Experiences from the non-ferrous metal industry in establishing substance sameness

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Inorganic UVCBs: background

- UVCBs defined according to ECHA guidance, variability is driver
- Complex materials that contain varying concentrations of metals, metal compounds and/or minerals (often composed of 10 or more constituents)
- Intermediates: substances transformed into another substance(s)
- Restricted life cycle, including manufacturing, transformation into other substance (=use)
- Often complex, interlinked material flows, e.g.
  - metal matte converted into blister/anode
  - slimes from copper production used as raw material to produce precious metals
  - bleeds, dust, etc., recycled and reverted back to various metal productions

→ Who can register together?
Primary sources
- Metal ore
- Metal concentrate

Secondary sources
- Dusts
- Secondary Metal material
- Metal Slags
- Metal Residues
- End-of-life materials (recyclables like e.g. catalysts, piping, metal containing substrates, ...)
- .....
Metal refining processes - examples

**Primary mix:**
- Copper ores conc.
- Fluxes
- Secondary Cu materials
- Dusts, etc

**Secondary mix:**
- Slags
- Different residues
- Copper iron
- Dusts, etc

**Additional inputs:**
- Materials

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**Matte Smelting**

**Secondary Smelting**

**Converting**

**Fire-refining & anode casting**

**Electrolytic Refining**

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**Example: Copper production**
Example: Precious metal production
SIEFs formation: start

• Started approximately 3 years before registration deadline

• Working Groups:
  - Regrouped major metal manufacturers around the table
  - Technical people, rather than marketing
  - History in cooperation under NFM BREF & ESR exercises

• Tools: questionnaires, flow sheets, decision trees, existing inventories
Example of early stage decision criteria

Is the material resulting from the copper production?
- E.g. Copper cement

Does the material contain copper?
- E.g. Gypsum

Is the material a Copper compound?
- E.g. Copper sulphate

Is the material a copper intermediate?

As appropriate:
Contact other consortium. Discuss best home
Further decision steps for complex substances (1)

• Starting point were always the commonalities:

- Reaction/vessel producing the substance?
  - Align to NFM BREF description and terminologies
  - E.g. smelting, electro refining, ....

- Name of the substance?
  - Marketing name
  - EINECS name and number

- Life cycle of the substance?
  - Company material streams
  - Input materials (transfer, handling), production (chemical reaction), storage and transfer until transformation process (into other substance)
Further decision steps for complex substances (2)

• Refinement of the initial clustering:
  ▫ Based on expert considerations:
    — E.g. matte and slag, slag and scale
  ▫ Based on additional testing
    — E.g. flue dust from primary smelter and flue dust from secondary smelter, flue dust from smelting and flue dust from converting

• Setting rules for further cooperation work
  — Agree on common terminology
  — Agree on a generic production and life cycle of the substance
  — Agree on common EC name and description (eventually improved)
SIEFs formation

• Steps
  ▫ Exchange of (non-confidential) information on company process flows (source, process)
  ▫ Exchange information on company specific compositions (elemental + speciation) – with secretariat, on confidentiality basis
  ▫ Establish list of existing EINECS entries and other existing substances/product definitions (e.g. LME)
  ▫ Development of Generic process flows to identify occurrence of different UVCBs – focus on commonalities!
  ▫ Overlap with other consortia’s scopes identified and discussed
Generic process flow: example

As from existing reference handbooks, etc.
- e.g. NFM BREF - Best Available Technologies
Challenges & solutions

1. Avoid overlap with other (metal) consortia
   a. Case of non-precise EINECS descriptions

   E.g. Doré

   Original EINECS description: Gold and silver bullion

   Description proposed by PMC: Metallic bars/ingots, grains or anodes and their residues (spent anodes) resulting from pyro-metallurgy processes applied on primary and secondary feeds with high precious metal content. Doré mainly contains silver and/or gold and copper, lower quantities of platinum group metals (iridium, osmium, palladium, platinum, rhodium, and ruthenium) and other non-ferrous metals in varying concentrations.

   -> New description added to dossier as description in the EINECS inventory does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (UVCB description should mention starting materials, production process step(s) and known main constituents)
Challenges & solutions

b. Case of multi purpose EINECS

E.g. Copper, dross

ESIS (European chemical Substances Information System).

Produced during copper manufacturing?

Produced during lead manufacturing?

