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Rare earth — Packaging and labelling

Terres rares — Emballage et étiquetage

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Foreword

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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).

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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.

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.

Introduction

The purpose of this document is to ensure quality assurance, enhanced safety and pollution prevention during the global trade of rare earth products.

Rare earth products (ores, concentrates, compounds, metals and alloys) have some unique chemical and physical properties. For example, some rare earth products can readily react with O_2, CO_2 and moisture. In addition, some rare earth products, such as monazite, can emit radiation because they contain thorium and uranium. Under certain circumstances, these features can result in accidents or create hazards (explosion, fire, downgrading the quality of products, radiation exposure, etc.) during transportation and storage. Indeed, several such incidents have been reported and these emphasize the possibility of harm to human health, pollution to the environment and a reduction in product quality. Such problems are likely to have global effects because rare earth products are transported across borders.

It is necessary to package rare earth products properly. It is also essential to share clearly defined information, in a readily accessible format, concerning their physical properties and traceability during global trade. This document provides requirements that will ensure proper packaging and appropriate labelling of rare earth products. Proper packaging can prevent rare earth products from losing their quality and causing accidents resulting from unwanted chemical reactions. Appropriate labelling with precise information on the properties, traceability and the ways of handling the product can also reduce the risk of quality degradation and accidents. Conforming to this document will contribute to ensuring quality, guaranteeing safety and preventing environmental pollution during the global trade of rare earths.

NOTE There are numerous existing regulations concerning the packaging, labelling and shipment of materials. Depending on circumstances, such regulations can include References [6] to [23]. In addition, local regulations concerning shipments, transport and packaging can also apply. Many jurisdictions require that a safety data sheet (SDS) accompany any shipment.

Rare earth — Packaging and labelling

1 Scope

This document specifies requirements and recommendations for the packaging and labelling of rare earth ores, concentrates, compounds, metals and alloys that are intended for sale or free distribution. It defines the performance and structure of packaging, and specifies the information to include on the labelling. These requirements and recommendations are designed to ensure quality assurance, enhance safety and prevent environmental pollution during the transportation and storage of rare earth products.

This document is applicable to packaging and labelling during transactions between companies. It does not include packaging by companies during storage in their own plant.

The method of labelling defined in this document enhances safety by indicating properties of rare earth products and ensures appropriate management of the product by indicating the identity of suppliers.

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 21067-1, *Packaging — Vocabulary — Part 1: General terms*

ISO 22444-1, *Rare earth — Vocabulary — Part 1: Minerals, oxides and other compounds*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21067-1, ISO 22444-1, ISO 22444-2 and the following 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/

3.1
supplier
company that produces and provides rare earth ores, concentrates, compounds, metals, alloys or solutions for its customer

Note 1 to entry: It includes the mines, beneficiation plants, hydrometallurgical plants, traders/brokers/blenders of rare earth products.

3.2
inner packaging
container designed to come into direct contact with the product

3.3
intermediate packaging
packaging placed between the *inner packaging* (3.2) and *outer packaging* (3.4) if deemed necessary

3.4
outer packaging
container designed to contain inner or *intermediate packaging* (3.3) including any protective materials where required

3.5
protecting gas
shielding gas
gas used in packaging that will displace oxygen and water vapour and will not react with the package contents, and will therefore prevent product degradation and chemical reaction

EXAMPLE Argon, nitrogen.

3.6
protecting liquid
oil or other liquid used as coating on, or to totally submerge, a product to isolate it from air and ensure quality stability

Note 1 to entry: It is usually used in the packaging of rare earth target products.

