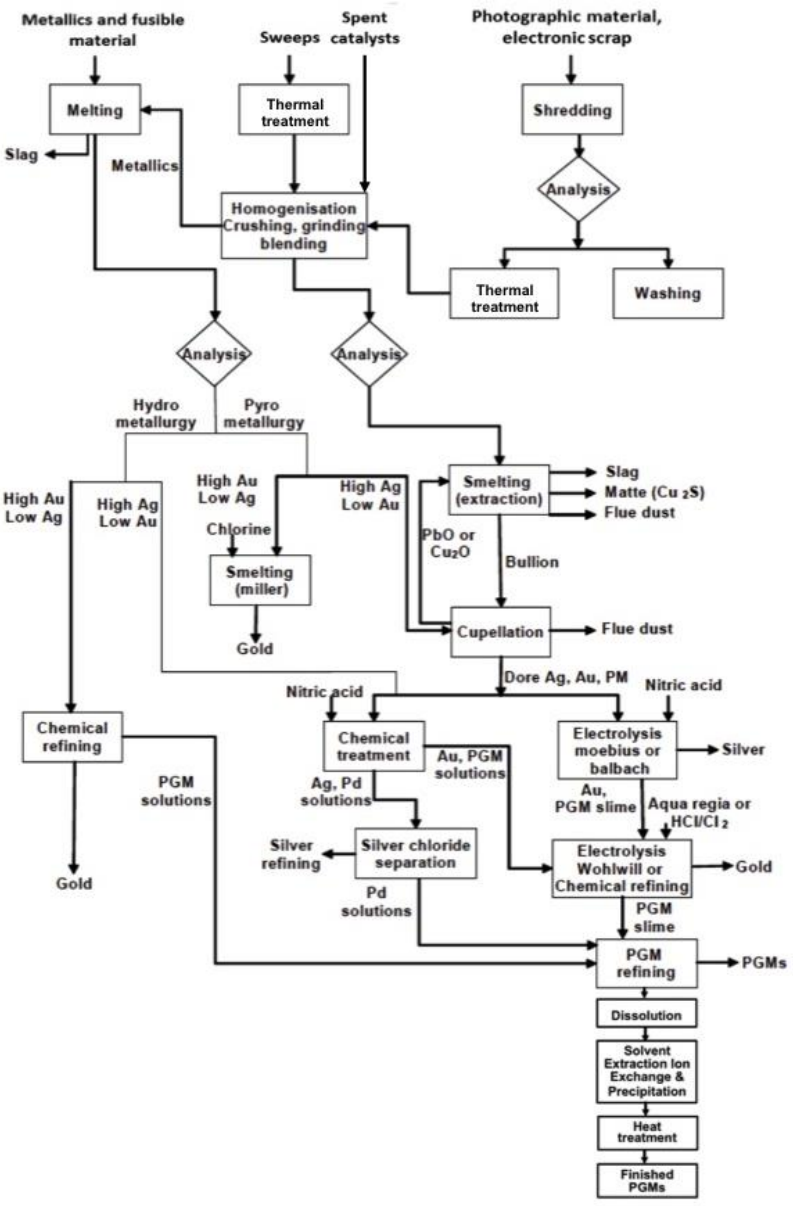
Refinables Project
Overview of process and source information available to date

GENERAL INTRODUCTION (INCLUDED IN ALL CSRS)

Intermediates produced during the refining of precious metals (Silver (Ag), Gold (Au), and six Platinum Group Metals (PGM): Platinum (Pt), Palladium (Pd), Ruthenium (Ru), Rhodium (Rh), Iridium (Ir), and Osmium (Os)) are included in the scope of the Precious Metals and Rhenium Consortium (PMC) c/o European Precious Metals Federation, a member of Eurométaux, and are commonly referenced as Precious Metals Refinables.

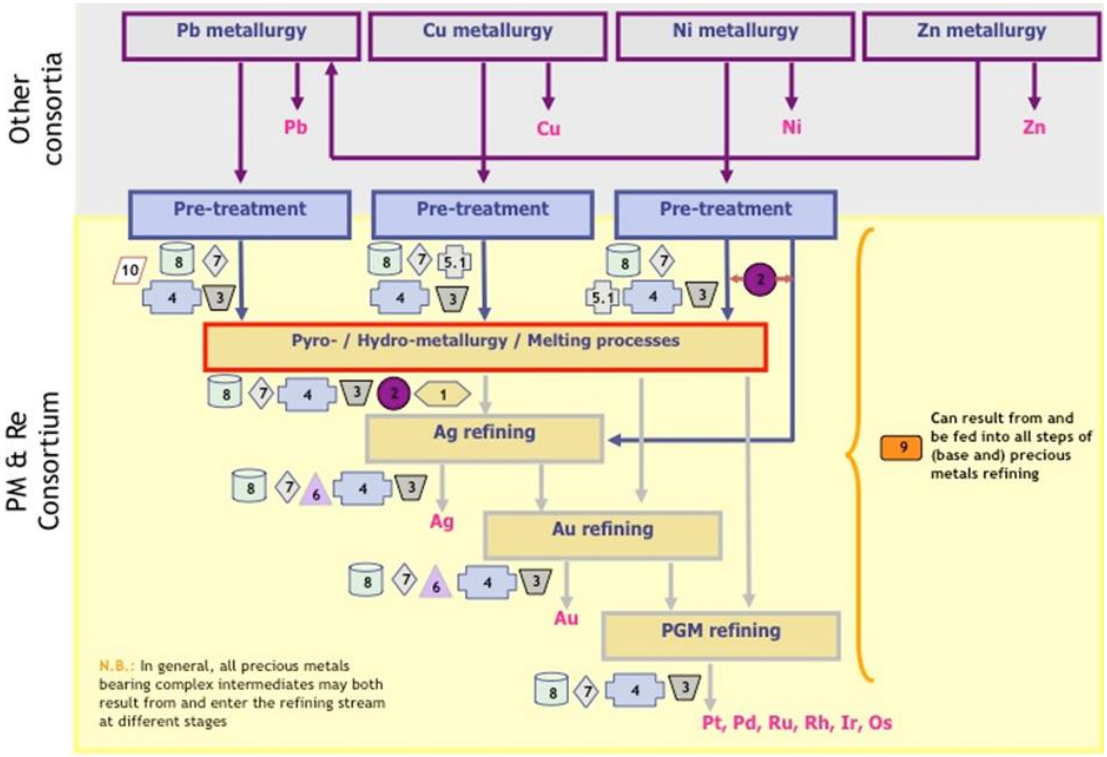
The most significant sources of precious metals are precious metal ores, by-products obtained from the processing of other non-ferrous metals (in particular anode slimes from copper production, leach residues and crude metal from zinc and lead production) and recycled material. They may be fed directly into the production process or require some level of pre-treatment, such as incineration or shredding, for instance.



Production processes are common for primary and secondary raw materials. In precious metal refining, production processes are usually carried out in various combinations to recover the precious metals that are present in a particular feedstock. Multi-purpose reactors and furnaces are used extensively and processing steps are often repeated, meaning it is difficult to identify single process steps. A variety of processes have been developed which exploit the chemical properties of precious metals. Although they are relatively inert, their reactivity varies and the various oxidation states of the metal in their compounds allows a variety of pyro- and hydro-metallurgical separation techniques to be used, as illustrated above.

Precious Metals Refinables are non-waste complex inorganic isolated intermediates resulting from the processing of a primary and/or secondary stream reclaimed for its precious metals content. Precious metals are contained in primary and secondary raw materials alone or 'embedded' or 'carried' by other metals, with whom precious metals have chemical affinity. For example, very generally summarised: copper and gold, lead and silver, and nickel and some PGM, are known to occur together, respectively. Precious Metals are hence present in most primary and secondary sources of zinc and lead, copper, and nickel.

The complexity of Precious Metals refining streams results first of all from the fact that they arise from a variety of other metals refining streams and sources, with a valuable presence of precious metals (Cf. Illustration below). These streams are collected together with other sources of precious metals by specialized refiners which apply the necessary subsequent and iterative pyro- and hydro-metallurgical processes to recover the precious metal content in the most efficient and innovative manner, in order to remain competitive.



1. Doré; 2. Matte PM; 3. Slags PM refining; 4. Slimes & sludges PM refining; 5.1. Residues matte leaching; 6. Ag electrolyte & Au electrolyte; 7. Flue dust PM refining; 8. Residues PM refining cementation & reduction; 9. Materials for reclaim PM; 10. Pb bullion PGM rich

The above illustration is a simplified scheme. A complete scheme would include additional arrows to indicate the iterative loops of base and precious metals recovery from the various process steps. Indeed, base metal rich streams are sent back to a base metal refining process, and a given precious metal-rich stream would be reused as feedstock in the various refining steps represented as discrete boxes in the illustration, according to the precious metal to be recovered and the other constituents to be removed and their affinity with the various process step conditions that exist in a given site. This is more visible in the 'simplified life-cycles' provided for each Refinable in Chapter 2 of the respective CSR, where 'black arrows' show the inputs and outputs from and to other base metals' refining, and 'green arrows' and 'red arrows' show the inputs and outputs from and to other precious metals' refining.

As precious metals are very scarce chemicals, and the precious metal refining capacity in EU is larger than the quantities of precious metals to be refined, any and all sources of precious metals are used as feedstock for smelting. Except for some secondary raw materials which need to be pre-treated before smelting or leaching, most primary and secondary raw materials containing precious metals can be used concomitantly in any smelting phase of the precious metals production, and in particular in an early smelting phase, such as the one leading to the production of doré or matte, precious metals refining. Slags and flue dust will be produced in all smelting phases. Outputs of the subsequent pyro- or hydro-metallurgical refining steps, such as the slimes and sludges and leaching residues, will hence be inherently influenced by the variability of sources that was used in the early steps of the refining by a given producer on a given day. Because precious metals refining allows (and even requires) combining as much sources as possible right from the start (i.e. combining variable primary and secondary sources), the variability of

precious metals UVCB will be large from the start of the refining process, and reduced at the end of the refining, when the precious metals are finally recovered and refined.

In summary, the variability within each type of Refinable is very much influenced by the source of the refining material as well as by the specificities and combination of the process steps which are applied to recover the precious metal content by each producer.

PMC Members have made an attempt to identify typical Refinables in line with REACH Substance Identification requirements. Considering the specific complexity of precious metal containing complex refining intermediates, a pragmatic approach has been followed to group streams resulting from similar source(s) and/or process(es).

Refinables are considered under REACH as UVCB substances in that they cannot be uniquely specified with the IUPAC name of the constituents, as not all the constituents can be identified; or that they may be generically identified on the basis of the sources and process, but with a lack of specificity due to variability of the exact composition.

The main identifiers for Refinables are related to the source of the substance and the process used, as further described in Chapter 2 of the CSR. Due to the lack of differentiation between constituents and impurities, the terms “main constituents” and “impurities” are not be used for Refinables, even if some constituents are known to be of no value to the actual purpose of the Refinable: to be transformed into (an)other substance(s) leading to the removal of unwanted constituents, and the concentration and recovery of (a given) precious metal(s).

The precious metal production route has therefore been used to categorise these substances. Major processes and the related intermediate types of the precious metal production have been mapped (see Chapter 2 of the CSR for more details).
In view to characterize each intermediate substance, the PMC proceeded as follows:
- For each intermediate substance, the range in elemental compositions within and across all companies has been assessed.
- Metal species were determined based on information available to registrants and/or mineralogical analysis (by means of XRD analysis).

