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Water quality — Plutonium, americium, curium and neptunium — Test method using alpha spectrometry

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National foreword

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Water quality — Plutonium, americium, curium and neptunium — Test method using alpha spectrometry

*Qualité de l'eau — Plutonium, americium, curium et neptunium —
Méthode d'essai par spectrométrie alpha*



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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/147, *Water quality*, Subcommittee SC 3, *Radioactivity measurements*.

Introduction

Radioactivity from several naturally-occurring and anthropogenic sources is present throughout the environment. Thus, water bodies (e.g. surface waters, ground waters, sea waters) can contain radionuclides of natural, human-made, or both origins.

- Natural radionuclides, including potassium 40, and those originating from the thorium and uranium decay series, in particular radium 226, radium 228, uranium 234, uranium 238, lead 210, can be found in water for natural reasons (e.g. desorption from the soil and wash-off by rain water) 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).
- Human-made radionuclides, such as transuranium elements (americium, plutonium, neptunium, curium), tritium, carbon 14, strontium 90 and some gamma emitting radionuclides, can also be found in natural waters as a result of authorized routine releases into the environment in small quantities in the effluent discharged from nuclear fuel cycle facilities. They are also released into the environment following their use in unsealed form for medical and industrial applications. They are also found in the water as a result of past fallout contamination resulting from the explosion in the atmosphere of nuclear devices and accidents such as those that occurred in Chernobyl and Fukushima.

Drinking water may thus contain radionuclides at activity concentrations which could present a risk to human health. In order to assess the quality of drinking water (including mineral waters and spring waters) with respect to its radionuclide content and to provide guidance on reducing health risks by taking measures to decrease radionuclide activity concentrations, water resources (groundwater, river, lake, sea, etc.) and drinking water are monitored for their radioactivity content as recommended by the World Health Organization [WHO] and as may be required by some national authorities.

An international standard on a test method for isotopes of plutonium, americium, curium and neptunium activity concentrations in water samples is justified for test laboratories carrying out these measurements, which are sometimes required by national authorities, as laboratories may have to obtain a specific accreditation for radionuclide measurement in drinking water samples.

^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Am , ^{242}Cm , ^{243}Cm , ^{244}Cm , ^{237}Np activity concentrations can vary according to any local effluent authorized discharges from nuclear plant and environmental characteristics. The guidance level for ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Am , ^{242}Cm , ^{243}Cm , ^{244}Cm , ^{237}Np in drinking water as recommended by WHO is 1 Bq/l for all of those isotopes, except for ^{242}Cm (10 Bq/l) [WHO-Guidelines for drinking waters quality, 2011, Geneva].

NOTE The guidance level is the activity concentration (rounded to the nearest order of magnitude) with an intake of 2 l/day of drinking water for 1 year, that results in an effective dose of 0,1 mSv/year for members of the public, an effective dose that represents a very low level of risk that is not expected to give rise to any detectable adverse health effect.

This International Standard is one of a set of International Standards on test methods dealing with the measurement of the activity concentration of radionuclides in water samples.

Water quality — Plutonium, americium, curium and neptunium — Test method using alpha spectrometry

1 Scope

This International Standard specifies a test method for measuring actinides (^{238}Pu , $^{239+240}\text{Pu}$, ^{241}Am , ^{242}Cm , $^{243+244}\text{Cm}$ and ^{237}Np) in water samples by alpha spectrometry following a chemical separation.

The method can be used for any type of environmental study or monitoring.

The volume of the test portion required depends on the assumed activity of the sample and the desired detection limit.

The detection limit of the test method is 5×10^{-3} to 5×10^{-4} Bq/l for a volume of the test portion of 0,1 l to 5 l with a counting time of two to ten days.

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 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 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 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, definitions and symbols given in ISO 80000-10 and ISO 11929 apply.

4 Symbols

The following symbols apply.

A	Activity of tracer added at the date of measurement, in becquerels
c_A	Activity concentration of the actinides isotopes in becquerels per litre
c_A^*	Decision threshold, in becquerels per litre
$c_A^\#$	Detection limit, in becquerels per litre
$c_A^{\triangleleft}, c_A^{\triangleleft}$	Lower and upper limits of the confidence interval, in becquerels per litre
ε	Counting efficiency
r_g, r_{gT}	Gross count rate per second from measured actinides isotopes and tracer, respectively
r_0, r_{0T}	Background count rate per second from actinides isotopes and tracer, respectively
R	Total measurement yield
R_c	Chemical yield
t_0	Background counting time, in seconds
t_g	Sample counting time, in seconds
$u(c_A)$	Standard uncertainty associated with the measurement result, in becquerels per litre
U	Expanded uncertainty, calculated by $U = k \cdot u(c_A)$ with $k = 1, 2, \dots$, in becquerels per litre
V	Volume of test sample, in litres
f	Correction factor for possible bias for curium isotopes using ^{243}Am as a tracer or for ^{237}Np using ^{236}Pu as a tracer. For plutonium isotopes or for ^{241}Am , f is equal to 1.

5 Principle

Actinide isotopes are deposited as a thin source for measurement by alpha spectrometry using a grid chamber or semi-conductor detector type equipment. The sources are usually prepared by electrodeposition or co-precipitation after chemical separation and purification of the actinide isotopes present in the test portion.^{[1][2][3][4]}

Specific chemical separation and purification procedures are required in order to avoid interference from the presence of other α emitters, and stable nuclides in the sample, in quantities that are often larger than the actinide isotopes of interest.