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Standards

Irish Standard  
I.S. EN ISO 16424:2017

Nuclear energy - Evaluation of homogeneity of Gd distribution within gadolinium fuel blends and determination of Gd<sub>2</sub>O<sub>3</sub> content in gadolinium fuel pellets by measurements of uranium and gadolinium elements (ISO 16424:2012)

## I.S. EN ISO 16424:2017

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## National Foreword

I.S. EN ISO 16424:2017 is the adopted Irish version of the European Document EN ISO 16424:2017, Nuclear energy - Evaluation of homogeneity of Gd distribution within gadolinium fuel blends and determination of Gd<sub>2</sub>O<sub>3</sub> content in gadolinium fuel pellets by measurements of uranium and gadolinium elements (ISO 16424:2012)

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**EUROPEAN STANDARD**  
**NORME EUROPÉENNE**  
**EUROPÄISCHE NORM**

**EN ISO 16424**

October 2017

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English Version

**Nuclear energy - Evaluation of homogeneity of Gd  
distribution within gadolinium fuel blends and  
determination of Gd<sub>2</sub>O<sub>3</sub> content in gadolinium fuel pellets  
by measurements of uranium and gadolinium elements  
(ISO 16424:2012)**

Énergie nucléaire - Évaluation de l'homogénéité de la  
distribution du Gd dans les mélanges de combustibles  
au gadolinium et détermination de la teneur en Gd<sub>2</sub>O<sub>3</sub>  
dans les pastilles combustibles au gadolinium par  
mesurage des éléments uranium et gadolinium (ISO  
16424:2012)

Kernenergie - Bewertung der Homogenität der Gd-  
Verteilung in Gadolinium-Brennstoffgemischen und  
Bestimmung des Gd<sub>2</sub>O<sub>3</sub>-Gehaltes in Gadolinium-  
Brennstofftabletten durch Messung der Uran- und  
Gadolinium-Bestandteile (ISO 16424:2012)

This European Standard was approved by CEN on 13 September 2017.

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**EN ISO 16424:2017 (E)**

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## **European foreword**

The text of ISO 16424:2012 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 16424:2017 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 April 2018, and conflicting national standards shall be withdrawn at the latest by April 2018.

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## **Endorsement notice**

The text of ISO 16424:2012 has been approved by CEN as EN ISO 16424:2017 without any modification.

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# INTERNATIONAL STANDARD

ISO  
16424

First edition  
2012-12-01

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## **Nuclear energy — Evaluation of homogeneity of Gd distribution within gadolinium fuel blends and determination of $Gd_2O_3$ content in gadolinium fuel pellets by measurements of uranium and gadolinium elements**

*Énergie nucléaire — Évaluation de l'homogénéité de la distribution  
du Gd dans les mélanges de combustibles au gadolinium et  
détermination de la teneur en  $Gd_2O_3$  dans les pastilles combustibles  
au gadolinium par mesurage des éléments uranium et gadolinium*



Reference number  
ISO 16424:2012(E)

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**ISO 16424:2012(E)**



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## **ISO 16424:2012(E)**

### **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 16424 was prepared by Technical Committee ISO/TC 85, *Nuclear Energy, Nuclear Technologies, and Radiological Protection*, Subcommittee SC 5, *Nuclear Fuel Cycle*.

# Nuclear energy — Evaluation of homogeneity of Gd distribution within gadolinium fuel blends and determination of $\text{Gd}_2\text{O}_3$ content in gadolinium fuel pellets by measurements of uranium and gadolinium elements

## 1 Scope

This International Standard is applicable to the evaluation of the homogeneity of Gd distribution within gadolinium fuel blends, and the determination of the  $\text{Gd}_2\text{O}_3$  content in sintered fuel pellets of  $\text{Gd}_2\text{O}_3+\text{UO}_2$  from 1 % to 10 %, by measurements of gadolinium (Gd) and uranium (U) elements using ICP-AES.

After performing measurements of Gd and U elements using ICP-AES, if statistical methodology is additionally applied, homogeneity of Gd distribution within a Gd fuel pellet lot can also be evaluated. However, this International Standard covers the statistical methodology only on a limited basis.

NOTE 1 ISO 16796 also provides a method for  $\text{Gd}_2\text{O}_3$  content determination by atomic emission spectrometry using an inductively coupled plasma source (ICP-AES). The methodology of ISO 16796 is different from the one of this International Standard.

NOTE 2 In this International Standard, gadolinium fuel blend represents a mixture of uranium dioxide ( $\text{UO}_2$ ) powder and gadolinium oxide ( $\text{Gd}_2\text{O}_3$ ) powder. The physically blended and homogenized powder may additionally contain in it rather large quantities of uranium oxide ( $\text{U}_3\text{O}_8$ ) powder particles and/or the  $\text{M}_3\text{O}_8$  powder particles obtained by oxidation of Gd pellets. In this International Standard, the symbol “M” in the chemical formula “ $\text{M}_3\text{O}_8$ ” and in the terminology “O/M ratio” represents metallic elements U and Gd.

## 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 amendments) applies.

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

## 3 Principle

If the Gd and U element contents and the oxygen to metal atomic ratio (commonly referred to as O/M ratio) in a gadolinium fuel pellet are measured or determined, the  $\text{Gd}_2\text{O}_3$  content of that pellet can be determined by calculation based on the stoichiometry of the pellet. The stoichiometric compositions for Gd and U will depend upon pellet manufacturing specification. If the specification requires that the  $\text{Gd}_2\text{O}_3$  content in the pellet be 6 % as mass fraction, after manufacturing, the ratio of total Gd mass to total U mass in that pellet will be close to 0,063.

The Gd and U element content values measured from a powder blend can make it possible to evaluate whether Gd distribution in the powder is sufficiently homogeneous. Moreover, the two values make it possible to estimate accurately the actual  $\text{Gd}_2\text{O}_3$  content of the pellet after sintering. The estimated  $\text{Gd}_2\text{O}_3$  content can be used to anticipate whether the Gd pellets to be produced will meet  $\text{Gd}_2\text{O}_3$  content specifications or not.

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