REFINABLE 1 – DORÉ

Identifiers

	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Doré	Doré
EC number	273-793-6	273-793-6
CAS number	69029-47-6	69029-47-6
Description	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.	Gold and silver bullion

Remark: the original EC description does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (i.e. a UVCB shall in general be identified by its name, its origin or source and the most relevant steps taken during processing.) Therefore, above description is proposed by the PMC.

Substances also falling under this group:

Name	EC number	CAS number	Description (EC inventory)
Residues, silver-refining	308-309-5	97926-88-0	Product resulting from the smelting, refining and/or use of silver and its alloys obtained from primary and secondary sources and including recycled plant intermediates. It consists primarily of silver and may contain other residual non-ferrous metals and their compounds.
Black metal, copper electrolytic slime smelting	266-974-6	67711-97-1	Slimes from electrolytic cells are smelted in a cupel, producing 'black' metal and a slag. The 'black' metal contains silver as a major constituent with significant amounts of tellurium and selenium and minor amounts of copper, gold and other metals.

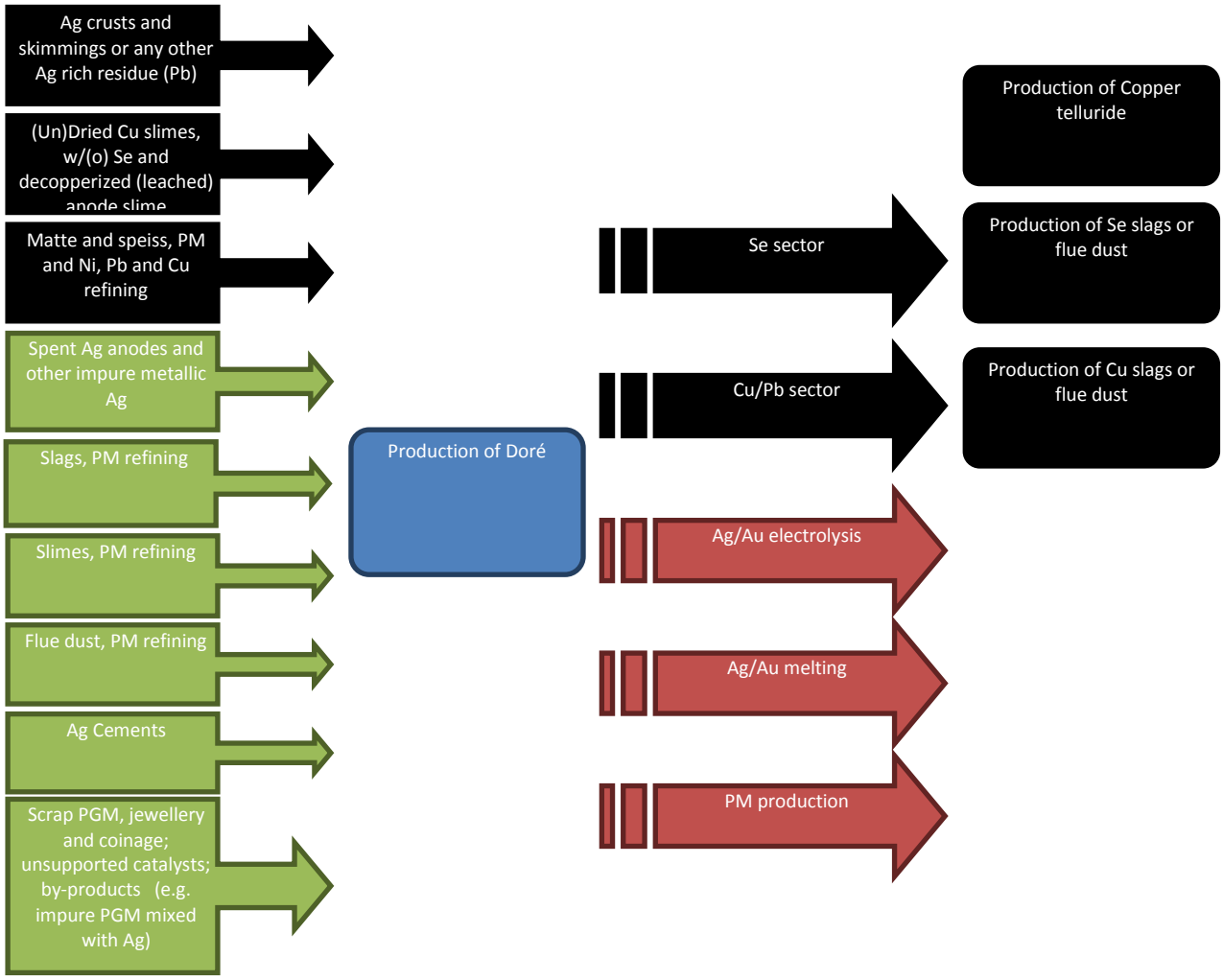
Remark: No registration dossier will be prepared by the PMC for the materials listed in the above table. PMC Members are recommended to register their material using the identifiers for Doré, for which a dossier will be prepared by the PMC.

CSR description of manufacturing process

Doré is produced by melting and smelting/refining anode slimes from copper electro-refining as well as from precious metals enriched alloy from lead refining, leach residues and crude metal from zinc and lead production, returns and sweeps from silver and/or gold production (such as dust from bag filters, slimes from wet dedusting systems, silver cement obtained from spent silver and/or gold electrolyte, slags, crushed refractory) and other silver and/or gold-rich materials and/or silver and/or gold scrap. Refining is carried out with coke, silica, lime and sodium carbonate fluxes to maximise separation from other metals whilst controlling the formation of volatile metal compounds. Different combinations of batch wise processes can be used depending on the composition of the raw materials and the local conditions. In general, the following process steps are involved:

- Drying of decopperised slime in indirectly heated steam dryers;
- Melting and converting in a furnace (e.g. Kaldo, top blown rotary or tilting rotating oxy-fuel (TROF) furnace) to remove impurities and retain crude PM alloy;
- Volatilisation and recovery of selenium from the furnace off-gas during melting or prior, via separate roasting in an electrically heated furnace;
- Final refining of the PM alloy/raw silver or gold in the same furnace or cupellation of precious metal-enriched alloys from lead and copper lines in a separate furnace (e.g. TBRC, TROF, BBOC);
- Casting of Doré anodes, ingots or bars.

The below flowsheet identifies influx/outflux substances in the production of Doré. Green/red arrows are used for influx from/outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



Though the production of Doré and precious metal containing metallic streams in general is normally the result of a smelting process (one process type), the composition of doré can be very variable from registrant to registrant, and from day to day, due to the number of sources that can be used (more than one source). This will depend on the number of types of sources available to that registrant on that day, for smelting, and whether that specific day the content will lead to a silver, or a gold doré. It is only after the production of the silver or gold doré that this is sent to a specialised step aimed at concentrating the silver or the gold. Also, because silver is less scarce than gold, silver doré is more common than gold doré. But the sources (because they are not necessarily pre-selected) and process to produce a silver rich or a gold rich doré are the same.

Although registrants having silver and/or gold production 'annexed' to a copper, lead or nickel production are more likely to use feedstocks from the copper, lead, and nickel refining on a more regular basis, these same registrants may use secondary sources in addition to the outputs of their copper, lead, and nickel production too, which would be the typical feed for registrants whose precious metals production is not annexed to any other base metal production. Likewise, precious metals producers not annexed to any base metal production may use base metal production outputs as feedstock when needed. When using copper refining outputs, the doré will contain more Cu and metals 'carried' by the Cu (Se, Te, Au, etc.). When using lead or nickel refining outputs, the doré will contain more Pb and Ni, and metals 'carried' by the Pb or Ni (Ag, PGM, etc.). This explains why the concentration ranges for the constituents in doré are larger for these metals than for others, and why the doré of some registrants will typically contain more Cu and Au, and others' will contain more Ni or Pb.

Production processes / sources based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for doré was produced. Those Refinables that were

identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Sources
Melting and refining in TBRC Converter	Decopporized Slime from copper elecrolyses
Melting and refining in Induction furnace	Silver crusts from lead refining
Melting of copper electrolytic slime	Decopporized Slime from copper elecrolyses
Casting Dore-metal into solid blocks after fire refining	Products with high PM content from primary and secondary sources
Doré metal (raw silver) obtained in the cupellation furnace	Products with high PM content from primary and secondary sources
Metallic bars and ingots resulting from pyrometallurgical processes	Primary or secondary feeds with high PM content (high silver content) Primary or secondary feeds with high PM content (lower silver content and higher iron content)
Dore metal obtained in the Kaldo furnace, from which it is transferred to an anode furnace, where casted into silver anodes	Products with high silver content from primary sources (anode slime from copper electro-refinery) and recycled plant's intermediates
Spent Ag anodes obtained as a residues from silver electrolytic refining	Products with high silver content from primary sources
Doré metal (raw silver) obtained in cuppellation furnace	Products with high (>20%) PM content from primary and secondary sources (such as silver crusts,…)
Obtained from pyro-metallurgical processes, somethings through collection on copper	Products with high (>20%) PM content from primary and secondary sources (such as silver crusts, anodic slimes, PM scraps,...)
Scrap resulting from the smelting, refining and/or use of silver and its alloys	Fine silver or silver alloys

REFINABLE 2 – MATTE PRECIOUS METAL

Identifiers

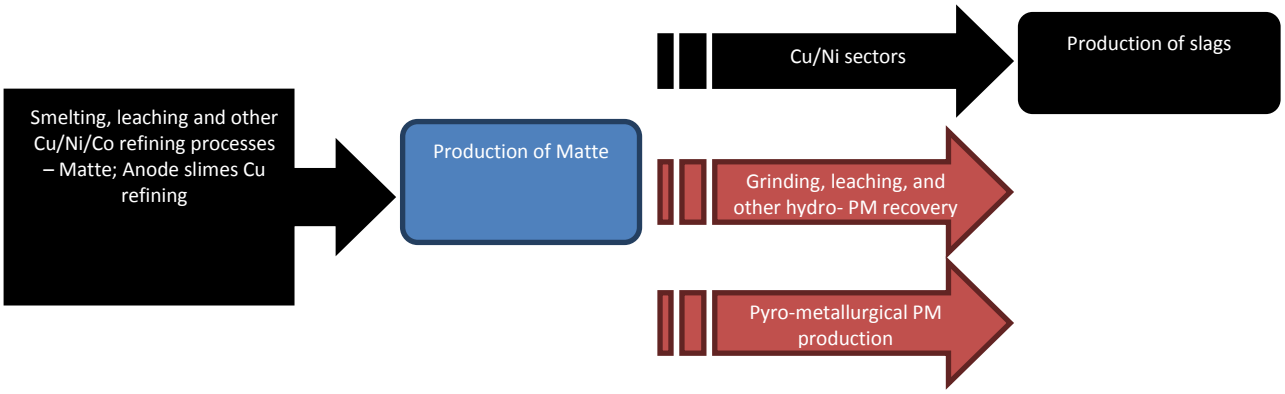
	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Matte, precious metal	Matte, precious metal
EC number	308-506-6	308-506-6
CAS number	98072-52-7	98072-52-7
Description	Substance resulting from the smelting of precious metals and its alloys obtained from primary and secondary sources and including recycled plant intermediates. Matte, precious metal is composed primarily of base metal sulphides containing precious metals and may contain other residual non-ferrous metals and their compounds in varying concentrations.	None

Remark: the original EC description does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (i.e. a UVCB shall in general be identified by its name, its origin or source and the most relevant steps taken during processing.) Therefore, above description is proposed by the PMC.

