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Responsible Minerals Initiative
Blockchain Guidelines

DISCLAIMER
This document was developed by the Responsible Minerals Initiative (RMI) in collaboration with interested stakeholders. The Blockchain Guidelines are a living document that is continuously updated as feedback and comments are received.
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INTRODUCTION

Blockchain technology is increasingly tested and used as a tool to enhance transparency in mineral supply chains with a view to determine the point of origin of minerals and metals as well as obtain data relative to responsible mining practices.

Blockchain enabled solutions and projects to date are often applied by a relatively limited number of supply chain actors and lack a shared understanding of definitions, concepts and data attributes.

The RMI has developed these draft Blockchain Guidelines (herein “Guidelines”) to promote:

1. The common adoption of definitions and concepts in the application of blockchain enabled solutions in mineral supply chains.
2. Consensus on the fundamental data attributes to be included at each stage of the blockchain enabled solution in mineral supply chains.

The Guidelines are inspired by the success of RMI’s Conflict Minerals Reporting Template (CMRT) and particularly, the underlying data exchange standard IPC 1755. They are agnostic to the type of operations for mineral production, trade and processing as well as the mineral or metal itself.

Blockchain technology is one tool that may be used to enhance transparency in mineral supply chains, build trust and share data between supply chain actors. The technology does not replace the need for individual companies to conduct due diligence on their mineral supply chains.
SCOPE

The Blockchain Guidelines promote:

1. The adoption of shared definitions of terms and concepts related to mineral supply chains;
2. The development and adoptions of a unique identification system for mineral supply chain actors;
3. Consensus on fundamental data attributes necessary to identify supply chain actors and establish provenance for minerals and metals.

The Guidelines apply to any mineral or metal supply chain, any geography and any type of mineral / metal production. As such, the Guidelines include definitions for commonly used actors and processes in mineral supply chains. Users of the Guidelines are encouraged to use these as a basis for more specific terminology as it applies for each mineral / metal or supply chain.

This first version of the Guidelines focuses on the upstream mineral supply chain between the point of extraction and the smelter or refiner. Emphasis has been placed on mined material. The RMI will consider adding further detail on the downstream mineral supply chain as well as recycled material in a second version of the Guidelines.

The Guidelines do not define a blockchain protocol or application and do not standardize upstream data expected to be reported by supply chain actors regarding their due diligence and / or responsible mining practices.

BLOCKCHAIN GUIDELINES DEVELOPMENT

The RMI applies a phased process for the development of the Guidelines:

March – November 2018: Drafting of the first version of the Blockchain Guidelines. The RMI shared draft versions of the Guidelines with any interested stakeholder throughout the process. The RMI logged and responded to 88 comments from eight (8) stakeholder groups during the consultation. Feedback from three (3) additional stakeholders was directly incorporated in the draft text.

The RMI Blockchain Workgroup reviewed all revisions to the draft in response to comments received from external stakeholders.


Starting January 2019: In 2019, the RMI encourages organizations to test the implementation of the first version of the Blockchain Guidelines. Insights obtained through the testing of the Guidelines will inform a new revision round by the RMI to further develop and finetune the Guidelines.
APPLICABLE DOCUMENTS

The following documents can be used as references for the implementation of these Guidelines, to the extent specified herein. The revision of the document in effect at the time of solicitation shall take precedence.

1. International Organization for Standardization (ISO)
   3166-1 Codes for the representation of names of countries and their subdivisions – Part 1: Country codes
   3166-2 Codes for the representation of names of countries and their subdivisions – Part 2: Country Subdivision code
   8601:2004 Codes for the representation of data elements and interchange formats, information interchange, representation of dates and times

XXX ISO Chain of Custody Standard for the representation of terms and concepts related to the chain of custody of minerals, metals or products (under development)

2. Informative References

The following documents are for information purposes only. These documents are related to areas covered by the Guidelines but are not required for usage of the Guidelines. This list is non-exhaustive and for indicative purposes only. It is based on RMI’s current knowledge of publicly available resources and will be updated on an ongoing basis.