3.7
vacuum
space where the air has been removed from the package before sealing

3.8
minimum packaging unit
smallest independent unit for sales and delivery, where items/products cannot be broken up

4 Packaging

4.1 General principles of packaging

Packaging for rare earth products should prevent the products from being accidentally dispersed or otherwise discharged into the environment and from absorbing moisture or gases. Solid rare earth metals and compounds can react with water, water vapour and other gases, causing damage to the quality of products, exothermic reaction and ignition. For these reasons, a sealed package should be used to contain solid rare earth products, including powders. Rare earth liquid products can flow out of the packaging if a package loses its integrity, causing potential damage to products, workers and surroundings. For these reasons, durable packaging should be used. This clause specifies requirements and recommendations for packaging appropriate to the properties of the rare earth product, including ores, concentrates, compounds, metals, alloys and solutions (see Annex A for additional information on the chemical characteristics of rare earth products and key information related to packaging and labelling).

Within each minimum packaging unit, products should be of the same batch, grade, specification and form. In the case of different batches of products put in the same minimum packaging unit, they should be separately packaged with clear identification to avoid mixing of products.

4.2 Requirements and recommendations for packaging

4.2.1 Inner (and intermediate) packaging

4.2.1.1 Polymer bottles

Polymer bottles are vessels made from polymer, having a comparatively narrow neck or mouth, with closure and usually no handle. They should have a load-bearing capacity depending on the content and the polymer should be chemically compatible.

4.2.1.2 Glass bottles

Glass bottles are rigid vessels made from borosilicate glass, having a comparatively narrow neck or mouth, with a closure and usually no handle. They should have load-bearing capacity depending on the content.

4.2.1.3 Polymer film bags

Polymer film bags are flexible containers made of polymer layers, generally enclosed on all sides except one, forming an opening that is sealed after filling. They should have load-bearing capacity depending on the content and should be chemically compatible.

4.2.1.4 Aluminized polymer bags

Aluminized polymer bags are flexible containers made from polymer film metallized with aluminium, which reduces the permeability of the polymer film to the external atmosphere. They may be used as inner or intermediate packaging for some rare earth metals and their alloys (such as cerium and cerium alloy). They should have a load-bearing capacity depending on the content and should be chemically compatible.

4.2.2 Outer packaging

4.2.2.1 Metal drums

Metal drums are cylindrical vessels made from iron, steel or alloys whose bottom end is permanently fixed to the body. The top-end (head) is either removable or non-removable. Steel drums with a capacity of over 200 l used for rare earth product packaging should meet the requirements specified in ISO 15750-1, ISO 15750-2 and ISO 15750-3. Steel drums with a capacity of less than 200 l used for rare earth product packaging should have load-bearing capacity depending on the content and should be chemically compatible or else an appropriate inner package should be used.

4.2.2.2 Polymer drums

Polymer drums are cylindrical vessels made from polymer whose bottom end is permanently fixed to the body. The top-end (head) is either removable or non-removable. They should have load-bearing capacity depending on the content and should be chemically compatible or else an appropriate inner package should be used.

4.2.2.3 Flexible containers

Flexible containers are containers made from a flexible material that are collapsible when empty. Flexible intermediate bulk containers used for rare earth products packaging should meet the requirements given in ISO 21898.

4.2.2.4 Polymer bulk containers

Polymer bulk containers are vessels made from polymer, designed to contain liquids, pastes or powders. They should have load-bearing capacity depending on the content and should be chemically compatible or an appropriate inner package used.

4.2.2.5 Corrugated fibreboard boxes

Corrugated fibreboard boxes consist of one or more fluted paper sheets glued to a flat sheet of board or between several sheets. They should have load-bearing capacity depending on the content and should be chemically compatible or else an appropriate inner package should be used.

4.2.2.6 Kraft bags

Kraft bags are flexible containers made from paper made using the kraft process and are generally enclosed on all sides except one, forming an opening that may or may not be sealed after filling. They should have load-bearing capacity depending on the content and should be chemically compatible or else an appropriate inner package should be used.

4.2.2.7 Wooden/plywood drums or containers

Drums or containers made of wood/plywood and with a top-end (head) that can be removed. They can be used as outer packaging for rare earth products. They should have load-bearing capacity depending on the content and should be chemically compatible or else an appropriate inner package should be used.

