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**Nuclear fuel technology — Determination of the isotopic and elemental uranium and plutonium concentrations of nuclear materials in nitric acid solutions by thermal-ionization mass spectrometry**

*Technologie du combustible nucléaire — Détermination de la teneur isotopique et des concentrations en matériaux nucléaires de l'uranium et du plutonium dans une solution d'acide nitrique par spectrométrie de masse à thermoionisation*



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Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland

## Contents

Page

Foreword.....	iv
1 Scope.....	1
2 Normative references .....	1
3 Principle.....	1
4 Reagents and materials.....	2
5 Apparatus.....	4
6 Apparatus for mass spectrometry .....	4
7 Sampling .....	5
8 Preparation of the filaments.....	7
9 Instrument calibration .....	8
10 Isotopic mass spectrometric measurements.....	9
11 Calculation of the results .....	10
12 Blanks.....	13
13 Quality control .....	13
14 Repeatability of the measurements .....	14
15 Accuracy of the method .....	14
16 Interferences.....	15
Annex A (normative) Preparation and standardization of spike solutions.....	16
Bibliography .....	22

## 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.

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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 8299 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 5, *Nuclear fuel technology*.

This second edition cancels and replaces the first edition (ISO 8299:1993), which has been technically revised.

# Nuclear fuel technology — Determination of the isotopic and elemental uranium and plutonium concentrations of nuclear materials in nitric acid solutions by thermal-ionization mass spectrometry

## 1 Scope

This method applies to the measurement of the isotopic composition and the concentration of uranium and plutonium in input solutions of irradiated Magnox and light water reactor fuels (boiling water reactor or pressurized water reactor), in final products at spent-fuel reprocessing plants and in feed and products of MOX and uranium fuel fabrication. The method is applicable to other fuels, but the chemical separation and spike solution are, if necessary, adapted to suit each type of fuel.

## 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 10980:1995, *Validation of the strength of reference solutions used for measuring concentrations*

ISO 11483, *Preparation of plutonium sources and determination of  $^{238}\text{Pu}/^{239}\text{Pu}$  isotope ratio by alpha spectrometry*

## 3 Principle

The described method is based on isotope ratio measurements by thermal ionization mass spectrometry (TIMS). TIMS analysis requires separation of the element to be analysed from all other elements. Two methods of separation for Pu and U using anion exchange columns are described in Clause 7. Other separation methods may be used provided that they lead to a separation of similar quality. Column extraction chromatography described in ISO 15366 is an example of a suitable alternative.

The described method consists of two separate TIMS measurements.

- a) One measurement is made to determine the isotopic composition of the element. The  $^{238}\text{Pu}$  isotope abundance is determined by combining mass spectrometry following the present method and alpha spectrometry as described in ISO 11483, if the interference of the isobar  $^{238}\text{U}$  is not eliminated by chemical separation.
- b) A second measurement is made on a mixture of the sample and a spike consisting of an artificially enriched isotope of the element to be analysed. This method of measuring an element's concentration is called isotope dilution mass spectrometry (IDMS). The spiking can be made using a spike isotope that either is present in the sample or not. The use of  $^{233}\text{U}$  or  $^{244}\text{Pu}$  spikes eliminates the need for an isotopic measurement in the unspiked sample to determine uranium and plutonium concentration. Although it is normally of interest to measure both the isotopic composition and the element concentration, it is however more common to use the less expensive  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$  and  $^{235}\text{U}$  spike solutions. Accurate measurements