- IPC 1755
- Dodd-Frank Wall Street Consumer Protection Act, Section 1502
- RMI Smelter lists and CID unique identifiers
- GS1 Standards
- Minespider: Open Protocol for Supply Chain Due Diligence
- Origin Trail: First purpose built protocol for supply chains based on blockchain
- OECD Due Diligence Guidance for Responsible Mineral Supply Chains from Conflict-Affected and High Risk Areas
- OECD Due Diligence Guidance for Responsible Business Conduct
- Global Reporting Initiative, Guidance on Due Diligence Reporting (under development)
CORE PRINCIPLES

These Guidelines are not intended to limit the development of Blockchain protocols / applications for mineral supply chains. However, the RMI believes that the relevance of blockchain enabled solutions to support company supply chain due diligence is strengthened by:

1) their adherence to common definitions, data format rules and a shared identification system for supply chain actors;
2) their ability to transfer data between different blockchain applications;
3) their ability to generate positive impact for supply chain actors and local communities in mineral producing countries.

Blockchain enabled solutions in mineral supply chains are encouraged to integrate the following core elements in their design and implementation:

- The blockchain enabled solution shall meet applicable legal requirements.
- The blockchain enabled solution shall be decentralized, whereby “decentralized” refers to the absence of a single place where data is aggregated or controlled.
- The blockchain enabled solution shall be interoperable, whereby interoperability refers to the ability to transfer data between blockchain applications.
- Supply chain data shall be self-sovereign, meaning no actor on the platform should be able to access supply chain data they do not own, or have not been provided access to by the owning actor.
- A governance model or consensus mechanism that includes adequate considerations on how to protect the application against attacks.
- Due consideration shall be taken for the impact and burden of implementation on all supply chain actors.
- Where possible and appropriate, apply existing global standards covering the areas of relevance to these Guidelines. Areas of relevance include, but are not limited to:
  - Data exchange
  - Restrictions for hazardous substances
  - Supply chain due diligence
  - Responsible business conduct
  - Responsible mining practices
- Be accessible to large, medium and small actors (where appropriate) to enter accurate data. At a minimum, and where applicable, ensure that artisanal and small scale miners are not excluded from the supply chain due to reduced access to technology and education.
- Account for the recording of individual transactions and a mass balance approach.
- Support a controlled reconciliation procedure to ‘adjust’ transactions where discrepancies have been reported, investigated and successfully reconciled. The procedure shall use the same consensus mechanism as applied to the initial data set.

DEFINITIONS

1 Examples of existing standards in some of these areas are included in the section on “Informative References” of these Guidelines.
Annual Production Volume: The annual production volume is defined as the estimated total weight of mineral ore, defined using the International System of Units (SI) at least to the first decimal place, extracted over the period of one calendar year. The estimate may be based on different sources, including, but not limited to, geological studies or previous production volumes.

Application: For the purpose of these Guidelines, the term “application” refers to a customized product leveraging blockchain technology and built on top of a blockchain protocol to facilitate a certain type of data and/or value transfer.

Attribute: A piece of information which determines the properties of a field or tag in a database or a string of characters in a display.

Batch: A specific quantity of mineral ore or concentrate that is identified using a unique identifier assigned to it (e.g. bar code, unique reference number, RFID tag or other identifier). A batch may be in bulk or contained in a bag, barrel or other container.


Blockchain: A distributed ledger technology used to synchronise digital records across multiple locations, which relies upon cryptography to confirm transactions.

Blockchain Event: An event that occurs in the supply chain and is recorded on the blockchain.

Blockchain Protocol: For the purpose of these Guidelines, the term “protocol” refers to the set of rules that govern a blockchain network, including but not limited to, a consensus mechanism, transaction validation, economic incentives and participation.

Calculated Metal Weight: The weight of the metal as calculated using the weight of the mineral and the estimated or measured metal grade defined using the International System of Units (SI).