4.3 Requirements and recommendations for packaging of rare earth products

4.3.1 Rare earth ore

In most cases, there are no special requirements for packaging ore. Consideration should be given to the use of flexible containers under special circumstances. Regarding those ores with a certain level of radioactivity, dust-tight flexible containers or polymer film bags should be used and the radioactivity on the outside surface of the packaging should take into account the requirements of the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA) (see References [6], [8], [12], [13], [14], [16] and [17]).

4.3.2 Rare earth concentrate

Flexible containers with a dust-tight integral liner should be used for the outer packaging.

4.3.3 Rare earth compound

4.3.3.1 Oxide

Some rare earth oxide (REO) powders can react with moisture or carbon dioxide in the air and form hydroxides or carbonates or become deliquescent. REOs shall be sealed in an airtight and waterproof package. Polymer bottles or polymer film bags should be used for the inner package. Steel drums, polymer drums, flexible containers, polymer bulk containers, corrugated fibreboard boxes, kraft bags or wooden/fibreboard drums should be used for the outer package.

4.3.3.2 Salts and other compounds

4.3.3.2.1 In solid-state

Most rare earth salts and compounds are in the form of dry powder, granules or solid blocks. They are usually chemically stable, but most can absorb moisture and become deliquescent. Suitable packaging should be used depending on their chemical characteristics. Instructions for packaging of typical rare earth compounds are provided in Table 1.

Table 1 — Instructions for packaging of typical solid rare earth salts and compounds

Type	Instructions for			Remarks
	inner packaging	intermediate packaging	outer packaging	
Carbonate	waterproof and airtight package	polymer bottles, polymer film bags or glass bottles	corrugated fibreboard boxes, steel drums, flexible containers, kraft bags or wooden/ plywood drums	
Chloride[a]				
Hydroxide				
Fluoride				
Nitrate[a]				
Sulfate[a]				
Oxalate				
Acetate[a]	waterproof package	polymer bottles or polymer film bags	corrugated fibreboard boxes	
Phosphate	no special requirement	no special requirement	no special requirement	polymer drums or polymer bulk containers can be used as a single package
Sulfide				
Citrate				
Hexaboride				
[a] These products can be traded as a solid or in solution.				

4.3.3.2.2 Aqueous solutions

Many rare earth salts can be dissolved in water to form an aqueous solution, including chloride, nitrate, acetate and sulfate. A solution of rare earth salt is usually chemically stable and often acidic. It shall be kept in a corrosion-proof package. Polymer bottles or polymer bulk containers should be used for the inner package of smaller shipments. Corrugated fibreboard boxes should be used for the outer package. Polymer drums or polymer bulk containers are recommended as the single package for larger shipments.

4.3.4 Rare earth metal and alloy

Most rare earth metals and some of their alloys are chemically reactive. They can react with oxygen in the air and become oxidized on the surface. The reactivity varies greatly for different rare earth metals, and even for the same metal or its alloy depending on its physical form. Therefore, the packaging requirements are variable depending on the chemical characteristics. The rare earth metal or its alloy shall be sealed in a protecting gas atmosphere or in a vacuum. Instructions for the packaging of rare earth metals and their alloys are provided in Table 2.

Table 2 — Instructions for packaging of typical rare earth metals and their alloys

Type	Instructions for			Remarks
	inner packaging	intermediate packaging	outer packaging	
Rare earth metals and alloys in bulk (block, ingot/slab, wire and sheet)	polymer film bags or aluminized polymer bags	polymer film bags	steel drums or corrugated fibreboard boxes	Seal in an inner package in a protecting gas atmosphere, or in a vacuum, or in a protecting liquid; the pressure of the protecting gas shall be kept above atmospheric pressure or in a vacuum low enough to prevent degradation. Packaging for cerium (UN 1333) and ferro-cerium (UN 1323) shall take Reference [18] into account.