CSR description of manufacturing process

Matte, precious metal results from the smelting of precious metals and its alloys obtained from primary and secondary sources and including recycled plant intermediates. The silica, alumina, iron oxides, calcium oxides, and other minor oxides form a molten slag, while the precious metals, with the sulphur, form the matte. The slag is lighter than the matte, and so it floats to the surface to be tapped off and sent back to the base metal refiners in order to recover the valuable base metal from it.
Matte is then used as further feedstock in further smelting steps, where the matte is oxidised and the metal content is separated from another slag phase.

The below flowsheet identifies influx/outflux substances in the production of Matte, precious metal. Red arrows are used for outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



Though the production of matte, precious metal refining is the result of a simple smelting process (one process), during which compounds segregate into whichever phase they are most soluble in (slag or matte), the composition of matte can vary (though will always be sulphidic) from registrant to registrant, and from day to day, due to the type of sources that can be used. This will depend on the number of type of sources available to that registrant on that day, for smelting, and whether that specific day the content will lead to e.g. a Cu or Ni rich matte. But the sources (because they are not necessarily pre-selected and can be smelted together) and process to produce a Cu or Ni rich matte are the same.

Although registrants having precious metals production 'annexed' to a copper or nickel production are more likely to use feedstocks from the copper or nickel refining, respectively, these same registrants may use other sulphur-rich primary and secondary sources in addition to the outputs of their copper or nickel production too. The production of matte is however typical from multi-metallic sites, and is not normally produced by precious metals producers not annexed to any base metal production. When using copper refining outputs, the matte will contain more Cu and metals 'carried' by the Cu (Ag, Au, etc.). When using nickel refining outputs, the matte will contain more Ni, and metals 'carried' by the Ni (PGM, etc.). This explains why the concentration ranges for the constituents in matte are larger for these metals than for

others, and why the matte of some registrants will typically contain more Cu and Ag, and others' will contain more Ni and PGM.

Production processes / sources based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for PM Matte was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Sources
Precious metals matte obtained by pyrometallurgical treatment from Cu Ni ore, rich in iron	Cu Ni ore
Material from pyrometallurgical upgrading process.	Material with a low to medium PM content from primary and secondary sources
Undissolved residue from Ni-matte. This material is melted in a furnace. A slag containing SiO2, Al2O3, CaO and FeO is removed, and what's left is a sulphidic PM matte	Undissolved residue from Nickel matte
Smelting	Internal and external sources

REFINABLE 3 – SLAGS,PRECIOUS METAL REFINING

CSR description of manufacturing process

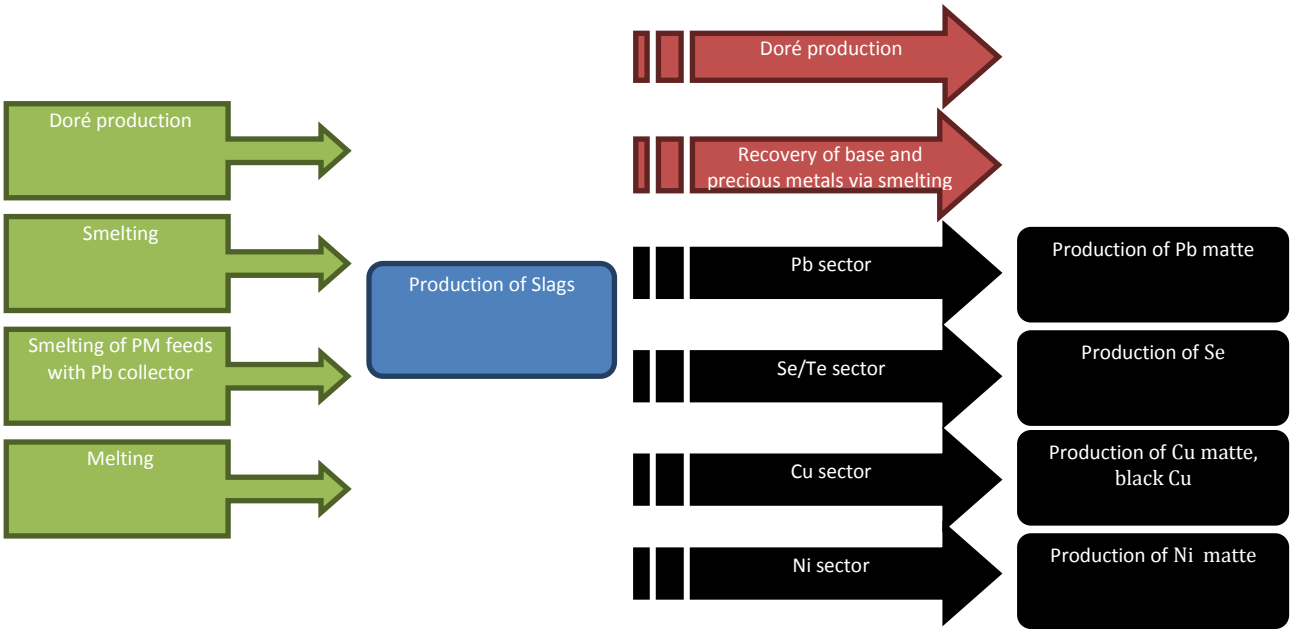
Various precious metals bearing materials such as ashes, sweeps, printed circuit boards, agglomerated fines, sludges, residues, by-products… containing also some base metals as copper, lead, nickel, are smelted in a pyro metallurgical device such as Ausmelt/ISA smelting furnace, electric, blast, rotary and reverberatory furnaces or top blown rotary converters (TBRC). The operation is conducted at elevated temperature (> 950 °C) under such reducing operating conditions that a concentration of the precious metals in a separate phase occurs and that impurities are concentrated in the slag. Electric power, coke, gas or oil are used as energy supplier for the smelting and as generator of the reducing atmosphere. In some cases, selected plastic waste can be used as a fuel or as a reducing agent and in these cases appropriate afterburning is used to prevent the emission of organic compounds such as VOCs and PCDD/F. Fluxes (such as sodium borate or borax, sodium carbonate, sodium phosphate, silica, and ammonium silicate amongst others) are added to process in order to lower the melting temperature and/or viscosity of the slags.
Depending of the precious metals concentration of the produced slags, slags could be depleted in separated batch runs in the same installation, put back previous steps of the smelting or refining process or could be disposed. Slags can be granulated or cast prior disposal, treatment for depletion or use.

Two types of slags are included in one dossier:

1. Slags, doré furnace
2. Slags, production of precious metals containing materials other than doré

Slags resulting from precious metals refining, whether to produce doré or another concentrated form of precious metals, can either be re-smelted in a precious metal refining loop (if the precious metal content in the slag is valuable), or sent back to a base metal refinery to recover the base metal of value.

The below flowsheet identifies influx/outflux substances in the production of Slags, precious metal refining. Green/red arrows are used for influx from/outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



The production of slag occurs in all sites having pyro-metallurgical operations. Though the production of slags, precious metal refining is the result of a simple smelting process (one process), during which compounds segregate into whichever phase they are most soluble in (slag or other), the composition of slags can vary from registrant to registrant, and from day to day, due to the type of sources that can be used. This will depend on the number of type of sources available to that registrant and that day, for smelting, and whether the slag is produced from a precious metal rich or poor starting material. The slag phase will normally be poor in precious metals and rich in other metals from which precious metals need to be separated, such as Cu and Pb. But the sources (because they are not necessarily pre-selected and can be smelted together) and process to produce a Pb or Cu rich slag are the same.

Although registrants having precious metals production 'annexed' to a copper or lead production are more likely to use feedstocks from the copper or lead refining, respectively, for their smelting steps, these same registrants may use other precious metals primary and secondary sources in addition to the outputs of their copper or lead production too. When using copper refining outputs, the slag will contain more Cu. When using lead refining outputs, the slag will contain more Pb. This explains why the concentration ranges for the constituents in slags are larger for these metals than for others, and why the slags of some registrants will typically contain more Cu, and others' will contain more Pb.

Over the past years, the PMC has made extensive efforts to determine substance identification of Refinables and to consider **splitting** to the best of their knowledge, based on ECHA guidance and reflection of the complexity of the PM refining flow sheets.

According to the ECHA Guidance for identification and naming of substances under REACH and CLP, the consequence of defining a substance as UVCB is that any significant change of source or process would likely lead to a different substance that should be registered separately. However, reality in the precious metals sector demonstrates a same Refinable can originate from different sources and process (steps) (cf. illustration in section 1.0 above).

The PM Refinables were originally grouped on the basis that they are usually captured, collected and/or treated without distinction and that even if they were considered separately (following a theoretical approach) their variability and hazard profile would not be significantly different.

In their efforts to refine substance identification, the PMC agreed to explore criteria and approaches which could be considered to split the Slags, precious metal refining in an objective manner. It was agreed to split based on the (pyro-metallurgical) process the slags originate from. Using the source or precious metal refining stream they result from (Ag/Au/PGM refining) as a criterion to split is not applicable since pyro-metallurgical processes are applied on materials containing more than one precious metal.

Based on company-specific production processes, it was agreed to split the Slags, precious metal refining in two groups:

- **Slags 1. Slags, doré production**: Slags produced as by-products in the production (smelting, reduction, converting, and refining processes) of doré. They generally contain copper and lead and small amounts of silver, antimony, tellurium and other metals. Depending on the fluxing agent used, slags in this group may contain metal oxides, phosphates, silicates, sulphides/sulphates
- **Slags 2. Slags, production of precious metals containing materials other than doré**: Slags produced as by-products in the smelting of precious metals bearing feeds to produce a precious metals containing material other than doré subject to further refining. They are typically rich in SiO_2. Depending on the fluxing agent used, slags in this group may contain ferrous and non-ferrous metal oxides, phosphates, silicates, sulphides/sulphates and/or fused salts in varying concentrations.and/or fused salts in varying concentrations.

It is noted that even after splitting the group Slags, precious metals refining, into the above two sub-groups, the variability remains large, for the same reasons as those provided above.

These two groups are registered together in the April 2014 version of the registration, as at that time, it was unclear which procedure should be followed to register them separately (e.g. which EINECS entry to use). The two groups identified will be registered separately once the PMC has confirmation from ECHA how the registration should be done.

Refinable 3.1 – Slags, doré furnace

Identifiers

	Proposed by PMC Refiners Work Group	Original (in EC inventory)	2010 Registration
Name	Slags, doré furnace	Slags, doré furnace	Slags, precious metal refining
EC number	266-975-1	266-975-1	308-515-5
CAS number	67711-98-2	67711-98-2	98072-60-7
Description	Slags produced as by-products in the production (smelting, reduction, converting, and refining processes) of Slags, doré furnace. They generally contain copper and lead and small amounts of silver, antimony, tellurium and other metals. Depending on the fluxing agent used, slags in this group may contain metal oxides, phosphates, silicates, sulphides/sulphates and/or fused salts in varying concentrations.	Slag produced as a by-product in the furnace smelting of metal wastes rich in gold and silver. Principal components are usually tellurium, selenium and copper with minor amounts of lead, antimony and other metals.	Heterogeneous solids (e.g.: lumps) resulting from pyro-metallurgy processes applied on precious metals containing-primary and secondary feeds, using several fluxing agents such as sodium borate or borax, sodium carbonate, sodium phosphate, silica, and aluminium silicate amongst others. Depending on the fluxing agent used, slags resulting from the refining of precious metals may contain ferrous and non-ferrous metal oxides, carbonates, phosphates, silicates, and/or fused salts in varying concentrations, with some quantities of precious metals.