Chain of Custody: To be added

Concentrating of ore (beneficiation): Beneficiation is the improvement of the grade of ore by milling, floatation, sintering, gravity, concentration, or other process. (Source: The Life Cycle of a Mineral Deposit—A Teacher’s Guide for Hands-On Mineral Education Activities, 2005. Appendix 1.—Glossary)
**Concentrator:** An individual or company that concentrates ore.

**Control point:** Per the OECD Guidance, “identified points in the supply chain” are required to carry out an independent third-party audit. For the purpose of these Guidelines, “identified points” are referred to as “control points” and may include:

1) key points of transformation in the supply chain
2) stages in the supply chain that generally include relatively few actors that process a majority of the commodity
3) stages in the supply chain with visibility and control over the mineral production and trade
4) key points of leverage over mineral production and trade

(Source: Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains)

**Downstream:** For the purpose of these Guidelines “downstream” includes any supply chain actor or entity that is not “upstream”.

**Due Diligence:** An on-going, proactive and reactive process through which companies can ensure that they respect human rights and do not contribute to conflict (Source: OECD Guidance)

**Due Diligence Data:** For the purpose of these Guidelines, “due diligence data” refers to any qualitative or quantitative data associated with a profile or a transaction and that is used to demonstrate conformance with the OECD Guidance.

**Export:** The process of sending mineral containing substances or products from one country to another country.

**Extraction:** The process to separate the mineral ore from the mineralized rock. The extraction takes place at the mine. The extraction process may include basic processes to wash, crush or otherwise remove gangue material and impurities from the mineral ore.

**Grade:** The quantity of metal or metal substances (e.g. oxides, sulphides or silicates) in a sample of mineral ore; normally expressed as a percentage of the total weight. (Source: ICGLR Certification Manual, Definitions)

**Import:** The process of receiving mineral containing substances or products from another country.

**Manufacturer:** For the purpose of this Guidelines, a manufacturer refers to a company that makes products and where the metal is added into a product and / or a product containing metals is further processed or assembled.

**Mass balance:** To be added

**Metal:** A class of chemical elements, that have a characteristic luster, are good conductors of heat and electricity, and are opaque, fusible, and generally malleable and ductile. (Source: The Life Cycle of a Mineral Deposit—A Teacher’s Guide for Hands-On Mineral Education Activities, 2005. Introduction)
Metal Weight: The weight of the metal at the stage of smelting, refining, alloying or manufacturing, defined using the International System of Units (SI) at least to the first decimal place.

Mine: The source of a mineral and the point of extraction of the mineral, to the greatest possible specificity.

Mine Location: The GPS coordinates of the point of extraction.

Mineral: A mineral is a naturally occurring inorganic chemical substance\(^2\) which can be contained in an ore or concentrate of that ore. The mineral is usually extracted from the ore sequentially through mining, concentrating and then smelting/refining.

Mineral Weight: The weight of the mineral at the stage of extraction, handling, trading or transporting before the smelting or refining process, defined using the International System of Units (SI) at least to the first decimal place.

Mineral By-product: A material produced while mining or processing another material, not the primary intended product but nevertheless a separate useful material. (Source: OECD Guidance, Gold Supplement)

Mineral Concentrate: A mineral that has undergone primary treatment to increase metal content and will undergo further chemical or metallurgical processing before use.


Origin: For the purpose of these Guidelines, the origin of metal or minerals is defined as follows:

- The mine where the mineral or metal is extracted (see also: “point of extraction” and “mine”) for primary material;
- The point where the mineral or metal is returned to a smelter or other downstream intermediate processor or recycler for recycled / scrap material;
- The point where the mineral or metal is extracted and refined from the final residue of the primary material for by-products.

(Source: OECD Guidance, Gold Supplement)

Ownership: The ultimate and exclusive right conferred by a lawful claim or title, and subject to certain restrictions to enjoy, occupy, possess, rent, sell, use, give away, or even destroy an item of property.

(Source: Business Dictionary)

\(^2\) Source: Oxford English Dictionary
Plausibility: The comparison of the estimated annual production volume of a point of extraction with the actual volume produced over the same period.