Table 2 *(continued)*

Type	Instructions for			Remarks
	inner packaging	intermediate packaging	outer packaging	
High purity rare earth metal	polymer film bags or aluminized polymer bags	not necessary	steel drums	Seal in an inner package in a protecting gas atmosphere, in a vacuum, or in a protecting liquid; buffer materials or packing materials should be put between the inner and outer packages.
High purity rare earth target product	polymer film bags	not necessary	steel drums	The product shall be thoroughly cleaned and dried in a vacuum; packaging is required in a vacuum for each product.
Rare earth magnesium alloy	polymer film bags	not necessary	steel drums	
Rare earth ferrosilicon alloy	polymer film bags	not necessary	steel drums	
Rare earth metals and alloys in powder form	polymer bottles or polymer film bags	polymer bottles, polymer film bags, aluminized polymer bags	steel drums, wooden/ plywood drums, or anti-static plastic bottles	Seal in a protecting gas atmosphere or in a vacuum to prevent the products from oxidation. All packaging should be anti-static.
Hydrogen storage alloy powder ($LaNi_5$, La_2Mg_{17}, etc.)	polymer bottles or polymer film bags	polymer film bags	steel drums	Seal in a protecting gas atmosphere or in a vacuum to prevent the products from oxidation.

5 Labelling

5.1 General principles of labelling

This clause specifies the minimum requirements for labels on packages containing rare earth products. Suppliers of rare earth ores, concentrates, compounds, metals, alloys and solutions shall follow the appropriate requirements.

Labels on packages of rare earth ores, concentrates, compounds, metals, alloys and solutions shall include the product and handling information in order to inform package handlers and, therefore, prevent accidents or environmental problems caused by the package being breached and its contents leaking. In addition, labels on packaging for rare earth ores and concentrates shall include information that will enable participants in the supply chain to determine the name of the supplier or source of the material. Both kinds of information shall be included in appropriate labels.

5.2 Product information

Labels on packaging for rare earth ores, concentrates, compounds, metals and alloys should include the following product information:

a) the name of the product: full name of the product and chemical/molecular formula;

b) the physical form of the product: solid (ingot/block/flake/powder) or liquid;

c) the production batch reference number: an indication noting different batches;

d) the gross mass/net mass: total mass of one package/net mass of each package inside

e) the date of production and, optionally, the date of packaging: using the YYYY-MM-DD format;

f) the name of the supplier: full name of the supplier, its abbreviation and address if possible;

g) the country of production: full name of the country or an acceptable abbreviation.

5.3 Requirements and recommendations for labelling of hazardous materials

5.3.1 General

Information or a symbol mark shall be used for those rare earth products listed as dangerous materials according to the regulations of the country of sale, as well as the relevant international organizations such as International Maritime Organization (IMO), International Air Transport Association (IATA), International Atomic Energy Agency (IAEA), United Nations (UN), and International Commission on Radiological Protection (ICRP). The rare earth products that are potentially dangerous, and requirements for their labelling, are provided in 5.3.2 to 5.3.4.

5.3.2 Cerium metal and cerium-containing flammable alloys

Cerium metal and some cerium-containing alloys (cerium content higher than 90 %) are flammable. Flammable indications shall be given on the label of the outer package.

5.3.3 Metals and alloys in the form of powder

Some rare earth metals and their alloy powders are flammable or even explosive, e.g. rare earth hydrogen storage alloy powder. Flammable/explosive indications shall be given on the label of the outer package.

5.3.4 Products containing radioactive elements

Some rare earth ores, mineral concentrates or other products, such as monazite, naturally contain thorium and uranium, and are therefore radioactive and can be potentially harmful to the health of human beings. In such cases, a radioactive indication shall be given on the label of the outer package.

5.4 Format of labels on packages

5.4.1 Product information

Labels on packages containing rare earth ores, concentrates, compounds, metals, alloys and solutions should be put on each outer package, and appropriate inner packages, such that they are readily visible. Indelible inks should be used in labelling.