Production processes based on data submitted by PM Refiners in 2014

Based on the data submitted by PM Refiners in 2014 (after proposed splitting of PM slags), below table of production processes for Slags, doré furnace was produced.

General description of production process	Sources
Slags produced as by-products in the production of doré – Trof slag (primary slag)	PM smelting, Trof furnace
Slags produced as by-products in the production of doré – Trof slag (secondary slag)	PM smelting, Trof furnace
Slags produced as by-products in the production of doré	Mainly slimes & sludges, Cu refining, but also concentrates and Ag and Au rich waste
Slag produced as a by-product in the refining oxydizing pyrometallurgical production process of PM doré	Products with high (>20%) PM content from primary and secondary sources (such as Ag crusts,…)
Slags produced as a by-product in the production process of metals doré (Melting and refining in TBRC Converter) (Slag TBRC 1 Converter 1st stage)	Decopperized Slime from copper electrolyses
Slags produced as a by-product in the production process of metals doré (Melting and refining in TBRC Converter) (Slag TBRC 1 Converter 2nd stage (Se oxidation and removal) Glatte 1)	Decopperized Slime from copper electrolyses
Slag obtained in further pyrometallurgical refining steps of doré from cuppelation furnace	Products with high (>20%) PM content from primary and secondary sources (such as Ag crusts,…)
Slags produced as a by-product in the further pyrometallurgical refining of doré (Ag rich materials) (Slag TBRC 2 Converter (TK2) 1st stage)	Dore, Raw silver, Silver rich bullion, Silver rich materials
Slags produced as a by-product in the further pyrometallurgical refining of doré (Ag rich materials) (Slag TBRC 2 Converter (TK2) 2nd stage)	Dore, Raw silver, Silver rich bullion, Silver rich materials
Slags produced as a by-product in the further pyrometallurgical refining of doré (Ag rich materials) (Te slag, removal of Te by addition of soda (Soda glatte); Different than previous 2 entries)	Dore, Raw silver, Silver rich bullion, Silver rich materials

Refinable 3.2 - Slags, production of precious metals containing materials other than doré

Identifiers

	Proposed by PMC Refiners Work Group	Original (in EC inventory)	2010 Registration
Name	Slags, production of precious metals containing materials other than doré	Slags, precious metal refining	Slags, precious metal refining
EC number	308-515-5 (or new?)	308-515-5	308-515-5
CAS number	98072-60-7 (or new?)	98072-60-7	98072-60-7
Description	Slags produced as by-products in the smelting of precious metals bearing feeds to produce a precious metals containing material other than doré subject to further refining. They are typically rich in SiO2. Depending on the fluxing agent used, slags in this group may contain ferrous and non-ferrous metal oxides, phosphates, silicates, sulphides/sulphates and/or fused salts in varying concentrations.	None	Heterogeneous solids (e.g.: lumps) resulting from pyro-metallurgy processes applied on precious metals containing-primary and secondary feeds, using several fluxing agents such as sodium borate or borax, sodium carbonate, sodium phosphate, silica, and aluminium silicate amongst others. Depending on the fluxing agent used, slags resulting from the refining of precious metals may contain ferrous and non-ferrous metal oxides, carbonates, phosphates, silicates, and/or fused salts in varying concentrations, with some quantities of precious metals.

Substances also falling under this group:

Name	EC number	CAS number	Description (EC inventory)
Slags, silver-smelting	308-315-8	97926-95-9	Product resulting from the smelting of silver and its alloys obtained from primary and secondary sources and including recycled plant intermediates. Consists primarily of SiO2 and other gangue constituents and may contain other residual non-ferrous metals and their compounds.
Slags, precious metal recovery lead refining	273-826-4	69029-85-2	Inorganic slags produced from treatment of calcined scrap metals and oxides with borax, litharge and sodium carbonate followed by fusion.

Remark: No registration dossier will be prepared by the PMC for the materials listed in the above table. PMC Members are recommended to register their material using the identifiers for Slags, production of precious metals containing materials other than doré, for which a dossier will be prepared by the PMC.

Production processes based on data submitted by PM Refiners in 2014

Based on the data submitted by PM Refiners in 2014 (after proposed splitting of PM slags), below table of production processes for Slags, production of precious metals containing materials other than doré was produced.

General description of production process	Sources
Slags produced as a by-product of the smelting of PM bearing feeds. Some of the PM containing feeds may have high Ag content. However, none of the slag streams are kept separate and they are all treated in the same way.	Smelting of PM containing material.
Reductive smelting of PM bearing feeds	Low grade feed materials smelted with fluxes and a lead collector
Slags produced as by-products in the smelting of PM bearing feeds to produce a PM containing material other than doré subject to further refining	Slag from production of PM matte. The input to this process is residues from Cu and Ni production
Slags from scrap smelting with flux (borax)	Pyro-metallurgy processes

REFINABLE 4 – SLIMES AND SLUDGES, PRECIOUS METAL REFINING

Identifiers

	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Slimes and Sludges, precious metal refining	Slimes and Sludges, precious metal refining
EC number	308-516-0	308-516-0
CAS number	98072-61-8	98072-61-8
Description	Dry or wet residues resulting from hydro-metallurgical and/or electrolysis processes used in the refining of precious metals. Slimes and sludges from precious metals refining generally contain precious and base metals, and insoluble inorganic compounds in varying concentrations.	None

Substances also falling under this group:

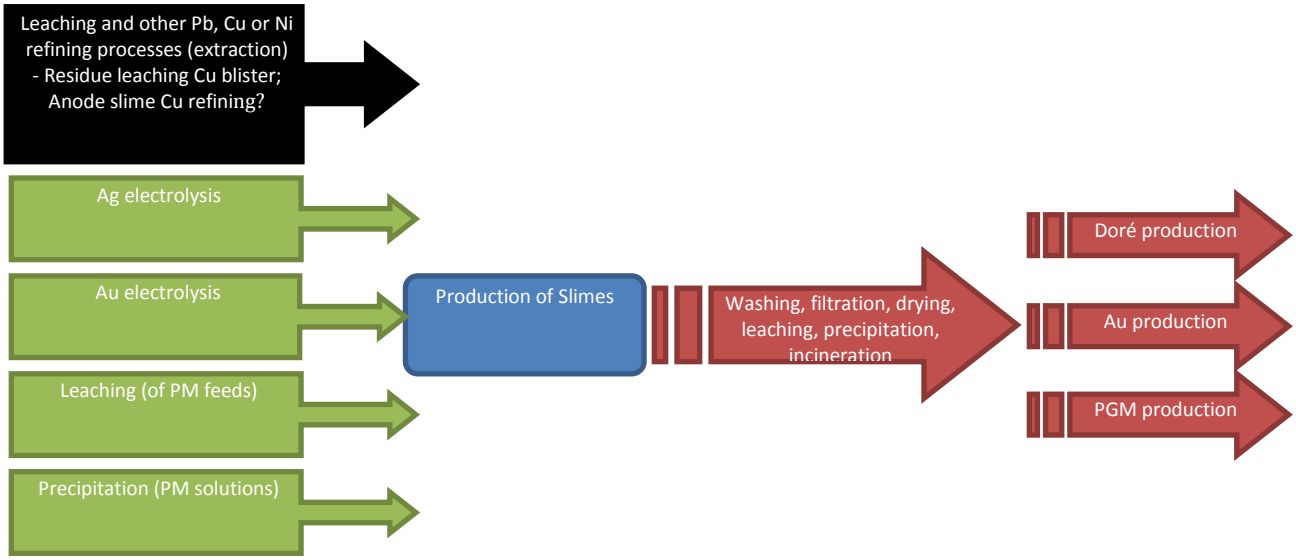
Name	EC number	CAS number	Description (EC inventory)
Residues, silver sludge-electrolysis zinc-pptd., precious metal-contg.	309-641-3	100656-52-8	The residue obtained by zinc precipitation of the material obtained during the recovery of palladium and platinum from the anode sludges of silver electrolysis. Composed primarily of palladium, platinum, rhenium and the oxides of iron and zinc.
Slimes and Sludges, copper pickling wastewater treatment	293-678-4	91081-71-9	Sludges formed by the precipitation of compounds of non-ferrous metals arising from the neutralizing during effluent treatment of wash waters and spent pickling acids used for the cleaning and removal of oxide from copper and copper alloys.
Leach residues, precious metal smelting scrap	309-770-5	100995-79-7	The residues obtained from the leaching of scrap and waste materials containing gold, iridium, osmium, palladium, platinum, rhenium, ruthenium or silver. Composed primarily of alumina and silica with traces of all of the precious metals.

Remark: No registration dossier will be prepared by the PMC for the materials listed in the above table. PMC Members are recommended to register their material using the identifiers for Slimes and Sludges, precious metal refining, for which a dossier will be prepared by the PMC.

CSR description of manufacturing process

Slimes & sludges are formed during the hydro-metallurgical and/or electrolysis processes used in the refining of precious metals (manufactured from precious metal containing primary and secondary feeds) in which precious metals are concentrated via leaching, precipitation, and other chemical separation techniques, from less valuable materials, in a form that can be collected and re-used as feedstock in further precious metals refining.

The below flowsheet identifies influx/outflux substances in the production of Slimes and sludges, precious metal refining. Green/red arrows are used for influx from/outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



The production of slimes and sludges occurs in all sites having hydro-metallurgical or electrolytic refining operations. Slimes typically result from electrolysis steps while sludges result from chemical separation steps such as concentration/upgrading, leaching and precipitation. In both electrolysis and other hydro-metallurgical refining steps, precious metals compounds segregate into whichever phase they are most stable.

In precious metals chemistry and manufacturing, electrolysis is a method of using a direct electric current to drive an otherwise non-spontaneous chemical reaction. It consists in the passage of that current through an ionic substance that is either molten or dissolved in a suitable solvent, resulting in chemical reactions at the electrodes and separation of materials.
In that way, electrolysis does not differ from hydrometallurgical processes, which apply techniques involving the use of aqueous chemistry for the recovery of metals from ores, concentrates and recycled or residual materials.

Electrolytic as well as hydrometallurgical processes are very complex and many individual process stages may have to be repeated to achieve the required purity. Processes are designed to obtain a pure target metal (Ag, Au, PGMs) as well as to recover as much as possible PM from process residues. The number and order of the stages also depend on the constituents to be removed and the specific mix of precious metals to be separated.
The composition of slimes & sludges is intrinsically variable as they result as process residues at various stages of the precious metals refining process, multiple process conditions and exact stage of refinement step.
The composition of slimes from electrolytic refining of silver and gold does not vary as much as the composition of sludges from hydro-metallurgical refining steps as the source material and process conditions are more defined.