A dross mainly containing Copper?

 resulted for EC#: 305-408-5

<table>
<thead>
<tr>
<th>General Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC#                  : 305-408-5</td>
</tr>
<tr>
<td>CAS#                 : 94551-59-4</td>
</tr>
<tr>
<td>Substance Name       : Copper, dross</td>
</tr>
<tr>
<td>De                   : Kupfer, Schrotte</td>
</tr>
<tr>
<td>Es                   : Cuivre, escarre</td>
</tr>
<tr>
<td>Fr                   : Cuivre, escarre</td>
</tr>
<tr>
<td>Molecular Formula    : Not available</td>
</tr>
<tr>
<td>Description          : Not available</td>
</tr>
</tbody>
</table>

Structural Formula:
Not available

Biocidal Products Directive (Directive 98/8/EC) Information:
There is no information in ESIS for this substance with respect to the BPD.

Classification and Labelling Information:
This substance is not classified in the Annex I of Directive 67/548/EEC.
Export and Import of Dangerous Chemicals (Regulation (EEC) No 394/2003) Information:
This substance is not listed in the Annex I of Council Regulation No (EC) 304/2003.
HPV-LPV (High and Low Production Volume) Information:
HPV Chemical : - List of Producers/Importers

→ Term “copper dross” no longer used:
  o lead drosses
  o Refined descriptions for copper slags (from smelting and from refining) and for copper scales (from melting)
Challenges & solutions

c. **Case of “orphan” UVCBs – e.g. former waste**

E.g. black copper, copper smelting

Material was waste, no entry in EINEC’s inventory

Description proposed by Copper Consortium:

<table>
<thead>
<tr>
<th>EC number:</th>
<th>918-452-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC name:</td>
<td>Black copper, copper smelting</td>
</tr>
<tr>
<td>Description:</td>
<td>Metallic substance produced by melting and/or processing of metallic (scrap) and/or oxidic copper bearing materials (slag, oxides, ashes). Black copper is composed primarily of copper, contains other residual ferrous and non-ferrous metals and may contain metal oxides and metal sulphides. Black copper will gradually be transformed into “blister copper” or “anode copper” with higher copper content, during further metallurgical processes</td>
</tr>
</tbody>
</table>
Challenges & solutions

2. Confidentiality of composition – handled by secretariat who developed “generic” composition (= across industry)

- Boundaries: generic elemental composition lists all known constituents and describes elemental composition across industry, derived as follows for each elemental constituent:
  - Typical concentration = average of Legal Entity typical concentrations;
  - Minimum concentration = minimum of Legal Entity typical concentrations;
  - Maximum concentration = maximum of Legal Entity typical concentrations.

- UVCB substance: number of constituents is relatively large and/or variability of composition is relatively large or poorly predictable -> concentration ranges outside the ones given in the generic composition do not necessarily exclude sameness.

- Metal species were determined based on information available to registrants and/or mineralogical analysis.
Challenges & solutions

- ID card developed by secretariat including:
  - Identification of the UVCB: name, EC nr, CAS nr, description
  - Usual elemental composition and speciation of the UVCB
  - Information on appearance, physical state and properties of the substance
  - Analytical methods for identification of the substance
  - Lead Registrant
  - REACH strategy
  - Classification
  - Reported uses
## Challenges & solutions

- ID card example - composition

<table>
<thead>
<tr>
<th>Table 2. Usual composition</th>
</tr>
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<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Precious metals</td>
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<tr>
<td>Other metals/constituents</td>
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</tbody>
</table>
### SID refinement process

<table>
<thead>
<tr>
<th>Site 1: Typical material</th>
<th>Site 2: Typical material</th>
<th>Site n: Typical material</th>
</tr>
</thead>
<tbody>
<tr>
<td>% various metals: typical</td>
<td>% various metals: typical</td>
<td>% various metals: typical</td>
</tr>
<tr>
<td>Form/granulometry: typical</td>
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<td>Form/granulometry: typical</td>
</tr>
</tbody>
</table>

**Generic Substance Identity:** representing the complex substance produced  
Generic process description & origin of the material (eg NFMBREF)  
Chemical composition % Cu, Zn, Pb, As, Ni, ...: typicals and ranges across manufacturers  
Chemical species: generic, eg oxidic, sulphidic, sulphates, ...  
Form/granulometry: typical and ranges
3. Metal specific: Input information on sameness is mainly based on processes and “precursors”:

Example of similar processes

Challenges & solutions
4. Testing and verification of sameness claims:

1) Development of standard sampling protocols – for composite samples

2) Identification of uncertainties and selection of representative samples (e.g. flue dusts from secondary & primary smelters) – tiered approach!