Point of Extraction: The point of extraction may be the mine pit or the mine site, depending on the type of mining operations.

Possession: The exclusive control and use of, a material object or property resulting from the fact of holding it (whether rightly or wrongly) in one's power. (Source: Business Dictionary)

Product: Any substance, material, sub-part, part, sub-assembly, or assembly up to a completed original manufacturer’s assembly that is the subject of a declaration. A product can also be referred to as a “good”. (Source: IPC 1755 Standard)

Product Information: The product object is an identification of a product or group of products to which information is associated. Each product object may represent one or more products as defined in the product ID fields.

The product object may contain a single product number, multiple product numbers, or a single product number representing an entire family of products. The requester and supplier are advised to clarify the correspondence between requester product identification and supplier product identification to ensure that supplier information associates correctly with requester product numbers. (Source: IPC 1755 Standard)

Profile: The entirety of data attributes associated with a single unique identifier.

Recycled / scrap material: Reclaimed end-user or post-consumer products, or scrap processed metals created during product manufacturing. Recycled metal includes excess, obsolete, defective, and scrap metal materials which contain refined or processed metals that are appropriate to recycle in the production of tin, tantalum, tungsten and/or gold. Minerals partially processed, unprocessed or a by-product from another ore are not recycled metals. (Source: OECD Guidance)

Responsible Mining: For the purpose of these Guidelines, “responsible mining” seeks to ensure the extraction of minerals and metals balances the delivery of economic and social benefits to host communities and nations, respect for the environment while providing financial returns to investors. Success in achieving this balance lies in the concept of ‘sustainable development’ whereby the needs of the present are met without compromising the ability of future generations to meet their own needs. The focus of responsible mining is on how mining, minerals and metals can contribute to sustainable development, even after an operation closes. (Source: International Council for Mining and Metals)

Responsible Mining Data: For the purpose of these Guidelines, “responsible mining data” refers to any qualitative or quantitative data associated with a profile or a transaction and that is used to demonstrate responsible mining practices.

Smelter: A smelter or refiner company is a company that procures and processes mineral ore, slag, metal concentrate and/or materials from recycled or scrap sources into refined metal or metal

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containing intermediate products. The output can be pure (99.5% or greater) metals, powders, ingots, bars, grains, oxides or salts. The terms “smelter” and “refiner” are used interchangeably throughout various publications. For clarification purposes, within this standard they will be referred to as a “smelter”. (Source: IPC 1755 Standard) A smelter may also be a mineral importer and / or a metal or product exporter.

**Supply Chain Actor:** For the purpose of these Guidelines, a supply chain actor is any individual or business entity that produces, transports, trades, processes or otherwise handles minerals or metals.

**Traceability: To be added**

**Trader:** An individual or company that buys and sells mineral containing substances or products without altering their physical or chemical state. This may include mineral, metal or product importers or exporters. (Source: RMI SnTa Smelter Standard).

**Transaction:** For the purpose of these Guidelines, the term “transaction” refers to the transmission of ownership and / or possession of mineral(s), metal(s) or product(s) from one unique single identifier to another unique single identifier.

**Transaction Time:** Time time at which the transaction occurred and/or was lodged, including time/zone indicators, consistent with ISO 8601.

**Transformation:** The altering of the properties of the mineral or metal using extraction, chemical and / or metallurgical methods.

**Transporter:** An individual or company that transports mineral containing substances or products without altering the physical or chemical state of the mineral. A transporter does not take ownership of the minerals in its custody.

**Upstream:** For the purpose of these Guidelines, upstream means the mineral supply chain from the mine to smelters/refiners. “Upstream” include miners (artisanal and small-scale or large-scale producers), local traders or exporters from the country of mineral origin, international concentrate traders, mineral re-processors and smelters/refiners. (Source: OECD Guidance)
FUNDAMENTAL ATTRIBUTES

This section defines core concepts and the fundamental attributes required to identify each supply chain actor in a mineral supply chain as well as to establish the origin for each transaction of minerals or metal that is traded on the blockchain. The Guidelines do not define the type due diligence or responsible mining data that may be uploaded to the blockchain.