The composition of sludges from hydro-metallurgical refining steps is intrinsically as variable as the sources and chemical reactions they result from. Multiple reactions can be applied on a number of sources concomitantly, on the basis of the composition of the sources and the desired outcome.
Depending on material or source (i.e. whether it has already been concentrated to a certain level, is only a starting material in the refining, or a material almost fully depleted from precious metals but which retains a valuable portion that can be retrieved with a specific hydro-metallurgical reaction), the content of precious and other (unwanted) metals in the sludge will vary.

According to the ECHA Guidance for identification and naming of substances under REACH and CLP, UVCB substance “shall be identified by its name, its origin or source and the most relevant steps taken during processing”. The consequence of defining a substance as UVCB is that any significant change of source or process would likely lead to a different substance that should be registered separately

However a simple differentiation between process and source in the precious metals sector is not feasible due to the significant complexity of the precious metals refining flow sheet, the fact that processes are designed to process various source materials with various levels of precious metals and base metals together and the need to repeat many individual process stages to achieve the required purity of precious metals as well as recovery of precious metals from all process residues to the extent possible. Reality in the precious metals sector demonstrates a same Refinable can originate from different sources and process (steps).

Over the past years, the PMC has put extensive efforts to determine and improve the substance identification for this UVCB and considered splitting to the best of our knowledge, using ECHA guidance and taking into account the complexity of the PM refining flow sheets. So far, splitting in an objective manner has not been possible but we are further exploring criteria and approaches which could be considered to split the group.

Proposed splitting 2013-2014

Slimes from silver and gold electrolytic refining appear as two discrete sub-groups of the Slimes and sludges, precious metals refining EINECS entry. The reason why they were REACH registered in this larger group back in 2010 is due to the fact that they are considered as part of the hydro-metallurgical refining of precious metals at large.

The composition of sludges from hydro-metallurgical refining steps is intrinsically as variable as the sources and chemical reactions they result from. Multiple reactions can be applied on a number of sources

concomitantly, on the basis of the composition of the sources and the desired outcome. Splitting the sludges per source and process would not be feasible and even if an attempt was made to virtually distinguish these into further sub-groups, they did not result in different and less variable composition profiles.

Depending on material or source, the content of precious and other (unwanted) metals in the sludge will vary. Although the composition of the sludge will infer on the best reaction to perform, several sludges can undergo a same reaction in principle. Hence, the sludges produced from the hydro-metallurgical refining of precious metal containing materials will be as variable as the sources available and processes performed in that specific occasion, which will neither be fully source-specific, process-specific, or registrant-specific; but instead, specific to the most efficient combination of refining steps recommended for the refining situation.

Over the past years, the PMC has made extensive efforts to determine substance identification of Refinables and to consider splitting to the best of their knowledge, based on ECHA guidance and reflection of the complexity of the PM refining flow sheets.

According to the ECHA Guidance for identification and naming of substances under REACH and CLP, the consequence of defining a substance as UVCB is that any significant change of source or process would likely lead to a different substance that should be registered separately. However, reality in the precious metals sector demonstrates a same Refinable can originate from different sources and process (steps).

The PM Refinables were originally grouped on the basis that they are usually captured, collected and/or treated without distinction and that even if they were considered separately (following a theoretical approach) their variability and hazard profile would not be significantly different.

In their efforts to refine substance identification, the PMC agreed to explore criteria and approaches which could be considered to split the Slimes and sludges, precious metal refining in an objective manner. Using the source or precious metal refining stream they result from (Ag/Au/PGM refining) as a criterion to split is not applicable since hydro-metallurgical processes are applied on materials containing more than one precious metal.
Based on preliminary PMC discussions, the following sub-groups appeared evident:

1. Slimes obtained/produced during the electrolytic refining of Silver.
2. Slimes obtained/produced during the electrolytic refining of Gold.
3. Sludges obtained/produced from hydro-metallurgical refining of PM containing materials including non-PM sources.

It is noted that even after splitting the group Slimes and sludges, precious metals refining, into the above three sub-groups, the variability for sub-group three remains very large, for the same reasons as those provided above.

These three groups have been registered together in the April 2014 version of the registration, as PMC Members did not unanimously agree on the proposed splitting. Possible identifiers for the three groups and reported processes/sources are listed below.

Refinable 4.1 - Slimes, electrolysis of silver

Identifiers

	Proposed by PMC Refiners Work Group
Name	Slimes, electrolysis of silver
EC number	NEW
CAS number	
Description	Slimes obtained/produced during the electrolysis of silver. These slimes generally contain high silver and gold concentrations and have lower concentrations of base metals.

Production processes based on data submitted by PM Refiners in 2014

Based on the data submitted by PM Refiners in 2014 (after proposed splitting), below table of production processes for Slimes, electrolysis of silver was produced.

General description of production process	Sources
Silver electrolysis	Slime silver electrolysis
Ag anode slime: hydro-metallurgical processes used	Ag refining electrolysis
Silver doré anodes are refined in a silver electrolysis process.	Doré anodes
Raw gold slime (anode gold slime) is produced in silver electro-refining process, carried out in electrolytic cells with titanium cathodes and silver anodes. The slime is further filtered, pre-leached with 5% HCl and transferred for recovery of gold and platinum-palladium concentrate.	Silver electro-refining process
Imported material	Slimes from Ag electrolysis

Refinable 4.2 - Slimes, electrolysis of gold

Identifiers

	Proposed by PMC Refiners Work Group
Name	Slimes, electrolysis of gold
EC number	NEW
CAS number	
Description	Slimes obtained/produced during the electrolysis of gold. These slimes generally contain high gold and silver concentrations and have lower concentrations of base metals.

Production processes based on data submitted by PM Refiners in 2014

Only one registrant provided a description of their production process that fits the description above.

Refinable 4.3 - Sludges, precious metals refining hydro-metallurgical processes

Identifiers

	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Sludges, precious metals refining hydro-metallurgical processes	Slimes and Sludges, precious metal refining
EC number	308-516-0	308-516-0
CAS number	98072-61-8	98072-61-8
Description	Sludges obtained/produced from the hydro-metallurgical refining of precious metals containing materials. These slimes generally contain precious and base metals, and insoluble inorganic compounds in varying concentrations.	None

Production processes / sources based on data submitted by PM Refiners in 2014

Based on the data submitted by PM Refiners in 2014 (after proposed splitting), below table of production processes for Sludges, precious metals refining hydro-metallurgical processes was produced.

General description of production process	Sources
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue) Ni and Cu free slime: Produced in closed autoclave and cementation process	Anode slime from Cu refining
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue) Roasted slime: pyro-metallurgical processes used	Filtered Cu and Ni free slime cake
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue)	PM matte
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue)	

Hydrometallurgical processes and gas-solid reaction processes are used	
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue)	Strong HCl solution resulting from the dissolution of PGM bullion with HCl/Cl
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue) Residue obtained by hydrometallurgical removal of base metals (Cu) in the PM refining processes	Cu based intermediate containing PM
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue) Residue obtained by hydrometallurgical removal of base metals (Fe) in the PM refining processes	Iron based intermediate containing PM
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue)	Residues obtained during hydrometallurgical steps of base metal refining
Slimes obtained/produced from hydro-metallurgical **upgrading** of PM containing solid materials including non-PM sources (i.e. removal of base metals or solvent, producing an upgraded/enriched residue)	Various
Slimes obtained/produced from the hydro-metallurgical **leaching** of PMs from PM containing solid materials (i.e. dissolution of PMs leaving a lower grade residue)	Leached slime silver electrolysis
Slimes obtained/produced from the hydro-metallurgical **leaching** of PMs from PM containing solid materials (i.e. dissolution of PMs leaving a lower grade residue). AgCl slime: Ag anode slime leaching	Ag anode slime
Slimes obtained/produced from the hydro-metallurgical **leaching** of PMs from PM containing solid materials (i.e. dissolution of PMs leaving a lower grade residue)	PM matte
Slimes obtained/produced from the hydro-metallurgical **leaching** of PMs from PM containing solid materials (i.e. dissolution of PMs leaving a lower grade residue). Could be considered as cementation processes	
Slimes obtained/produced from the hydro-metallurgical **leaching** of PMs from PM containing solid materials (i.e. dissolution of PMs leaving a lower grade residue)	Various
Slimes obtained/produced by **precipitation** from solutions containing PMs	Ag-anode slime leaching solution
Slimes obtained/produced by **precipitation** from solutions containing PMs. PGM concentrate: filtering, drying and packing	Slime from Au reduction
Slimes obtained/produced by **precipitation** from solutions containing PMs. After Cl leaching and precipitation of gold remains Pd and Pt in the solution. Those elements are precipitated as metal powder with sodium formate.	
Slimes obtained/produced by **precipitation** from solutions containing PMs	PM matte
Slimes obtained/produced by **precipitation** from solutions containing PMs	Metal recovery by precipitation from Cu hydrometallurgy
Slimes obtained/produced by **precipitation** from solutions containing PMs	Various

REFINABLE 5.1 - RESIDUES, COPPER-IRON-LEAD-NICKEL MATTE, SULFURIC ACID-INSOL.

Identifiers

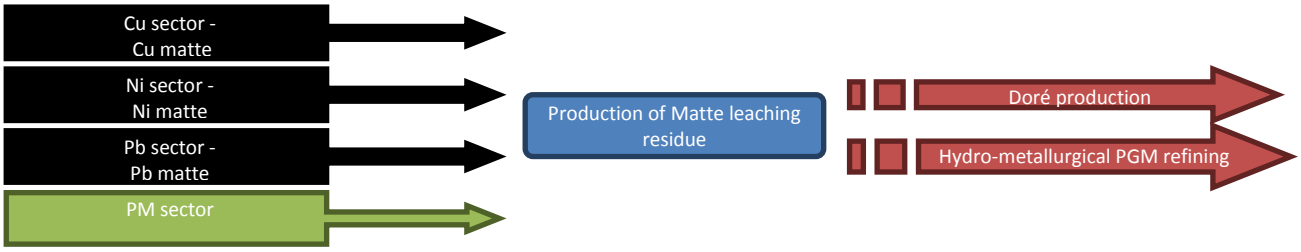
	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Residues, copper-iron-lead-nickel matte, sulfuric acid-insol.	Residues, copper-iron-lead-nickel matte, sulfuric acid-insol.
EC number	310-050-8	310-050-8
CAS number	102110-49-6	102110-49-6
Description	Dry or wet insoluble residues resulting from successive sulfuric acid-based leaching and/or pyro-metallurgical processes applied on primary and secondary streams resulting from the refining of copper, nickel and other base metals-containing ores and concentrates. Residues from copper-iron-lead-nickel matte leaching mainly contain precious and base metals such as copper, nickel and iron in metallic, sulphate, hydroxide and other mineral forms in varying concentrations.	None

Remark: the original EC description does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (i.e. a UVCB shall in general be identified by its name, its origin or source and the most relevant steps taken during processing.) Therefore, the description in above table is proposed by the PMC.

CSR description of manufacturing process

Residues, copper-iron-lead-nickel matte, sulfuric acid-insol. are dry or wet insoluble residues resulting from successive sulfuric acid-based leaching and/or pyro-metallurgical processes applied on primary and secondary streams resulting from the refining of copper, nickel and other base metals-containing ores and concentrates.