5.4.2 Language

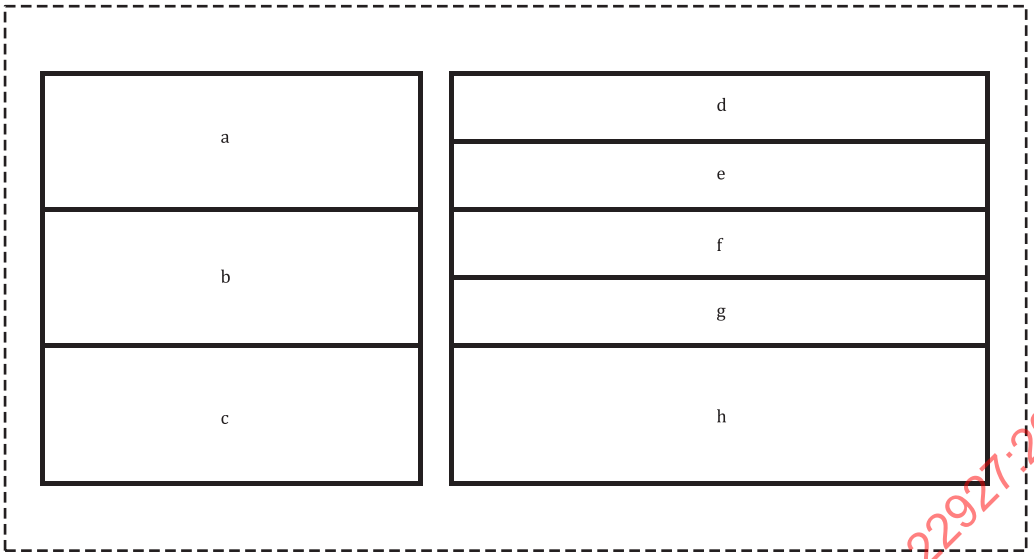
The information on the labels should be legible and provided in English or a language appropriate for the destination country. For international trading, the name of products and suppliers should be in English as well as the other language, if a language other than English is appropriate.

5.4.3 Quality of the label

Labels should be waterproof and corrosion-resistant and firmly affixed to the package.

5.4.4 Format of the label

Labels should include the product information (see 5.2). The information on the labels (as indicated in Figure 1) should be provided in English or a language appropriate for the country of sale. For international trading, the name of the product and the supplier (see key items a and f) should be in English as well as the other language, if appropriate. Key item h should meet the requirements given in ISO 7010 and Reference [20] if symbol marks for safety and protection are used.



Key

a name of the product
b physical form of the product
c production batch reference number
d gross mass/net mass
e date of production /optionally, date of packaging
f name of supplier
g country of production
h information text or symbol mark on safety and protection according to international or country-of-sale regulations

Figure 1 — Label format for a rare earth ore, concentrate, compound, metal, alloy or solution

Annex A
(informative)

Chemical characteristics of rare earth products

Tables A.1 to A.3 provide the chemical characteristics of rare earth products and the key information related to packaging and labelling.

