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

*Qualité de l'eau — Détermination de l'activité volumique des
radionucléides — Méthode par spectrométrie gamma à haute résolution*



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10703 was prepared by Technical Committee ISO/TC 147, *Water quality*.

This second edition cancels and replaces the first edition (ISO 10703:1997), which has been technically revised.

Introduction

This International Standard allows (after proper sampling, sample handling and, when necessary or desirable, sample preparation) the simultaneous determination of the activity concentration of several gamma-ray emitting radionuclides in water samples by gamma-ray spectrometry using high purity germanium [HPGe] detectors. Gamma-ray emitting radionuclides are widespread both as naturally occurring and as man-made radionuclides. Therefore, environmental samples usually contain a multitude of different gamma-ray emitters and high resolution gamma-ray spectrometry provides a useful analytical tool for environmental measurements.

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

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This International Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

IMPORTANT — It is absolutely essential that tests conducted in accordance with this International Standard be carried out by suitably trained staff.

1 Scope

This International Standard specifies a method for the simultaneous determination of the activity concentration of various radionuclides emitting gamma rays with energies $40 \text{ keV} < E < 2 \text{ MeV}$ in water samples, by gamma-ray spectrometry using germanium detectors with high energy resolution in combination with a multichannel analyser.

NOTE The determination of the activity concentration of radionuclides emitting gamma rays with energy below 40 keV and above 2 MeV is also possible within the scope of this International Standard, provided both the calibration of the measuring system and the shielding are adapted to this purpose.

This International Standard includes the procedures for energy calibration, determination of the energy dependent sensitivity of the measuring system, the analysis of the spectra and the determination of the activity concentration of the various radionuclides in the sample studied. It is only applicable to homogeneous samples. Samples with activities typically between 1 Bq and 10^4 Bq can be measured as such, i.e. without dilution or concentration of the sample or special (electronic) devices.

Depending on different factors, such as the energy of the gamma rays and the emission probability per nuclear disintegration, the size and geometry of the sample and the detector, the shielding, the counting time and other experimental parameters, the sample should be concentrated by evaporation when activities below about 1 Bq have to be measured. Also, when the activity is considerably higher than 10^4 Bq, the sample should be either diluted or an aliquot of the sample should be taken or the source to detector distance should be increased, or a correction for pile-up effects should be applied.

2 Normative references

The following referenced documents are indispensable for the application 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 31-9, *Quantities and units — Part 9: Atomic and nuclear physics*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

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: Guidance on the preservation and handling of water samples*

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

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

Guide to the expression of uncertainty in measurement (GUM), BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML

IEC 60973, *Test procedures for germanium gamma-ray detectors*

IEC 61151, *Nuclear instrumentation — Amplifiers and preamplifiers used with detectors of ionizing radiation — Test procedures*

IEC 61452, *Nuclear instrumentation — Measurement of gamma-ray emission rates of radionuclides — Calibration and use of germanium spectrometers*

3 Terms and definitions

For the purposes of this document, the definitions, symbols and abbreviations given in ISO 31-9 and the following apply.

3.1
blank sample
container of an identical composition to the one used for the water test sample filled with radon free demineralized water

3.2
dead time
time interval which must elapse between the occurrence of two consecutive pulses or ionising events for them to be recognized by the detection system as separate pulses or events

3.3
dead time correction
correction to be applied to the observed number of pulses in order to take into account the number of pulses lost during the dead time

3.4
decay constant
 λ
(radionuclide in a particular energy state) quotient of dP by dt , where dP is the probability of a given nucleus undergoing a spontaneous nuclear transition from that energy state in the time interval dt

$$\lambda = \frac{dP}{dt} = -\frac{1}{N} \frac{dN}{dt}$$

where N is the number of nuclei of concern existing at time t

3.5
efficiency
under stated conditions of detection, the ratio of the number of detected gamma-photons to the number of gamma-photons of the same type emitted by the radiation source in the same time interval