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Traceability of rare earths in the supply chain from mine to separated products

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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).

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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

0.1 General

The adoption of a traceability system is a strategic decision for an organization that can help provide a sound basis for a sustainable supply chain. A traceability system is a useful tool to assist an organization operating within a rare earth supply chain to achieve defined goals and objectives within their overall management system(s). The choice of how a traceability system is defined is influenced by regulations, product characteristics, and end user expectations. The complexity of the traceability system may vary depending on the nature of the product(s) within the supply chain, the sources of inputs, and the objectives to be achieved.

The implementation of a traceability system by an organization depends on:

- technical limits inherent to the supply chain organization and products (i.e. nature of the raw materials, size of the lots, collection and transport procedures, processing and packaging methods);
- the cost benefits of applying such a system,
- the characteristics of mining and processing, and
- the environmental impact, waste treatment and disposal processing.

The potential benefits of implementing a traceability system based on this document are:

- the ability to trace rare earth materials and products between mine and separated products;
- to reduce and prevent pollution;
- promotion of environmentally responsible and sustainable production of rare earths throughout the supply chain;
- to align a rare earth supply chain with sustainable development goals;
- to provide better service for users/customers by supplying quality product

This document can be used by all participants in the rare earth supply chain. However, it is not the intent of this document to require the need for:

- complete uniformity in the structure of traceability systems for different rare earth supply chains;
- alignment of documentation to the clause structure of this document;
- use of the specific terminology of this document within the rare earth supply chain.

In this document, the following verbal forms are used:

- “shall” indicates a requirement;
- “should” indicates a recommendation;
- “may” indicates a permission;
- “can” indicates a possibility or capability.

Information marked as “NOTE” is for guidance in understanding or clarifying the associated requirement(s).

0.2 Description

This document describes a traceability system covering the rare earth supply chain between the originating mine and separated rare earth products. This document is intended to give supply chain members the ability to access information relating to rare earth materials or products as they pass

through the supply chain. This information will include the identity of each business in the supply chain which has handled the rare earth material or product shipment. This document will thereby make it possible for the purchasers of separated rare earth products to identify the businesses in the supply chain that were involved in the production processes.

The types of businesses in the rare earth supply chain that are considered in this document are the following:

- a) Mines - in which rare earth-bearing minerals are i) extracted as ore from the ground in solid form by underground, open-pit or dredge mining methods, or, ii) extracted as a rare earth-bearing solution from the ground using in-situ leaching/recovery methods, or as a solution using heap or vat leaching methods,
- b) Beneficiation plants – in which solid ore containing rare earth minerals is processed to concentrate the rare earth minerals into one or more mineral concentrates,
- c) Hydrometallurgical plants – in which either, i) the rare earth minerals is an ore or beneficiation plant product are dissolved and the solution processed, or ii) an in-situ or heap leach or vat leach solution, is processed. In either case, the hydrometallurgical plant produces a relatively pure precipitated solid, or a concentrated solution, containing mixed rare earths and suitable as feed to a separation plant,
- d) Separation plants – in which mixed rare earth products from hydrometallurgical plants are separated into one or more relatively pure products each containing one or more specific rare earths to the substantial exclusion of other rare earths. Separation plant products are further processed into alloys, magnets, catalysts and other materials in downstream operations outside the rare earth supply chain considered herein,
- e) Traders, brokers, and wholesalers – entities that handle rare earths, generally the products of hydrometallurgical and separation plants, possibly re-package or blend material, but otherwise do not change the chemical or physical nature of the rare earth-bearing material,
- f) Transporters – businesses that move rare earth products between different businesses in the rare earth supply chain.

The connections between the businesses are illustrated in [Figure 1](#).

