Measurement of radioactivity - Gamma-ray emitting radionuclides - Generic test method using gamma-ray spectrometry (ISO 20042:2019)

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 20042:2021 sisaldab Euroopa standardi EN ISO 20042:2021 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 20042:2021 consists of the English text of the European standard EN ISO 20042:2021.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 04.08.2021.	Date of Availability of the European standard is 04.08.2021.
Standard on kättesaadav Eesti Standardimis- ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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EUROPEAN STANDARD

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EN ISO 20042

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English Version

Measurement of radioactivity - Gamma-ray emitting radionuclides - Generic test method using gamma-ray spectrometry (ISO 20042:2019)

Mesurage de la radioactivité - Radionucléides émetteurs gamma - Méthode d'essai générique par spectrométrie gamma (ISO 20042:2019)

Bestimmung der Radioaktivität - Gammastrahlung emittierende Radionuklide - Allgemeines Messverfahren mittels Gammaspektrometrie (ISO 20042:2019)

This European Standard was approved by CEN on 25 July 2021.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

The text of ISO 20042:2019 has been prepared by Technical Committee ISO/TC 85 "Nuclear energy, nuclear technologies, and radiological protection" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 20042:2021 by Technical Committee CEN/TC 430 "Nuclear energy, nuclear technologies, and radiological protection" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2022, and conflicting national standards shall be withdrawn at the latest by February 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document is read in conjunction with EN XXX.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 20042:2019 has been approved by CEN as EN ISO 20042:2021 without any modification.

Contents

Page

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, SC 2, *Radiological protection*.

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.

Introduction

Everyone is exposed to natural radiation. The natural sources of radiation are cosmic rays and naturally occurring radioactive substances which exist in the earth and flora and fauna, including the human body. Human activities involving the use of radiation and radioactive substances add to the radiation exposure from this natural exposure. Some of those activities, such as the mining and use of ores containing naturally-occurring radioactive materials (NORM) and the production of energy by burning coal that contains such substances, simply enhance the exposure from natural radiation sources. Nuclear power plants and other nuclear installations use radioactive materials and produce radioactive effluent and waste during operation and decommissioning. The use of radioactive materials in industry, agriculture, medicine and research is expanding around the globe.

All these human activities give rise to radiation exposures that are only a small fraction of the global average level of natural exposure. The medical use of radiation is the largest and a growing man-made source of radiation exposure in developed countries. It includes diagnostic radiology, radiotherapy, nuclear medicine and interventional radiology.

Radiation exposure also occurs as a result of occupational activities. It is incurred by workers in industry, medicine and research using radiation or radioactive substances, as well as by passengers and crew during air travel. The average level of occupational exposures is generally similar to the global average level of natural radiation exposure (see Reference [1]).

As uses of radiation increase, so do the potential health risk and the public's concerns. Thus, all these exposures are regularly assessed in order to,

a) improve the understanding of global levels and temporal trends of public and worker exposure,

b) evaluate the components of exposure so as to provide a measure of their relative importance, and

c) identify emerging issues that may warrant more attention and study.

While doses to workers are mostly measured directly, doses to the public are usually assessed indirectly using the results of radioactivity measurements of waste, effluent and/or environmental samples.

To ensure that the data obtained from radioactivity monitoring programs support their intended use, it is essential that the stakeholders (for example nuclear site operators, regulatory and local authorities) agree on appropriate methods and procedures for obtaining representative samples and for handling, storing, preparing and measuring the test samples. An assessment of the overall measurement uncertainty also needs to be carried out systematically. As reliable, comparable and 'fit for purpose' data are an essential requirement for any public health decision based on radioactivity measurements, international standards of tested and validated radionuclide test methods are an important tool for the production of such measurement results. The application of standards serves also to guarantee comparability of the test results over time and between different testing laboratories. Laboratories apply them to demonstrate their technical competences and to complete proficiency tests successfully during interlaboratory comparisons, two prerequisites for obtaining national accreditation.

Today, over a hundred International Standards are available to testing laboratories for measuring radionuclides in different matrices.

Generic standards help testing laboratories to manage the measurement process by setting out the general requirements and methods to calibrate equipment and validate techniques. These standards underpin specific standards which describe the test methods to be performed by staff, for example, for different types of sample. The specific standards cover test methods for

— naturally-occurring radionuclides (including ^{40}K, ^{3}H, ^{14}C and those originating from the thorium and uranium decay series, in particular ^{226}Ra, ^{228}Ra, ^{234}U, ^{238}U and ^{210}Pb) which can be found in materials from natural sources or can be released from technological processes involving naturally occurring radioactive materials (e.g. the mining and processing of mineral sands or phosphate fertilizer production and use), and

— human-made radionuclides, such as transuranium elements (americium, plutonium, neptunium, and curium), ^{3}H, ^{14}C, ^{90}Sr and gamma-ray emitting radionuclides found in waste, liquid and gaseous effluent, in environmental matrices (water, air, soil and biota), in food and in animal feed as a result of authorized releases into the environment, fallout from the explosion in the atmosphere of nuclear devices and fallout from accidents, such as those that occurred in Chernobyl and Fukushima.

The fraction of the background dose rate to man from environmental radiation, mainly gamma radiation, is very variable and depends on factors such as the radioactivity of the local rock and soil, the nature of building materials and the construction of buildings in which people live and work.