3) Determination of (elemental) compositions and mineralogy/speciations, granulometry

4) Evaluation of results and documentation in registrant dossiers

Role of expert judgment to assess uncertainties - example
Typical and representative samples

1. Industry data (Typical samples)
   - Tier 1 analysis: ICP
     - Elemental composition
       - Cu x\% (avg)
       - As y\% (avg)
       - ...

2. Industry data (Representative samples)
   - Tier 2 analysis: XRD & expert judgement
     - Speciation / Element Distribution (measured or calculated)
       - Cu in species (from total Cu x\%):
         - % Cu in Chalcocite Cu2S form
         - % Cu in Metal Cu form
         - %Cu in Domeykite Cu3As form
         - ...

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How was variability addressed?

Between UVCB variability (= within UVCB similarity) as part of substance ID.

UVCB

Composition
Elemental Speciation/
mineralogy

Process
Variability and the challenge for classification

<table>
<thead>
<tr>
<th></th>
<th>UVCB: unknown</th>
<th>UVCB: variable</th>
<th>Analytical testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elemental composition</td>
<td>Known</td>
<td>Low to large variability</td>
<td>By each registrant</td>
</tr>
<tr>
<td>Speciation/mineralogical composition</td>
<td>Largely known, some unknown</td>
<td>No variability for enriched UVCBs and sometimes large variability for side-product UVCBs</td>
<td>By consortium (representative sample)</td>
</tr>
<tr>
<td>Physical appearance</td>
<td>Known</td>
<td>Constant</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Known</td>
<td>Constant/ specific for enriched UVCBs, can potentially come from different furnaces/reactors but always &quot;removed&quot; in the same way for side-product UVCBs (e.g. tapping, exhausting leaching, etc...)</td>
<td></td>
</tr>
</tbody>
</table>

Can lead to different classifications
Within UVCB variability and grouping

Objectives:
• to increase understanding of the variability within UVCB (i.e. “capturing” site specific variability and (to a large extend) also variability over time)
• to allow companies to easily derive a worst-case classification for possible new streams (practical feasibility for SDS generation and labelling)
SID approach should be considered in perspective of UVCB assessment
Concluding remarks

• SID profiles: establishment and maintenance – determinant role of source, process (e.g. NFM BREF notes) and main constituent(s)
• Hazard profiles – 1 (UVCB) substance but eventually several (classification) grades
• Progress in technologies – e.g. late joiner: SID profile and common testing protocol are basis for evaluation (”reasonable” level of details to be agreed upfront)
• Impact from progress in analytical techniques periodic re-assessment of classifications/hazard profiles necessary
Back-up slides
Back-up: UVCBs, why?

- Variability is the driver
- UVCBs defined according to ECHA guidance

Figure 4.1: Key to guidance document chapters and appendices for appropriate guidance for various types of substances
MeO

Flue dust (10-50% Me)

Slag (0-30% Me)

MeS

Matte (30-70% Me)

Black metal (60-90% Me)

MeSO4

Spent electrolyte (0-20% Me)

Slimes/sludges (10-20% Me)

Anode (95-99% Me)

Cathode (100% Me)

Process driven perspective: example

Ores/concentrates scrap
Composition driven perspective

Principal component analysis:
Multidimensional speciation data set reduced to 2 dimensions
Composition driven perspective: example

- **MeO**
  - Flue dust (10-50% Me)
  - Slimes/sludges (10-20% Me)
  - Spent electrolyte (0-20% Me)
  - Slag (0-30% Me)
  - Matte (30-70% Me)
- **MeS**
  - Anode (95-99% Me)
  - Black metal (60-90% Me)
- **Me**
- **MeSO4**
  - Black metal (60-90% Me)
  - Matte (30-70% Me)
Composition driven perspective

Flue dust versus slag:
- Overlapping concentration range
- Distinct physical form
- Distinct process

Slimes versus strong acid:
- Overlapping concentration range
- Distinct physical form

Anode versus matte:
- Similar smelting and tapping process
- Distinct metal concentration
- Distinct speciation/mineralogy

Slag:
- Multiple speciation possible
- Specific process
- Low metal concentration

MeO

Me

MeS

MeSO4