



BSI Standards Publication

**Recycling of rare earth elements — Methods  
for the measurement of rare earth elements in  
industrial waste and end-of-life products**

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## National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Recycling of rare earth elements —  
Methods for the measurement of rare  
earth elements in industrial waste and  
end-of-life products**

*Recyclage des éléments des terres rares — Méthodes pour le  
mesurage des éléments des terres rares dans les déchets industriels et  
les produits en fin de vie*



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# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms, definitions and abbreviated terms</b> .....	<b>1</b>
3.1 Terms and definitions.....	1
3.2 Abbreviated terms.....	1
<b>4 Sampling</b> .....	<b>2</b>
4.1 Industrial waste.....	2
4.1.1 Processing waste.....	2
4.1.2 Scrap.....	2
4.2 End-of-life products.....	2
4.2.1 Magnets.....	2
4.2.2 NiMH batteries.....	2
4.2.3 Phosphors.....	2
<b>5 Selection of measurement methods</b> .....	<b>3</b>
<b>6 Measurement methods</b> .....	<b>3</b>
6.1 X-ray fluorescence spectrometry (XRF).....	3
6.1.1 General.....	3
6.1.2 Sample preparation.....	3
6.1.3 Calibration.....	4
6.1.4 Analysis and calculation.....	4
6.2 ICP-OES.....	5
6.2.1 General.....	5
6.2.2 Sample preparation.....	5
6.2.3 Calibration.....	5
6.2.4 Analysis and calculation.....	5
6.3 ICP-MS.....	6
6.3.1 General.....	6
6.3.2 Sample preparation.....	6
6.3.3 Calibration.....	6
6.3.4 Analysis and calculation.....	6
<b>Annex A (informative) Example measurement report</b> .....	<b>8</b>
<b>Bibliography</b> .....	<b>9</b>

## 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](http://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](http://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 of 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 298, *Rare earth*.

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](http://www.iso.org/members.html).

## Introduction

With technical advancement, rare earth elements (REEs) are increasingly important due to their importance in a number of applications, including green technologies. However, there are high supply risks arising from the dependence on a single source of extraction. Recycling and systemic management of rare earth elements are key issues for solving the waste and supply risks of REEs.

In order to efficiently recycle and systemically manage rare earth elements, a standard measurement method of REEs in industrial wastes and end-of-life cycled products is needed. Industrial wastes and end-of-life products can be found in solid, solid-liquid mixture and liquid forms. For example, machining waste contains chips and flakes with coolant oils, greases and numerous other forms of aqueous and non-aqueous contaminants. Similarly, waste liquid slurries contain REEs, as in LEDs, and batteries contain numerous acids, bases etc. Furthermore, in order to verify the information provided by the producer about REEs in the waste, standardized measurement procedure is necessary.

There are several scientific methods for quantitatively measure REEs in matters, such as X-ray fluorescence (XRF), inductively coupled plasma mass spectroscopy (ICP-MS), inductively coupled plasma optical emission spectroscopy (ICP-OES) and glow discharge mass spectrometry (GD-MS). However, these different characterization techniques often offer dissimilar measurement results depending on the composition and physical state of the sample under observation. This is another reason to establish standard measurement methods.

This document provides a brief overview and several measurement methods for REEs in industrial wastes and end-of-life products. Sample preparation methods are also provided. The accurate measurement of rare earth content (e.g. in ppm range) is still under active research and is not covered by this document. However, this document does provide measurement methods for identifying the presence and approximate content of rare earth elements.

This document is designed to be used with ISO 22450.

# Recycling of rare earth elements — Methods for the measurement of rare earth elements in industrial waste and end-of-life products

## 1 Scope

This document provides measurement methods for quantifying rare earth elements (REEs) in industrial wastes and end-of-life products in solid, solid-liquid mixture or liquid forms. It provides an overview of sample preparation and measurement of REEs in industrial waste and end-of-life products.

**WARNING — The use of this document can involve hazardous materials, operations and equipment. This document does not address any safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices.**

## 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 22444-2, *Rare earth — Vocabulary — Part 2: Metals and their alloys*

ISO 22450, *Recycling of rare earth elements — Requirements for providing information on industrial waste and end-of-life products*

## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22444-2 and ISO 22450 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.2 Abbreviated terms

REE	rare earth element
TREE	total rare earth element content
ppm	parts per million
XRF	X-ray fluorescence spectrometry
EDXRF	energy dispersive X-ray fluorescence spectrometry
WDXRF	wavelength dispersive X-ray fluorescence spectrometry
ICP-MS	inductively coupled plasma mass spectrometry