In order to identify each supply chain actor, as well as to establish the origin for each transaction of minerals or metals, the Guidelines are based on the following main concepts:

1. Single Unique Identifier (ID)

Mineral supply chains are composed of individuals and / or business entities involved in the production, processing, transporting, trade or handling of minerals or metals. Each entity is defined by the type of business operation(s) it is involved in. The single unique identifier allows the linkage of the entity to other data system, as long as these equally refer to the single unique identifier. The single unique identifier further allows the linkage of individual transactions of minerals, metals, scrap or products from one entity to another.

Each entity that owns or possesses the mineral, metal, scrap or product shall be assigned a unique identifier. The identifier shall be automatically assigned by an established identification system and linked to either a single location, individual or business. The unique identifier will be fixed for the entity and may only be changed if there is a change to the entity’s business operations impacting the ownership and / or possession of the mineral, metal or product.

It is expected that multiple names or aliases could be used to describe a single location, individual or business and therefore multiple names or aliases could be associated to a single unique identifier. (Source: IPC 1755)

A single unique identifier may be linked to one or multiple supply chain elements (e.g. an exporter identifier can be associated with extraction, transport, trading and export). Each single unique identifier is associated with a profile, which includes all the supply chain elements associated with the single unique identifier.
2. Profile

Each single unique identifier is linked to a profile. The profile includes fundamental attributes to determine the type of business operation(s) as well as the mineral(s) or metal(s) associated with the entity.

At a minimum, each profile should include the following attributes:

- The single unique identifier;
- All supply chain elements carried out by and associated with the single unique identifier (refer to Tables 1 and 2 in the section on Supply Chain Elements);
- Each transaction associated with the single unique identifier;
- The metal name(s).

Entities requiring single unique identifiers (ID):

**Mine ID**: A unique identifier assigned to a single mine location according to an established mine identification system. Each mine ID is expected to be linked to a mine pit or mine site location, specified by GPS coordinates.

**Transporter ID**: A unique identifier assigned to a single individual or business according to an established transporter identification system.

**Blender ID**: A unique identifier assigned to a single location according to an established blender identification system.

**Concentrator ID**: A unique identifier assigned to a single individual or business according to an established concentrator identification system.

**Smelter ID**: A unique identifier assigned to a single smelter or refiner location according to an established smelter and refinery identification system. The established smelter and refinery identification system most commonly used is the Smelter Identification Number using CID and a six-digit number.

**Trader ID**: A unique identifier assigned to a single individual or business according to an established trader identification system.

**Exporter ID**: A unique identifier assigned to a single individual or business according to an established exporter identification system.

**Importer ID**: A unique identifier assigned to a single individual or business according to an established importer identification system.

**Manufacturer ID**: A unique identifier assigned to a single manufacturer location according to an established manufacturer identification system.
3. Transaction

A transaction involves at least two profiles as the ownership and/or possession of the mineral, metal, scrap or product is transmitted from one entity with a unique single identifier to another.

Each transaction recorded shall be linked, at any point in time, to a single unique identifier for ownership and a single unique identifier for possession.

The transaction may be linked to two single unique identifiers where the entity that owns the mineral, metal or product is not the same than the entity that possesses the mineral, metal or product. The transaction may be linked to one single unique identifier where the ownership and possession of the mineral, metal or product overlap. For example:

- Material ownership may be transferred with the possession of the mineral, metal or product;
- Material ownership may be transferred without a change in the possession of the mineral, metal or product (e.g. where minerals are already in the custody of a refiner after assaying/appraisal); or
- Possession of the mineral, metal or product may be transferred without a change in material ownership (e.g. in tolling agreements, transportation or storing).