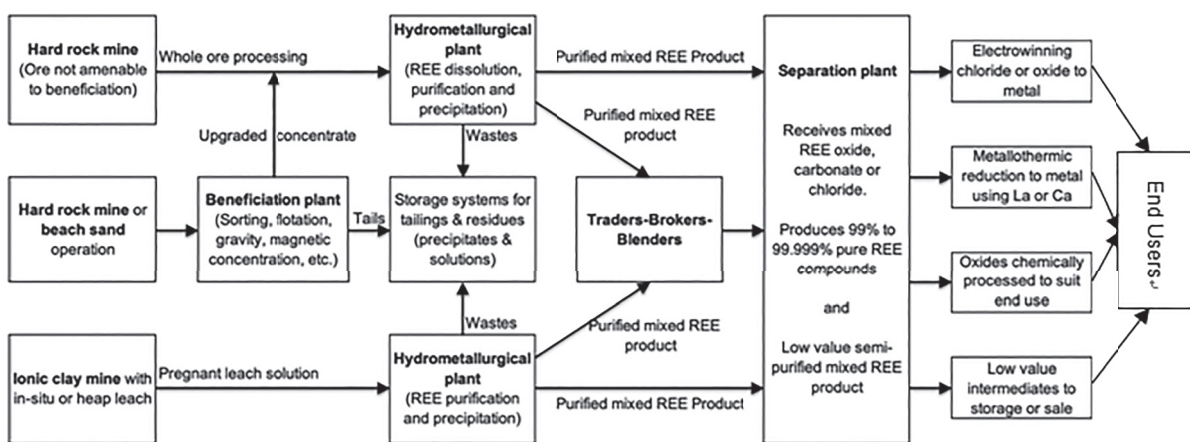


Figure 1 — Overview of rare earth supply chain: mine to separated products

It is recognized that some business entities conduct more than one of the above-mentioned activities either at a single site or at two or more sites. For example, it is common for a mine to own and operate a beneficiation plant, so its product is an upgraded concentrate rather than whole ore. It is also common for a mining company to additionally own and operate a hydrometallurgical plant to process its ore or mineral concentrate and so ship a purified mixed rare earth product to a separation plant or to a

trader. Traders may be involved in the supply chain as indicated but also in the marketing of mineral concentrates.

The scheme specified in this document does not demand perfect traceability. Pragmatically, it is recognized that there will be occasions where whole chain traceability of rare earth materials and products are neither possible nor commercially practical. Also, some supply chains may focus on certain rare earth elements rather than on the full suite of rare earth elements. For example, the focus may be on neodymium-praseodymium oxide (or NdPr oxides) which is a precursor material for NdFeB magnets versus total rare earth oxides (TREO). Thus, rather than providing full traceability for all the rare earth elements, some supply chains may choose to focus on this subset. These limitations and choices should be recognized and taken into consideration when auditing against this document and should not be taken as non-compliance of an otherwise compliant rare earth supply chain traceability system.

Not explicitly described in [Figure 1](#) is the process of rare earth recycling. Recycled rare earth materials could be inputs at several points in the supply chain model described in [Figure 1](#). It is recognized that recycling may comprise significant inputs or outputs for some rare earth supply chain nodes. By their nature, recycled materials are often difficult to trace back the origin of the rare earth materials such as a rare earth mine. Consequently, a percentage of the material in the supply chain may not be traceable back to a source. Thus, if recycling is an important input or output for a supply chain, it is the responsibility of the supply chain partners to define and disclose how recycling will be handled such that the overall objectives of the traceability system are met (see [Section 4.1](#)).

Given that rare earth supply chains operate within and between different countries and varying legal requirements, the documented information specifications in this document cannot stipulate all the requirements for every situation. A measure of flexibility is allowed for supply chain businesses to record further supplementary documented information, in their own non-standardized format, but keyed to the same documented information requirements specified herein.

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Traceability of rare earths in the supply chain from mine to separated products

1 Scope

This document specifies the requirements, and provides guidance, for the design and use of a traceability system when a rare earth supply chain needs to specify the information to be recorded by rare earth supply chain businesses during the passage of rare earth materials or products through the supply chain from mine to separated products.

The documented information will assist purchasers and suppliers of separated rare earth products to identify parties in the supply chain who process a given shipment of rare earth material, and the location of that rare earth material as it passes between supply chain nodes.

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 9000, *Quality management systems — Fundamentals and vocabulary*

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

ISO 22927,²⁾ *Rare earth — Packaging and labelling*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000, ISO 22444-1, ISO 22927 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

beneficiation plant

node that receives unprocessed ore from mines and produce a rare earth concentrate using various methods, such as, gravity or magnetic concentration, or froth flotation

3.2

confidential information

information related to product traceability that a company possesses that, although it might share with a counterparty, usually within a non-disclosure agreement, it does not wish to become public

Note 1 to entry: Confidential information might be considered as such by the possessor because of legal or business reasons.