A reliable determination of the activity concentration of gamma-ray emitting radionuclides in various matrices is necessary to assess the potential human exposure, to verify compliance with radiation protection and environmental protection regulations or to provide guidance on reducing health risks. Gamma-ray emitting radionuclides are also used as tracers in biology, medicine, physics, chemistry, and engineering. Accurate measurement of the activities of the radionuclides is also needed for homeland security and in connection with the Non-Proliferation Treaty (NPT).

This document describes the generic requirements to quantify the activity of gamma-ray-emitting radionuclides in samples after proper sampling, sample handling and test sample preparation in a testing laboratory or in situ.

This document is to be used in the context of a quality assurance management system (ISO/IEC 17025). It forms the basis for measurement tasks using gamma-ray spectrometry, such as those set out in ISO 18589-3, ISO 18589-7, ISO 10703, ISO 13164-2 and ISO 13165-3.

This document is one of a set of generic International Standards on measurement of radioactivity such as ISO 19361.

Measurement of radioactivity — Gamma-ray emitting radionuclides — Generic test method using gamma-ray spectrometry

1 Scope

This document describes the methods for determining the activity in becquerel (Bq) of gamma-ray emitting radionuclides in test samples by gamma-ray spectrometry. The measurements are carried out in a testing laboratory following proper sample preparation. The test samples can be solid, liquid or gaseous. Applications include:

— routine surveillance of radioactivity released from nuclear installations or from sites discharging enhanced levels of naturally occurring radioactive materials;

— contributing to determining the evolution of radioactivity in the environment;

— investigating accident and incident situations, in order to plan remedial actions and monitor their effectiveness;

— assessment of potentially contaminated waste materials from nuclear decommissioning activities;

— surveillance of radioactive contamination in media such as soils, foodstuffs, potable water, groundwaters, seawater or sewage sludge;

— measurements for estimating the intake (inhalation, ingestion or injection) of activity of gamma-ray emitting radionuclides in the body.

It is assumed that the user of this document has been given information on the composition of the test sample or the site. In some cases, the radionuclides for analysis have also been specified if characteristic limits are needed. It is also assumed that the test sample has been homogenised and is representative of the material under test.

General guidance is included for preparing the samples for measurement. However, some types of sample are to be prepared following the requirements of specific standards referred to in this document. The generic recommendations can also be useful for the measurement of gamma-ray emitters in situ.

This document includes generic advice on equipment selection (see Annex A), detectors (more detailed information is included in Annex D), and commissioning of instrumentation and method validation. Annex F summarises the influence of different measurement parameters on results for a typical gamma-ray spectrometry system. Quality control and routine maintenance are also covered, but electrical testing of the detector and pulse processing electronics is excluded. It is assumed that any data collection and analysis software used has been written and tested in accordance with relevant software standards such as ISO/IEC/IEEE 12207.

Calibration using reference sources and/or numerical methods is covered, including verification of the results. It also covers the procedure to estimate the activity content of the sample (Bq) from the spectrum.

The principles set out in this document are applicable to measurements by gamma-ray spectrometry in testing laboratories and in situ. However, the detailed requirements for in situ measurement are given in ISO 18589-7 and are outside the scope of this document.

This document covers, but is not restricted to, gamma-ray emitters which emit photons in the energy range of 5 keV to 3 000 keV. However, most of the measurements fall into the range 40 keV to 2 000 keV. The activity (Bq) ranges from the low levels (sub-Bq) found in environmental samples to activities found in accident conditions and high level radioactive wastes.

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 542, *Oilseeds — Sampling*

ISO 707, *Milk and milk products — Guidance on sampling*

ISO 5500, *Oilseed residues — Sampling*

ISO 5538, *Milk and milk products — Sampling — Inspection by attributes*

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

ISO 5667-10, *Water quality — Sampling — Part 10: Guidance on sampling of waste waters*

ISO 10703, *Water quality — Determination of the activity concentration of radionuclides — Method by high resolution gamma-ray spectrometry*

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*

ISO 17604, *Microbiology of the food chain — Carcass sampling for microbiological analysis*

ISO 18400-101, *Soil quality — Sampling — Part 101: Framework for the preparation and application of a sampling plan*

ISO 18400-102, *Soil quality — Sampling — Part 102: Selection and application of sampling techniques*

ISO 18400-103, *Soil quality — Sampling — Part 103: Safety*

ISO 18400-104, *Soil quality — Sampling — Part 104: Strategies*

ISO 18400-107, *Soil quality — Sampling — Part 107: Recording and reporting*

ISO 18400-202, *Soil quality — Sampling — Part 202: Preliminary investigations*

ISO 18400-203, *Soil quality — Sampling — Part 203: Investigation of potentially contaminated sites*

ISO 18400-204, *Soil quality — Sampling — Part 204: Guidance on sampling of soil gas*

ISO 18400-205, *Soil quality — Sampling — Part 205: Guidance on the procedure for investigation of natural, near-natural and cultivated sites*

ISO 18589-2, *Measurement of radioactivity in the environment — Soil — Part 2: Guidance for the selection of the sampling strategy, sampling and pre-treatment of samples*

ISO 18589-7, *Measurement of radioactivity in the environment — Soil — Part 7: In situ measurement of gamma-emitting radionuclides*

ISO 24333, *Cereals and cereal products — Sampling*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

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

3 Terms and definitions

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