The below flowsheet identifies influx/outflux substances in the production of Residues, copper-iron-lead-nickel matte, sulfuric acid-insol. Green/red arrows are used for influx from/outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



Though the production of residues from the leaching of matte is the result of a single process (leaching with sulphuric acid), the materials that can be fed to this leaching process are typically from more than one source (copper, nickel, lead or others), and can be leached together depending on the material available from registrant to registrant, and from day to day. Hence, the sources (because they are not necessarily pre-selected and can be smelted together) and process to produce a Cu or Ni rich matte are the same.

Although registrants having precious metals production 'annexed' to a copper or nickel production are more likely to use feedstocks from the copper or nickel refining, respectively, these same registrants may use other primary and secondary sources in addition to the outputs of their copper or nickel production too. When using copper refining outputs, the matte will contain more Cu and metals 'carried' by the Cu (Ag, Au, etc.). When using nickel refining outputs, the matte will contain more Ni, and metals 'carried' by the Ni (PGM, etc.). This explains why the concentration ranges for the constituents in these residues are larger for these metals than for others, and why the residues from leaching of some registrants will typically contain more Cu and Ag, and others' will contain more Ni and PGM.

If the resulting residue is high in PGM, it will be used as input material to the hydro-metallurgical process steps aiming at recovering PGM. If the residue contains more Cu and hence, more Ag and Au, it will fed to the smelting of feeds leading to the production of doré.

Production processes based on data submitted by PM Refiners in 2009

Only one registrant provided a description of their production process that fits the description above.

REFINABLE 6.1 - ELECTROLYTE, SILVER ELECTROLYSIS

Identifiers

	Proposed by PMC Refiners Work Group	Pre-registered as	
Name	Electrolyte, silver electrolysis	Slimes and Sludges, precious metal refining	Reaction mass of silver nitrate, copper dinitrate (and nitric acid)
EC number	911-538-9	308-516-0	231-853-9, 221-838-5 (231-714-2)
CAS number		98072-61-8	7761-88-8, 3251-23-8 (7697-37-2)
Description	Fresh or spent aqueous silver nitrate solution used in and resulting from the electrolytic refining of silver. This electrolyte is constituted of silver nitrate, copper dinitrate, nitric acid, and it may contain some other metallic and non-metallic ions in varying concentrations, which will vary depending on the nature and composition of the primary or secondary raw material from which silver is recovered.	None	None

Production processes / sources based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for Electrolyte, silver electrolysis was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Sources
Electrolyte bleed from silver electrolytic refining	Solution of AgNO3 and HNO3; Silver anodes
Obtained after leaching of the slime from silver electrolysis	Slime, silver electrolysis
Dissolving silver crystals in HNO3	Silver crystals, HNO3
Electrolyte bleed from silver electrolytic refining	Product with high Ag content from primary sources

REFINABLE 6.2 - ELECTROLYTE, GOLD ELECTROLYSIS

Identifiers

	Proposed by PMC Refiners Work Group	Pre-registered as
Name	Electrolyte, gold electrolysis	Slimes and Sludges, precious metal refining
EC number	913-584-5	308-516-0
CAS number		98072-61-8
Description	Fresh or spent aqueous gold trichloride solution used in and resulting from the electrolytic refining of gold. This electrolyte is constituted of gold trichloride, clorhidric acid, and it may contain some other metallic and non-metallic ions in varying concentrations, which will vary depending on the nature and composition of the primary or secondary raw material from which gold is recovered.	None

Production processes / sources based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for Electrolyte, gold electrolysis was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Sources
Electrolyte bleed from gold electrolytic refining	Solution of AuCl3 and HCl; Gold anodes
Obtained after gold precipitation from the spent electrolyte from gold electrolysis	Spent electrolyte, gold electrolysis

REFINABLE 7 – FLUE DUST, PRECIOUS METAL REFINING

Identifiers

	Proposed by PMC Refiners Work Group	Pre-registered as	
Name	Flue dust, precious metal refining	Flue dust, precious metal refining	Flue dust, silver-refining
EC number	308-496-3	308-496-3	308-276-7
CAS number	98072-44-7	98072-44-7	97926-57-3
Description	Product resulting from the smelting, refining and/or use of PMs and its alloys obtained from primary and secondary sources and including recycled plant intermediates. Recovered from exhaust air by filtration via cloth bags, arising from hygiene extraction systems on processes in the Precious metals recovery flowsheet. Flue dusts mainly contain metal oxides, hydroxides, sulphides and chlorides in varying concentrations, with some small quantities of precious metals.	The dust obtained from the refining of materials from primary and secondary sources containing gold, iridium, osmium, palladium, platinum, rhenium, ruthenium and silver. Composed primarily of lead with traces of other metals.	Product resulting from the smelting, refining and/or use of silver and its alloys obtained from primary and secondary sources and including recycled plant intermediates. Consists primarily of oxides and halide compounds of silver and lead and may contain other residual non-ferrous metals and their compounds.

Remark: the original EC description is incorrect/does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (i.e. a UVCB shall in general be identified by its name, its origin or source and the most relevant steps taken during processing.) Therefore, the description in above table is proposed by the PMC.

Substances also falling under this group:

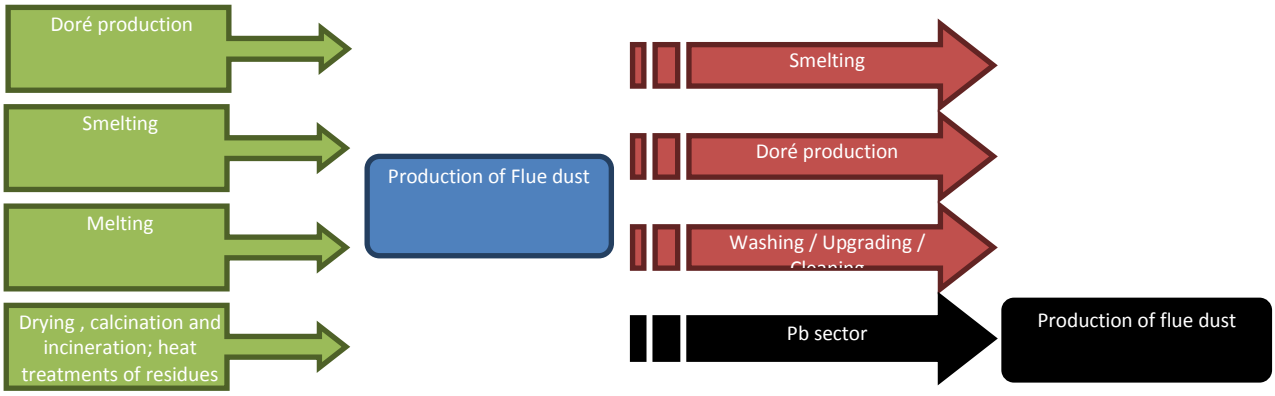
Name	EC number	CAS number	Description (EC inventory)
Flue dust, silver-refining	308-276-7	97926-57-3	Product resulting from the smelting, refining and/or use of silver and its alloys obtained from primary and secondary sources and including recycled plant intermediates. Consists primarily of oxides and halide compounds of silver and lead and may contain other residual non-ferrous metals and their compounds.

Remark: No registration dossier will be prepared by the PMC for the materials listed in the above table. PMC Members are recommended to register their material using the identifiers for Flue dust, precious metal refining, for which a dossier will be prepared by the PMC.

CSR description of manufacturing process

Flue dust, precious metal refining is the dust generated as a by-product during the pre-treatment, smelting, refining and/or use of precious metals and their alloys obtained from primary and secondary sources and including recycled plant intermediates. Recovered from exhaust air by filtration via cloth bags and cartridge filters, arising from hygiene extraction systems on processes in the precious metal recovery flowsheet, flue dusts are collected in a centralised system in order to be reused as input material for the precious metals production or other metals production, depending on their content.

The below flowsheet identifies influx/outflux substances in the production of Flue dust, precious metal refining. Green/red arrows are used for influx from/outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



The production of flue dust occurs in all sites having thermal treatments, pyro-metallurgical operations, and process and/or hygiene gas collection. Flue dusts are collected in order to prevent emissions to air as well as to recover any (precious) metal which escaped as dust during a given hot process or other operation. Flue dusts, because of the reason they are generated, are composed of all (and many) elements which may have escaped a process, ranging from the more valuable to the less valuable ones. Except for lead (which is a natural carrier of metals which is used in most pyro-metallurgical refining steps to improve the recovery rates of precious metals), most of the constituents present in flue dust will be contained in relatively low amounts.

Although they result from various processes which use various sources, flue dusts from precious metals refining cannot be separated per process because they are physically collected via the same centralised exhaust ventilation system in each site. Though such systems will normally be installed per production loop (i.e. flue dusts from a copper or lead production annexed to a precious metals production would be collected separately from the flue dust generated in the precious metal production areas), some overlaps may exist depending on the configuration of the various production sites. It is hence 'normal' to have high copper and lead content in precious metals refining flue dust, when for example, the copper or lead refining is physically not fully segmented from the precious metals refining, or due to differences in 'determining' the start and end of each refining loop across sites (e.g. the production of doré may start with the roasting of the copper slime to remove Se before smelting, or sometimes the Se is removed after smelting). But this overlap is in most cases very minor.

As for any Refinable, the flue dust will be poor or rich in precious metals depending on the stage of the refining where it occurs and the sources that fed the refining process for that registrant, that day. If the main operation of a given site that day was to smelt input material to produce doré or matte, the flue dust will be very rich in base metals and possibly also silver, and comparatively poor in gold and PGM. To the contrary, if the main operation of a given site that day was to pre-treat spent catalysts before hydro-metallurgical recovery of PGM, the flue dust will be very rich in nickel and PGM, when compared to other constituents. Again, because all flue dusts are collected together, the differences across registrants and days cannot be accounted for in the substance identification and the result is a UVCB of significantly large and variable composition.