1) Under preparation.

2) Under preparation.

**3.3
counterparty**

business or other entity that either supplies or receives rare earth-bearing material, to or from a given party

Note 1 to entry: A party's counterparties may be its supplier of rare earth-bearing material or product; or the customer to whom it supplies rare earth-bearing material or product.

**3.4
data matrix code
DM**

two-dimensional code that contains encoded data

Note 1 to entry: There are several data matrix systems in use including Quick Response (QR) code (see ISO 17367:2013), Portable Data File (PDF) 417 (see ISO 15438:2015), and Han Xin code (see ISO/IEC CD 20830).

**3.5
end product**

separated or partially separated rare earth product

**3.6
end user**

customer that buys and/or uses a rare earth separated product

**3.7
entity**

node that exists separately from other nodes and has a clear identity of its own

**3.8
hydrometallurgical plant**

node that receives ore from mines, or mineral concentrates from beneficiation plants, or solutions from in situ leach operations, extract rare earths from other elements by a series chemical and/or thermal processes, and generate a purified mixed rare earth concentrate

**3.9
node**

rare earth supply chain business and/or organization

EXAMPLE rare earth mine, beneficiation plant, hydrometallurgical plant, separation plant, and trading company, broker, or blender.

Note 1 to entry: Other nodes not identified in this document may also be considered as part of the traceability system if their contribution to the rare earth supply chain is substantial (e.g., sources of recycled rare earth materials).

Note 2 to entry: The movement between nodes is generally downstream although lateral movements are possible (e.g., from one separation plant to another, or upstream movement, such as the reprocessing of recycled material scrap sources of rare earths or off-specification rare earth material). The movement of material through a rare earth supply chain may include substantial holding periods while material is being warehoused or passing through a process with a long residence time.

**3.10
primary producer**

business or company involved in primary production of rare earth ores or materials

EXAMPLE rare earth mine, ionic clay processor.

**3.11
rare earth ore**

naturally occurring solid material containing rare earth minerals that can be commercially exploited

3.12**rare earth concentrate**

material containing rare earths, obtained by physical or chemical processes, and in the form of a solid or solution

Note 1 to entry: The concentrate might be obtained from an ionic clay deposit by in-situ dissolution followed by solution purification and precipitation of the rare earths or from an ore or concentrate by leaching followed by solution purification and precipitation of the rare earths.

3.13**rare earth material**

inputs to manufacturing processes containing rare earths used to produce products or more complex or refined materials containing rare earths

3.14**rare earth-containing material**

material in which the rare earth content is not the primary constituent

3.15**recycled rare earth material**

recycled magnets or industrial waste or scrap from rare earth permanent magnet manufactures, other rare earth end users, and rare earth end-of-life recyclers

Note 1 to entry: Includes end-of-life lamp phosphors, catalysts, or other waste streams containing significant concentrations of rare earths.

3.16**rare earth oxide**

compound that contains only rare earths and oxygen

Note 1 to entry: Generally, the formula for a rare earth oxide is RE_xO_y where x is 2 and y is 3.

Note 2 to entry: Three of the rare earth oxides have different formulae, specifically CeO_2 , Pr_6O_{11} , and Tb_4O_7 .

3.17**radio frequency identification****RFID**

use of a device (commonly referred to as an RFID tag) applied to or incorporated into a product for the purpose of identification and tracking using radio waves

3.18**separation plant**

receives purified mixed rare earth concentrate either directly from hydrometallurgical plants or from traders/brokers/blenders and separates the feed material into several purified rare earth products that are purchased by downstream businesses for the production of metal, alloys, magnets, ceramics, catalysts, etc.

3.19**ship-to-party**

person or business that receives goods or materials

3.20**transit time**

time taken between receipt of raw material or products and shipment of processed material or products

Note 1 to entry: The transit times for rare earths passing through beneficiation and hydrometallurgical plants may be in the order of days. However, the time from when rare earths enter a blending/broker/logistics facility or a separation plant to when the rare earths exit such a facility could be several months, for example,

— when warehousing of products with limited demand;