At a minimum, each transaction should include the following attributes:

- A hash unique to the transaction
- The single unique identifier at the beginning of the transaction
- The single unique identifier at the end of the transaction
- Primary metal name

In addition, each transaction should include the following attributes for:

Upstream supply chains:
- Grade (based on assay or estimates)
- Mine location
- Ore/concentrate weight (wet or dry)
- Calculated metal weight
- Export documentation complete (if required)

Downstream supply chains:
- Product information

4. Blockchain Events

At a minimum, the following events are expected to be recorded on the blockchain:

- A change in ownership of the mineral, metal or product;
- A change in possession of the mineral, metal or product;
- A change to the fundamental attributes associated with the single unique identifier;
- A change to the fundamental attributes associated with the profile.
5. Transformation

Minerals and metals may be transformed using extraction, chemical and/or metallurgical methods. Material may also be blended, disaggregated, transported or traded without any transformation of the mineral or metal itself.

Each transformation of the mineral, metal or product is expected to be carried out within defined parameters. Minerals, metals or products that undergo a transformation need to ensure incoming transactions are linked to outgoing transactions. Supply chain elements concerned are defined in Tables 1 and 2.

Transformation parameters may be entered manually to the blockchain and include the following possibilities:

- **Single transaction traceability:**
  Direct link between one incoming transaction unique identifier and one outgoing unique identifier. Such linkage could be verified by production records.

- **Batch traceability:**
  Direct link between multiple incoming transactions unique identifiers to one outgoing transaction unique identifier (a batch); or
  Direct link between one incoming unique identifier (a batch) to multiple outgoing transaction unique identifiers; or
  Direct link between multiple incoming transaction unique identifiers (a batch) to multiple outgoing transaction unique identifiers (a batch).
  Such linkage could be verified by production records.

- **Mass balance approach:**
  In the mass balance approach there is no direct link between incoming and outgoing unique identifiers. This approach serves to demonstrate that an equal volume of minerals or metals is received from the blockchain prior to the transformation and is returned to the blockchain after the transformation, subject to the transformation parameters.

  E.g. A smelter may purchase 10 tonnes of mineral concentrate via the blockchain solution. The concentrate has a metal concentration of 40 percent.
  Following the smelting process, and based on the transformation parameters defined for the type of metal and type of operations of the smelter, the smelter may enter 4 tons of refined metal of a grade of 99 percent or higher on the blockchain.

Parameters for acceptable material losses (actual or estimated) during transformation may be defined by blockchain participants, subject to the governance model or consensus mechanism.
SUPPLY CHAIN ELEMENTS

This section provides an overview of commonly identified supply chain entities, based on the types of business operations. Tables 1 and 2 demonstrate typical inputs and outputs for each supply chain entity and indicate whether the mineral or metal is expected to undergo a transformation. This section is intended as a resource to identify the main entities that would require a single unique identifier as well as the types of transactions commonly associated with each type of business operations. It is non-exhaustive and for indicative purposes only.

Table 1 summaries the main elements in mineral supply chains where minerals, metals or scrap are processed between the point of extraction and the integration of a metal product into the product manufacturing process:

<table>
<thead>
<tr>
<th>SUPPLY CHAIN ELEMENTS WITH TRANSFORMATION</th>
<th>Extraction</th>
<th>Concentration</th>
<th>Smelting</th>
<th>Refining</th>
<th>Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>The process to separate the mineral ore from the mineralized rock. The extraction takes place at the mine. The extraction process may include basic processes to wash, crush or otherwise remove gangue material and impurities from the mineral ore. The extraction process is the first point where the mineral grade can be determined for a transaction of mineral ore.</td>
<td>The process to improve the grade of ore by milling, floatation, sintering, gravity, concentration, or other process. The concentration of the mineral to increase the percentage contained of metal by weight. Concentration may occur at different stages in the supply chain, typically at the mine or at the export level in the mineral producing country.</td>
<td>Smelting refers to the chemical or metallurgical process to extract metal from the mineral ore, slag, metal concentrate and/or materials from recycled or scrap sources. Smelting takes place at a smelter and may or may not include refining of the mineral.</td>
<td>Refining is the process to purify metal with a view to increase the grade. Refining can be a multi-stage process and may or may not include smelting of the mineral.</td>
<td>For the purpose of this Guidelines, manufacturing involves two stages: 1) the addition of metal into a product; or 2) the further processing or assembling of a product containing metals. The metal does not undergo any treatment during this process.</td>
</tr>
<tr>
<td>Main Single Unique Identifiers</td>
<td>Mine ID</td>
<td>Mine ID</td>
<td>Smelter ID</td>
<td>Smelter ID</td>
<td>Manufacturer ID</td>
</tr>
<tr>
<td>Ownership Change</td>
<td>Yes or No</td>
<td>A change of ownership is possible where a mine is owned and operated by two different parties.</td>
<td>Yes or No</td>
<td>A change of ownership is possible where concentration may be carried out by a third party.</td>
<td>Yes</td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Possible Linked Single Unique Identifiers</td>
<td>Exporter ID</td>
<td>Concentrator ID Exporter ID</td>
<td>Importer ID</td>
<td>Importer ID</td>
<td>Exporter ID</td>
</tr>
<tr>
<td>Input</td>
<td>Mineralized rock</td>
<td>Mineral Ore</td>
<td>Different inputs are used including mineral ore, mineral concentrate and recycled / scrap material</td>
<td>Different inputs are used including metal products obtained in the smelting process and recycled / scrap material</td>
<td>Metal or other product containing metal</td>
</tr>
<tr>
<td>Output</td>
<td>Mineral Ore</td>
<td>Mineral concentrate</td>
<td>Different forms of metal products</td>
<td>High purity metal</td>
<td>Product containing metal</td>
</tr>
<tr>
<td>Transformation Parameters</td>
<td>The outgoing transaction must be linked to all the incoming transactions used to produce it.</td>
<td>The outgoing metal transaction must be linked to all incoming transactions used through a mass balance approach, batch or single transaction traceability.</td>
<td>The outgoing product information must be linked to all incoming transactions used through a mass balance approach, batch or single transaction traceability.</td>
<td>The outgoing product information must be linked to all incoming transactions used to produce it.</td>
<td></td>
</tr>
</tbody>
</table>
Table 2 summarizes the main supply chain elements associated with the handling, trade and transport of minerals, metals, scarp or products where the material does not undergo a chemical or metallurgical transformation:

**Table 2: Supply Chain Elements without Transformation**

<table>
<thead>
<tr>
<th>SUPPLY CHAIN ELEMENTS WITHOUT TRANSFORMATION</th>
<th>Blending</th>
<th>Transportation</th>
<th>Trade</th>
<th>Disaggregation</th>
<th>Export</th>
<th>Import</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>The process of mixing ores or concentrates of varying quality with fluxes or to mix different secondary raw materials, to produce a stable and homogeneous feed.</td>
<td>The physical movement mineral containing substances from one point to another in the supply chain, without altering the physical or chemical state of the mineral. A transporter does not take ownership of the minerals in its custody.</td>
<td>The buying or selling of mineral containing substances, without altering their physical or chemical state. Trade may include other supply chain elements, such as for example aggregation or concentration.</td>
<td>The process of disaggregating a larger batch of mineral ore or mineral concentrate into smaller batches. Previously aggregated mineral ore or mineral concentrate may be mixed with new mineral ore or mineral concentrate batches during the process. The mineral ore or concentrate are not subject to any treatment during this process.</td>
<td>The process of sending the mineral, metal or product from one country to another country. Legal ownership is often transferred from the entity in the exporting country to the entity in the importing country during this process.</td>
<td>The process of receiving the mineral, metal or product from another country. Legal ownership is often transferred from the entity in the exporting country to the entity in the importing country during this process.</td>
</tr>
<tr>
<td><strong>Main Single Unique Identifiers</strong></td>
<td>Blender ID</td>
<td>Transporter ID</td>
<td>Trader ID</td>
<td>Trader ID</td>
<td>Exporter ID</td>
<td>Importer ID</td>
</tr>
<tr>
<td><strong>Ownership Change</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Possible Linked Single Unique Identifiers</strong></td>
<td>Mine ID</td>
<td>Mine ID</td>
<td>Exporter ID</td>
<td>Blender ID</td>
<td>Trader ID</td>
<td>Trader ID</td>
</tr>
<tr>
<td></td>
<td>Exporter ID</td>
<td>Blender ID</td>
<td>Trader ID</td>
<td>Exporter ID</td>
<td>Blender ID</td>
<td>Trader ID</td>
</tr>
<tr>
<td>Input</td>
<td>Importer ID</td>
<td>Smelter ID</td>
<td>Min. ore or concentrate</td>
<td>Min. ore, mineral concentrate, metal or product</td>
<td>Min. ore, mineral concentrate, metal or product</td>
<td>Min. ore, mineral concentrate, metal or product</td>
</tr>
<tr>
<td>-------</td>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Output</td>
<td>Importer ID</td>
<td>Smelter ID</td>
<td>Min. ore or concentrate</td>
<td>Min. ore, mineral concentrate, metal or product</td>
<td>Min. ore, mineral concentrate, metal or product</td>
<td>Min. ore, mineral concentrate, metal or product</td>
</tr>
<tr>
<td>Transformation Parameters</td>
<td>N/A</td>
<td>N/A</td>
<td>The outgoing transaction must be linked to all the incoming transactions used to produce it.</td>
<td>N/A</td>
<td>The outgoing transaction must be linked to all the incoming transactions used to produce it.</td>
<td>N/A</td>
</tr>
</tbody>
</table>
APPENDIX 1: MATERIALS’ FLOW