Table A.1 — Rare earth ores and concentrates

Material	Key information related to packaging and labelling	Source of the information
Monazite-bearing ore	Monazite is a rare earth phosphate that typically contains 35 % to 78 % rare earth oxide (REO). Monazite is chemically very inert and only soluble in strong acid or alkali. Monazite usually also contains 5 % to 6 % ThO_2 corresponding to the radioactivity of 200 Bq/g, which does not include the radioactivity of daughter nuclides. Monazites from some sources can contain as little as 0,2 % ThO_2. U_3O_8 levels are typically less than 0,4 % corresponding to about 40 Bq/g, which does not include the radioactivity of daughter nuclides. Monazite is a concern because of the radiation emitted, the possibility of inhaling radioactive dust particles, and the inhalation of radioactive gas (^{220}Rn and ^{222}Rn) released by monazite. The radioactivity of monazite can impose packaging and labelling restrictions if the proportion of monazite, and its inherent radioactivity, in a shipment exceeds a certain level. Ores containing monazite will be radioactive in proportion to the amount of monazite in the ore and the activity of the monazite. Unprocessed ore generally does not contain a high level of monazite and it is possible that it will not be a concern.	References [15] and [16]
Monazite-bearing mineral concentrate	Monazite-bearing concentrate can be very high and contain close to 100 % monazite, although lower levels are more common. Radioactivity levels can be high and must be measured to allow selection of appropriate packaging and labelling.	
Xenotime and xenotime-bearing ore and mineral concentrate	Xenotime is a rare earth phosphate that typically contains about 54–65 % REO, often dominantly yttrium. Xenotime from some sources can contain Th-related activity of 60 Bq/g and U-related activity of 50 Bq/g. Although typically not as radioactive as monazite, the information provided about monazite is generally applicable. Xenotime is chemically very inert and only soluble in strong acid or alkali.	References [15] and [16]
NOTE This information can be applied to other rare earth-bearing minerals, depending on their thorium and uranium contents. This includes the mixed-type of ores and mineral concentrates.		

Table A.1 *(continued)*

Material	Key information related to packaging and labelling	Source of the information
Bastnaesite and bastnaesite-bearing ore and mineral concentrate	Bastnaesite is a rare earth fluorocarbonate that typically contains 58 % to 75 % REO. Bastnaesite concentrate and bastnaesite-monazite concentrate occurring in China and the United States can contain Th-related radioactivity of 3–10 Bq/g, but U-related activity is usually low, which does not include the radioactivity of daughter nuclides. Although typically not as radioactive as monazite, the information provided about monazite is generally applicable to bastnaesite-bearing ores and concentrates. Bastnaesite is chemically very inert and only soluble in strong acid or alkali.	References [15] and [16]
Loparite and loparite-bearing ore and mineral concentrate	Loparite is a rare earth fluorocarbonate that typically contains 28–37 % REO. Loparite can contain 0,5 % to 1 % ThO_2 and up to about 0,03 % U_3O_8 leading to Th-related radioactivity of 21 Bq/g and U-related activity of about 3 Bq/g. Although typically not as radioactive as monazite, the information provided about monazite is generally applicable to loparite. Loparite is chemically very inert and only soluble in strong acid or alkali.	References [15] and [16]
Ionic adsorption rare earth concentrate	Ionic adsorption rare earth concentrate is usually a mixture of REOs or carbonates which has been precipitated from a leach solution obtained from ionic adsorption ore and usually contains 90 % to 92 % REO. Ionic adsorption rare earth concentrate is soluble in acids. The total radioactivity is very low (below 1 Bq/g).	References [7], [11] and [16]
NOTE This information can be applied to other rare earth-bearing minerals, depending on their thorium and uranium contents. This includes the mixed-type of ores and mineral concentrates.		

Table A.2 — Rare earth compounds

Material	Key information related to packaging and labelling	Source of the information
Oxide	Rare earth oxides (REOs) are hygroscopic and can be hydrated or carbonated, or both, at room temperature or by heating in the air; the oxides can produce heat and swell when contacted with water. The REOs are soluble in acid and deliquesced.	References [7] and [19]
Carbonate	Rare earth carbonates react with acids to evolve carbon dioxide gas and can be decomposed by heating. The carbonates can contain crystallisation water.	References [7] and [19]
Chloride	Rare earth chlorides can generate chlorine gas by heating them to very high temperatures. The chlorides can agglomerate and are deliquescent, which can lead to the formation of a corrosive solution. The chlorides can contain crystallisation water and soluble in water; they can react with alkali, sodium sulfate or ammonium sulfate.	References [7], [9] and [19]
Hydroxide	Rare earth hydroxides can be decomposed by heating. The hydroxides are soluble in acid and carbonated in the air.	References [7] and [9]
Fluoride	Rare earth fluorides are chemically stable and hardly soluble in water.	Reference [19]