Production processes / sources based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for Flue dust was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Source
Flue Dust produced as a by-product of PM Smelting operations, material is then leached for PGM recovery	
Flue dust captured from reductive smelting of PM bearing feeds to produce a PM Pb alloy and a base metal silicate and borate slag	A mixture of lead oxide, silicates and fluxes containing low concentrations of PM's from secondary sources.
Dust collected from bag filter of fire refining process (from Trof converter)	
Obtained from the production process of metal dore - smelting and refining in TBRC Converter (Dust TBRC 1 Converter)	Decopperized Slime from copper electrolysis
Obtained in the further pyrometallurgical refining of doré (Ag rich materials) (Dust TBRC 2 Converter)	Dore, Raw silver, Silver rich bullion, Silver rich materials
Metal fume and dust is generated by processes for smelting and refining silver. It is filtered from the air by cloth bags.	Finely divided metal oxides and other fine particulates recovered from process exhaust air by filtration cloth bags. Fate: Returned to the Ag Rotary Furnace for recovery / disposal.
Flue Dust produced as a by-product of Precious Metal Smelting operations, material is then leached for PGM recovery	Smelting of Products with high PM content from primary and secondary sources
The dust obtained from the refining of materials from primary and secondary sources containing gold, iridium, osmium, palladium, platinum, rhenium, ruthenium and silver. Composed primarily of lead with traces of other metals	Products with high (>20%) PM content from primary and secondary sources (such as silver crusts,…)

REFINABLE 8 - RESIDUES, PRECIOUS METAL REFINING CEMENTATION AND REDUCTION

Identifiers

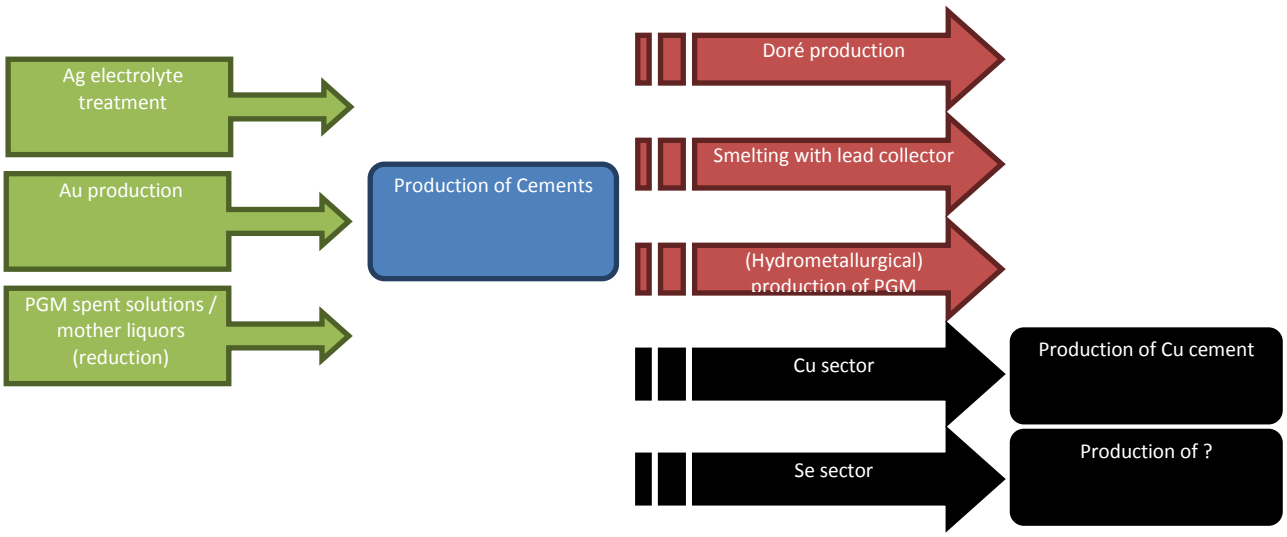
	Proposed by PMC Refiners Work Group	Pre-registered as	
Name	Residues, precious metal refining cementation and reduction	Residues, precious metal refining cementation	Slimes and Sludges, precious metal refining
EC number	310-051-3	310-051-3	308-516-0
CAS number	102110-50-9	102110-50-9	98072-61-8
Description	Dry and wet residues recovered through cementation and/or reduction with a reducing agent (such as aluminium, copper, iron, zinc or organic agents) of precious metal refining streams before release to waste water treatment operations. Residues include cements and polishing sludges which generally contain precious metals, metal oxides, and metal chlorides in varying concentrations.	The residues obtained by the addition of aluminum or zinc to end liquors obtained from secondary refining of gold, iridium, osmium, palladium, platinum, rhenium, ruthenium or silver. Composed primarily of the precious metals, ammonium chloride and chlorides of aluminum, magnesium and zinc.	None

Remark: the original EC description is incorrect/does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (i.e. a UVCB shall in general be identified by its name, its origin or source and the most relevant steps taken during processing.) Therefore, the description in above table is proposed by the PMC.

CSR description of manufacturing process

Residues, precious metal refining cementation and reduction are dry and wet residues recovered through cementation and/or reduction with a reducing agent (such as aluminium, copper, iron, zinc, hydrazine or organic agents) of precious metal refining streams before they are released to waste water treatment operations. Residues include cements and polishing sludges.

The below flowsheet identifies influx/outflux substances in the production of Residues, precious metal refining cementation and reduction. Green/red arrows are used for influx from/outflux to precious metal sector, whereas black arrows indicate influx from/outflux to other base metal sectors.



The recovery of valuable metals before the spent liquors from hydro-metallurgical are released to waste water treatment units is a best practice (both commercial and environmental) in all sites having electrolysis or hydro-metallurgical operations to refine precious metals. Indeed, residues from cementation or reduction, commonly described in general as cements, are produced in order to prevent emissions to water as well as to recover any (precious) metal which escaped in any of the solvents during a given electrolysis or hydro-metallurgical process or related operation. Cements, because of the reason they are generated, are composed of all (and many) elements which may have escaped a process, ranging from the more valuable to the less valuable ones, but are usually rich in copper and precious metals (note: rich in PGM needs to be interpreted differently than for copper or silver content; very small

concentrations of PGM are commercially as valuable as large concentrations of silver). When selenium has not been removed upfront in the refining process, the cementation and reduction is used to recover it, and selenium can hence be present in very large concentrations in the cements or residues as well.

Although they result from one process (chemical reduction, also called cementation or precipitation), because the process can be applied on a variety of more or less purified sources concomitantly, it is not possible to refine the variability in composition of residues and cements produced in the precious metals industry. The choice of reactant will also depend on the nature of the composition of the spent liquors produced by a given registrant, a given day, as determined/influenced by the starting materials used for the initial refining steps.

Production processes / sources based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for Residues, precious metal refining cementation and reduction was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Source
Precipitated sludge	Cementation, reduction
Cementation processes on refining effluent streams.	All process refining streams directed to the effluent plant.
Cementation silver with copper powder from Ag electrolyte bleed and with iron powder from silver chloride obtained in gold production process.	Products with high silver content from primary sources
Residues obtained by the addition of a reductant (aluminium, zinc, copper, …) to end liquors of the refining of precious metals	Wastewaters from various PM refining steps
A residue produced by the formic acid reduction of palladium solutions	A mixture of palladium oxide, hydroxide and metal from primary and secondary sources.
A residue produced by the formic acid reduction of rhodium solutions	A mixture of rhodium oxide, hydroxide and metal from primary and secondary sources.
Produced by the iron and/or zinc cementation of aqueous precious metal containing solutions	A mixed PM and base metal residue from primary and secondary sources.

REFINABLE 9.1 - MATERIALS FOR RECLAIM, PM WITH OR WITHOUT SUPPORTS

Identifiers

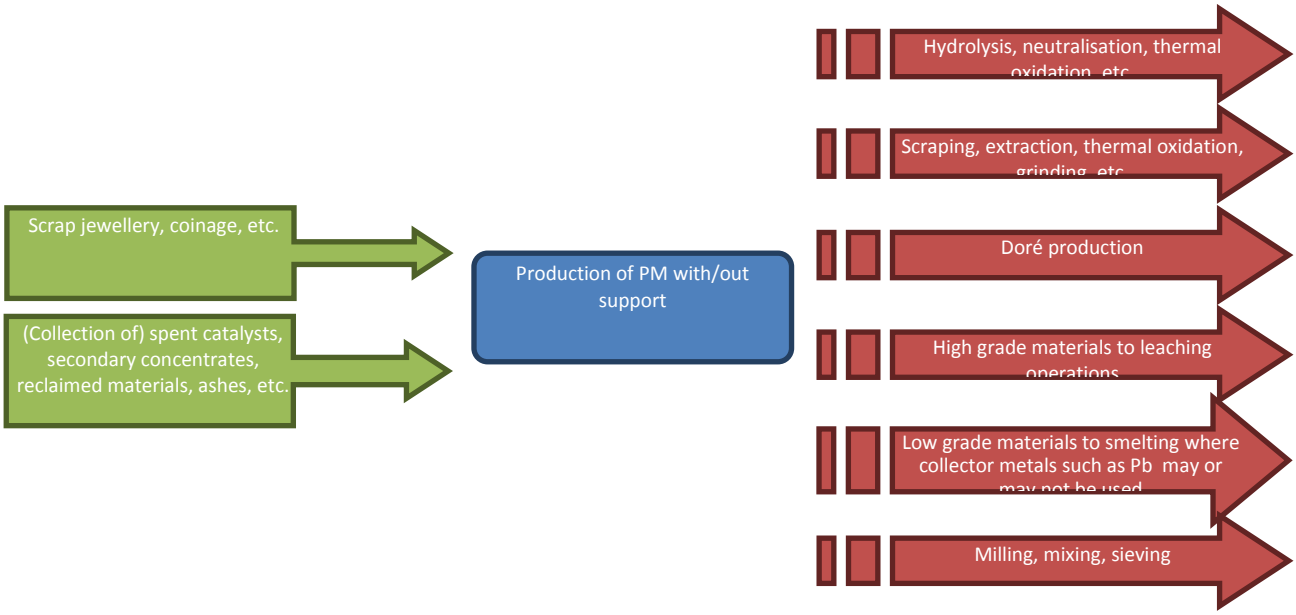
	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Materials for reclaim, precious metals with or without supports	Waste solids, precious metal refining
EC number	308-526-5	308-526-5
CAS number		98072-70-9
Description	Primary and secondary sources of precious metals in metallic, oxide, chloride and other forms in varying concentrations, resulting from the application of thermal or thermo-chemical processes or end-of-life criteria whose supports may, where present, include varying amounts of: □ Ceramics (such as silica, alumina and zeolites), □ Carbon or organics (such as carbon, paper, or plastics), and/or □ Metallics (such as stainless steel or other transition metal alloys).	None

Remark: the original EC name "Waste solids, precious metal refining" does not match as the entry in the EC inventory was split in 3 registrations for 2010 registration:
1) Materials for reclaim, precious metal with or without supports
2) Materials for reclaim, precious metal in bricks, crucibles, trays, etc. (covered in this CSR)
3) Materials for reclaim, precious metal production by-products
The original EC number 308-526-5 was used for registration of the first group. No separate EC entry was found in 2010 for groups 2 and 3 and a separate entry was created.
The original EC description does not fulfil the ECHA guidance for identification and naming of substances under REACH and CLP (i.e. a UVCB shall in general be identified by its name, its origin or source and the most relevant steps taken during processing.) Therefore, above description is proposed by the PMC.

CSR description of manufacturing process

Materials for reclaim, precious metals with or without supports are primary and secondary sources of precious metals in metallic, oxide, chloride and other forms in varying concentrations, resulting from the application of thermal or thermo-chemical processes or end-of-life criteria, whose supports may, where present, include varying amounts of:
□ Ceramics (such as silica, alumina and zeolites),
□ Carbon or organics (such as carbon, paper, or plastics), and/or
□ Metallics (such as stainless steel or other transition metal alloys).

The below flowsheet identifies influx/outflux substances in the production of materials for reclaim, Precious Metal with or without supports. Green/red arrows are used for influx from/outflux to precious metal sector.



Precious metals are scarce metals. They are present as traces in the ores and ores concentrates of other metals, as well as in by-products from the production of other metals, and in precious metal products which have been spent during use and can be re-used as feedstock to recover the precious metal content. In whatever form and wherever they come from, they are reclaimed, separated from the less valuable constituents, and further refined. The variability in composition of this Refinable results from the fact that it groups materials of similar physical form (all solids), with relatively high concentrations of precious metals, arising from different sources and process or products.

In some EU Member States these materials would be considered to be wastes (out of the scope of registration under REACH) or by-products (exempt from registration unless they are placed on the market), in other Member States they are not. There was one existing EINECS entry 'fitting' with this group of materials and various chemically transformed primary sources (since naturally occurring and not chemically transformed ores and ore concentrates are exempted from registration under REACH). The registration was submitted using the existing EINECS entry, even if it would not fully fit with the description of this Refinable, in order to legitimize the access of these materials to the EU market, as non-wastes, in line with the objective of the EU Raw Materials Initiative.

