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Measurement of radioactivity — Gamma emitting radionuclides — Reference measurement standard specifications for the calibration of gamma-ray spectrometers

Mesurage de la radioactivité — Radionucléides émetteurs gamma — Caractéristiques des étalons de mesure de référence pour l'étalonnage de spectromètres gamma

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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).

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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee 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 existing in the Earth itself and inside the human body. Human activities involving the use of radiation and radioactive substances cause radiation exposure in addition to the natural exposure. Some individual activities, such as the mining, use of ores containing naturally radioactive substances and the production of energy by burning coal that contains such substances, can simply enhance the exposure from natural radiation sources. Nuclear installations use radioactive materials and produce radioactive effluent and waste during operations. The use of radioactive materials in industry, medicine, agriculture and research is expanding around the globe.

All these human activities generally also 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 and space travel. The average level of occupational exposures is generally similar to the global average level of natural radiation exposure[10].

As the uses of radiation increase, the potential health risk and the public's concerns may increase. Thus, ionizing radiation exposures are regularly assessed in order to improve the understanding of regional levels and temporal trends of public and worker exposure, to evaluate the components of exposure to provide a measure of their relative importance, and to identify emerging issues that may warrant more attention and scrutiny. While doses to workers are usually directly measured, doses to the public are usually assessed by indirect methods using radioactivity measurements results performed on various sources, including waste, liquid or air effluent, and environmental samples. Environmental samples may include ambient air, soil, surface water, ground water, treated water, vegetation, livestock and game or other biota.

Surveillance programs require financial and technical resources. The program should be designed to acquire data to adequately monitor potential risks. To ensure that the data obtained from radioactivity monitoring programs support their intended use, it is essential in the dose assessment process that stakeholders (the operators, the regulatory bodies, the local information committee and associations, etc.) agree on appropriate data quality objectives, methods and procedures for

— the acquisition, handling, transport, storage and preparation of test samples;

— the test analytical method, and

— for calculating measurement uncertainty.

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 over time of the test results and between different testing laboratories. Laboratories apply them to demonstrate their technical qualifications with successful completion of proficiency tests during laboratory intercomparison, two prerequisites to obtain national accreditation. Today, over a hundred international standards, prepared by Technical Committees of the International Organization for Standardization, including those produced by ISO/TC 85, and the International Electrotechnical Commission, are available for application by testing laboratories to measure the main radionuclides.

A reliable determination of the activity concentration of gamma-emitting radionuclides in various matrices is necessary for the assessment of any potential human exposure (public and workers) to the radioactivity of these sources.

Gamma-ray spectrometry is commonly used to determine the activity of gamma-emitting radionuclides. ISO 20042 describes the generic requirements and instrumentation to quantify the

activity concentration of gamma-emitting radionuclides in samples after proper sampling, sample handling and test sample preparation in a testing laboratory or directly on site. ISO 20042 also helps testing laboratories to manage the measurement process by setting out the general requirements and methods to calibrate and validate techniques. 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.

According to ISO 20042 and the above-mentioned ISO standards, reference measurement standards that are traceable to International Standards or national standards are required to calibrate gamma-ray spectrometry systems. The necessity for developing this document originated from the need for standardized specifications for radioactive reference measurement standards used to calibrate gamma-ray spectrometers, as mentioned in those International Standards. Accordingly, traceability of measurement standards to International Standards or national standards is established by use of sources of reference measurement standards that comply with this document.

Measurement of radioactivity — Gamma emitting radionuclides — Reference measurement standard specifications for the calibration of gamma-ray spectrometers

1 Scope

This document specifies the characteristics of solid, liquid or gas sources of gamma emitting radionuclides used as reference measurement standards for the calibration of gamma-ray spectrometers. These reference measurement standards are traceable to national measurement standards.

This document does not describe the procedures involved in the use of these reference measurement standards for the calibration of gamma-ray spectrometers. Such procedures are specified in ISO 20042 and other documents.

This document specifies recommended reference radiations for the calibration of gamma-ray spectrometers. This document covers, but is not restricted to, gamma emitters which emit photons in the energy range of 60 keV to 1 836 keV. These reference radiations are realized in the form of point sources or adequately extended sources specified in terms of activity which are traceable to national standards.

Liquid standards that are intended to be used for preparing extended standards by the laboratories are also within the scope of this document. Reference materials (RMs) produced in accordance with ISO 17034 are out of scope of this document.

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 2919, *Radiological protection — Sealed radioactive sources — General requirements and classification*

ISO 9978, *Radiation protection — Sealed sources — Leakage test methods*

ISO 12749-2, *Nuclear energy, nuclear technologies, and radiological protection — Vocabulary — Part 2: Radiological protection*

ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

IEC 60050-395, *International Electrotechnical Vocabulary — Part 395: Nuclear instrumentation: Physical phenomena, basic concepts, instruments, systems, equipment and detectors*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12749-2, IEC 60050-395, ISO/IEC Guide 99 and the following apply.

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/