limits can vary for planned, existing and emergency exposure situations. As an example, during either a planned or existing situation, the WHO guidance level for gross beta activity in drinking water is 1,0 $Bq{\cdot}l^{-1}$ [4], see NOTES 1, 2 and 3. Conformity with these limits is assessed by measuring radioactivity in water samples and by comparing the results obtained, with their associated uncertainties, as specified by ISO/IEC Guide 98-3[12] and ISO 5667-20[5].

NOTE 1 If the value is not specified in Annex 6 of Reference, [4] the value has been calculated using the formula provided in Reference [4] and the dose coefficient data from References [6] and [7].

NOTE 2 Gross alpha and gross beta activity are often measured together; the WHO guidance level for gross alpha activity in drinking water is 0,5 $Bq{\cdot}l^{-1}$ [4].

NOTE 3 The guidance level calculated in Reference [4] is the activity concentration that results in a committed effective dose of 0,1 $mSv{\cdot}a^{-1}$ to members of the public for an intake of 2 $l{\cdot}d^{-1}$ of drinking water for one year. This is an effective dose that represents a very low level of risk to human health and which is not expected to give rise to any detectable adverse health effects[4].

This document contains a test method to support laboratories which need to determine the gross beta activity concentration in water samples. The method(s) described in this document can be used for various types of waters (see Clause 1). Minor modifications such as sample volume and counting time can be made if needed to ensure that the decision threshold, detection limit, and uncertainties are below the required limits. This can be done for several reasons such as emergency situations, lower national guidance limits and operational requirements.

NOTE 4 This method does not cover low energy beta emitters, such as ^{3}H, ^{14}C and ^{228}Ra or volatile beta emitters such as ^{131}I and radon, which are covered in standards such as ISO 9698[9], ISO 13162[10] and ISO 22908[11].

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Water quality — Gross beta activity — Test method using thick source

WARNING — Persons using this document shall be familiar with normal laboratory practice. This document does not purport to address all of the safety issues, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

IMPORTANT — Tests conducted according to this document shall be carried out by suitably trained staff.

1 Scope

This document specifies a test method for the determination of gross beta activity concentration in non-saline waters.

This document covers non-volatile radionuclides with maximum beta energies of approximately 0,3 MeV or higher.

This document does not apply to the measurement of low-energy beta emitters (e.g. ^{3}H, ^{228}Ra, ^{210}Pb, ^{14}C, ^{35}S and ^{241}Pu) and some gaseous or volatile radionuclides (e.g. radon and radioiodine).

This document is applicable to the analysis of raw and drinking waters with low amounts of total soluble salts in the water. The limit of detection depends on the performance characteristics (background count rate and counting efficiency) of the counter used.

As this method requires sample preparation in laboratory facilities, this method is not suited for rapid, in-the-field analysis.

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 5667-1, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes and sampling techniques*

ISO 5667-3, *Water quality — Sampling — Part 3: Preservation and handling of water samples*

ISO 5667-14, *Water quality — Sampling — Part 14: Guidance on quality assurance and quality control of environmental water sampling and handling*

ISO 11929-1, *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation — Fundamentals and application — Part 1: Elementary applications*

ISO 80000-10, *Quantities and units — Part 10: Atomic and nuclear physics*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 80000-10 and ISO 11929-1 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/

4 Symbols

A	beta activity in calibration source, at the time of calibration	Bq
c_A	beta activity concentration, without and with corrections	$Bq \cdot l^{-1}$
c_A^*	decision threshold, without and with corrections	$Bq \cdot l^{-1}$
$c_A^\#$	detection limit, without and with corrections	$Bq \cdot l^{-1}$
$\tilde{c}_A$	possible or assumed true quantity values of the measurand	$Bq \cdot l^{-1}$
$c_A^\triangleleft$	lower limit of the probabilistically symmetric coverage interval	$Bq \cdot l^{-1}$
$c_A^\triangleright$	upper limit of the probabilistically symmetric coverage interval	$Bq \cdot l^{-1}$
$c_A^<$	lower limit of the shortest coverage interval	$Bq \cdot l^{-1}$
$c_A^>$	upper limit of the shortest coverage interval	$Bq \cdot l^{-1}$
k_p	quantiles of the standardised normal distribution for the probabilities p (for instance $p = 1-\alpha$, $1-\beta$ or $1-\gamma/2$)	
k_q	quantiles of the standardised normal distribution for the probabilities q (for instance $q = 1-\alpha$, $1-\beta$ or $1-\gamma/2$)	
m	mass of baked residue from volume, V	mg
m_r	mass of the sample residue deposited on the planchet	mg
$r_{0\alpha}$	background count rate from the alpha window	s^{-1}
$r_{0\beta}$	background count rate from the beta window	s^{-1}
$r_{\mathrm{g}\alpha}$	sample gross count rate from the alpha window	s^{-1}
$r_{\mathrm{g}\beta}$	sample gross count rate from the beta window	s^{-1}
$r_{\mathrm{s}\alpha}$	calibration count rate of the alpha source from the alpha window	s^{-1}
$r_{\mathrm{s}\beta}$	calibration count rate of the beta source from the beta window	s^{-1}
$r_{\mathrm{s}\alpha\to\beta}$	calibration count rate in the beta window when the alpha calibration source is measured	s^{-1}
S	surface area of the planchet	mm^2
t_0	background counting time	s
t_g	sample counting time	s
t_s	calibration count time of the alpha and beta sources	s
$u(c_A)$	standard uncertainty associated with the measurement result	$Bq \cdot l^{-1}$

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