Material supply chains vary in their structure and complexity. To support this Guidelines, this Appendix provides simplified examples of simple and complex mineral supply chains as well as simplified supply chain examples for selected minerals.

The Appendix serves to inform users about common supply chain structures and how these are linked to the single unique identifiers. It is non-exhaustive and for indicative purposes only.

Figure 1: Simple Supply Chain Example

Example of a simple supply chain:

- Extraction / Concentrator / Exporter (Mine ID / Exporter ID)
- International Transportation (Transporter ID)
- Importer / Smelter / Refiner (Importer ID / Smelter ID)
- Domestic / International Transportation (Transporter ID)
- Manufacturing (Manufacturer ID)

Figure 2: Complex Supply Chain Example

Example of a complex supply chain:

- Extraction (Mine ID)
- Local Transportation (Transporter ID)
- Local Trader / Market (Trader ID)
- Regional Transportation (Transporter ID)
- Concentrator / Exporter (Exporter ID)
- International Transportation (Transporter ID)
- Importer (Importer ID)
- Smelter / Refiner (Smelter ID)
- International Trader (Trader ID)
- Domestic / International Transportation (Transporter ID)
- Manufacturing (Manufacturer ID)
- Tolling / Outsourcing / External Storage

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Specific Material Supply Chains

1. Tantalum
   Figure 3: Simplified tantalum value chain

   **Primary processor:** potassium tantalum fluoride (\(K_2\)TaF\(_7\) or "K-Salt"), tantalum oxide (Ta\(_2\)O\(_5\)), tantalum chloride (TaCl\(_5\)), tantalum carbide (TaC)

   **Finished products:** electronics industry, capacitors, cutting tools, super alloys

   **Primary materials:** Tantalite, tantalum concentrate

   **Secondary Processor:** 'K-salt', high purity oxides, tantalum metal powder, metal products (tubes, wires)

   (Source: Tantalum and Niobium International Study Center (TIC), accessed on: https://www.tanb.org/about-tantalum)

2. Tin
   Figure 4: Simplified tin value chain

   **Primary materials:** Cassiterite ore or concentrate

   **Processed materials:** Refined tin (99.9%)

   **Semi-finished products:** Alloys, plates, sheets, chemicals

   **Finished products:** Electronics (solder), packaging (tin plates), PVC stabilizers, steel sheets

3. Tungsten

Figure 5: Simplified tungsten value chain


4. Gold

Figure 6: Simplified value chain of gold

5. Cobalt

Figure 7: Simplified cobalt value chain