Production processes based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for Materials for reclaim, precious metals with or without supports was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Source
Secondary concentrate	PGM refining
Reclaimed/spent catalysts	Catalytic processes
PGM enriched feedstock for thermal process prior to smelting	PGMs collected onto activated charcoal in recovery processes or as part of a catalyst for recycling
PGM feedstock for smelting	PGMs collected in filteraid in recovery processes or as part of a catalyst for recycling
Recovered catalyst materials, and other PM containing residues from pyrometallurgical operations.	Alumina silicate materials containing low concentrations of PM's from secondary sources.

REFINABLE 9.2 - MATERIALS FOR RECLAIM, PM IN BRICKS, CRUCIBLES, TRAYS, ETC.

Identifiers

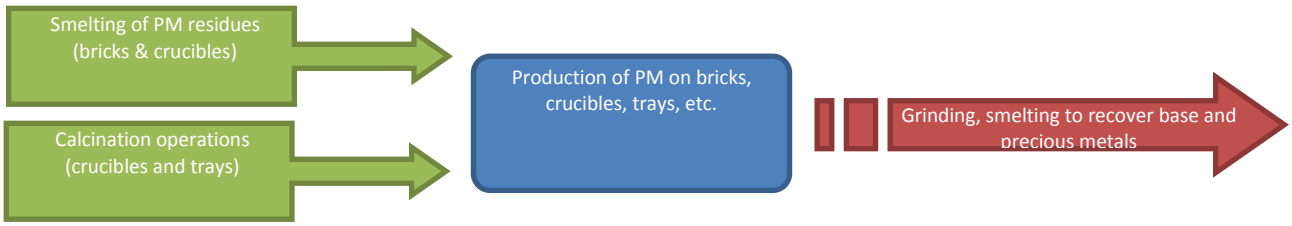
	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Materials for reclaim, precious metals in bricks, pots, crucibles and trays, etc.	Waste solids, precious metal refining
EC number		308-526-5
CAS number		98072-70-9
Description	Spent artifacts used in the processing of precious metal streams that have retained fractions of precious metals from/during processing and that are reclaimed as secondary sources of precious metals. These materials may be silicate or refractory based, and contain low and varying concentrations of precious metals in metallic, oxide, and other forms. These materials are crushed to varying degrees and added to smelting furnaces where they act as both flux and precious metal source.	None

Remark: No separate EC entry was found in 2010 for this substance, as it is a split from EC entry 308-526-5. EC entry 308-526-5, with the original EC name "Waste solids, precious metal refining" was split in 3 registrations for 2010 registration:
1) Materials for reclaim, precious metal with or without supports
2) Materials for reclaim, precious metal in bricks, crucibles, trays, etc. (covered in this CSR)
3) Materials for reclaim, precious metal production by-products
The list number assigned by ECHA for group 2 is 931-674-2.

CSR description of manufacturing process

Materials for reclaim, PM in bricks, crucibles, trays, etc. are spent artifacts used in the processing of precious metal streams that have retained fractions of precious metals from/during processing and that are reclaimed as secondary sources of precious metals.
These materials may be silicate or refractory based, and contain low and varying concentrations of precious metals in metallic, oxide, and other forms.
These materials are crushed to varying degrees and added to smelting furnaces where they act as both flux and precious metal source.

The below flowsheet identifies influx/outflux substances in the production of Materials for reclaim, Precious Metal in bricks, crucibles, trays, etc. Green/red arrows are used for influx from/outflux to precious metal sector.



Precious metals are scarce metals. They are retained by the process equipment used for the refining or precious metal containing feeds and as such are present in valuable concentrations in bricks, crucibles, trays, etc. They are present in low concentrations in these spent artifacts, but still in concentrations which are worth recovering, considering the scarcity of precious metals. The variability in composition of this Refinable results from the fact that it groups various sources collected and used together, of inert composition, with low concentrations of precious metals.

In some EU Member States these materials would be considered to be wastes (out of the scope of registration under REACH), in other Member States they are not. Though they are in principle re-used on-site, they can also be made available from sources others than the site which treats them to recover the precious metal content. Overall, the re-use of these artifacts reduce the production of waste and allow the recovery of precious metals.

There was no EINECS entry 'fitting' with this group of materials, which were preliminarily pre-registered under another EINECS number. Hence the registration was submitted without an EINECS number, in order to generate one which would legitimize the access of these materials to the EU market, as non-wastes, in line with the objective of the EU Raw Materials Initiative.

Production processes based on data submitted by PM Refiners in 2009

Based on the data submitted by PM Refiners in Summer 2009 (after grouping of PM Refinables as per registration), below table of production processes for Materials for reclaim, precious metals in bricks, pots, crucibles and trays, etc. was produced. Those Refinables that were identified by PM Refiners as REACH exempt (following updated substance and tonnage band declarations from Jan 2013) have been removed.

General description of production process	Source
Leach residues originating from recycled refractories	Bricks, pots and crucibles crushed after end of life to recover PGMs
Recovered refractory materials from lead smelting of PM feeds containing economically recoverable quantities of precious metals.	Chrome magnesia refractory containing low concentrations of PM's from secondary sources.
Recovered silicon carbide crucibles from melting of precious metal containing materials	Silicon carbide alumina materials containing low concentrations of PM's from secondary sources.

REFINABLE 9.3 - MATERIALS FOR RECLAIM, PRECIOUS METAL PRODUCTION BY-PRODUCTS

Identifiers

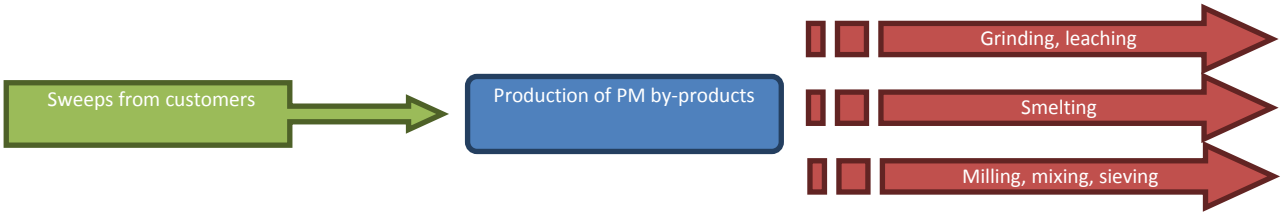
	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Materials for reclaim, precious metal production by-products	Waste solids, precious metal refining
EC number		308-526-5
CAS number		98072-70-9
Description	Materials that are non-intentional products of the production and refining of precious metals, which contain precious metals as well as other metals and their compounds (oxides and others) in varying concentrations. One example of such refining by-products are so-called production "sweeps" and dusts. These materials will either undergo hydrometallurgical processes to leach the precious metal content or be smelted to recover the precious metals.	None

Remark: No separate EC entry was found in 2010 for this substance, as it is a split from EC entry 308-526-5. EC entry 308-526-5, with the original EC name "Waste solids, precious metal refining" was split in 3 registrations for 2010 registration:
1) Materials for reclaim, precious metal with or without supports
2) Materials for reclaim, precious metal in bricks, crucibles, trays, etc. (covered in this CSR)
3) Materials for reclaim, precious metal production by-products
The list number assigned by ECHA for group 3 is 931-663-2.

CSR description of manufacturing process

Materials for reclaim, Precious Metal production by-products are materials that are non-intentional products of the production and refining of precious metals, which contain precious metals as well as other metals and their compounds (oxides and others) in varying concentrations.
One example of such refining by-products are so-called production "sweeps" and dusts.
These materials will either undergo hydrometallurgical processes to leach the precious metal content or be smelted to recover the precious metals.

The below flowsheet identifies influx/outflux substances in the production of Materials for reclaim, Precious Metal production by-products. Green/red arrows are used for influx from/outflux to precious metal sector.



Precious metals are scarce metals. They are released during processing into various forms that can be collected and re-used as input material to precious metals refining processes. They are present in low concentrations in these production by-products, but still in concentrations which are worth recovering, considering the scarcity of precious metals. The variability in composition of this Refinable results from the fact that it groups by-products collected in a centralized manner from various processes and used as a mixture input material in precious metals refining processes.

In some EU Member States these materials would be considered to be wastes (out of the scope of registration under REACH), or by-products (exempt from registration unless they are placed on the market) in other Member States they are not. Though they are in principle re-used on-site, they can also be made available from sources others than the site which treats them to recover the precious metal content. Overall, the re-use of these by-products reduce the production of waste and allows the recovery of precious metals.

There was no EINECS entry 'fitting' with this group of materials, which were preliminarily pre-registered under another EINECS number. This Refinable's registration constitutes a home for all by-products from precious metals refining which do not belong to the Materials for reclaim, precious metals with or without

support; or Materials for reclaim, precious metals in bricks, crucibles, and trays, etc. The registration was submitted without an EINECS number, in order to generate one which would legitimize the access of these by-product materials to the EU market, as non-wastes, in line with the REACH requirements for by-products placed on the market, and the objective of the EU Raw Materials Initiative.

Production processes based on data submitted by PM Refiners in 2009

Only one registrant provided a description of their production process that fits the description above.

REFINABLE 10 - LEAD BULLION, PLATINUM GROUP METALS RICH

Identifiers

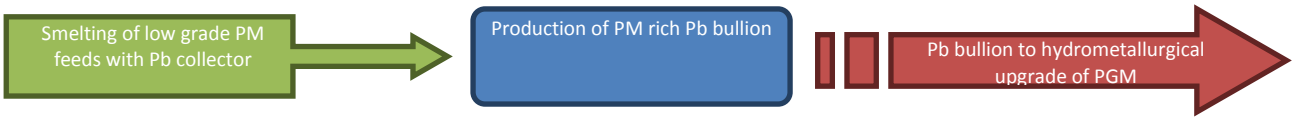
	Proposed by PMC Refiners Work Group	Original (in EC inventory)
Name	Lead Bullion, Platinum Group Metals Rich	Lead Bullion
EC number		308-011-5
CAS number		97808-88-3
Description	Primary and secondary feed materials usually in the form of residues containing low concentrations of precious metals, together with higher and variable concentrations of base metals and refractory materials that are mixed with fluxes and smelted with a lead collector, resulting in two phases: a lead one which concentrates precious metals, and a silicate slag phase (Slags, precious metals refining). The lead phase, or Platinum Group Metals rich Lead Bullion is used as a feed in the hydrometallurgical upgrading of platinum group metals; it contains predominantly lead with lower concentrations of platinum group metals, silver and gold and other non-ferrous metals in varying concentrations.	Lead Bullion is a mixed metallic substance usually formed during the primary production of lead but may also be from the smelting of secondary lead containing materials. This substance can contain high concentrations of lead and will also contain other metals in varying concentrations depending on the source of the material.

Remark: No separate EC entry was found in 2010 for this substance, as it is a split from EC entry 308-011-5 (registered by the Pb consortium). The list number assigned by ECHA is 931-607-7. The name proposed by the PMC is "Lead bullion, Platinum Group Metals rich". The above description for this substance is proposed by the PMC.

CSR description of manufacturing process

Lead Bullion, Platinum Group Metals Rich are produced from primary and secondary feed materials usually in the form of residues containing low concentrations of precious metals, together with higher and variable concentrations of base metals and refractory materials that are mixed with fluxes and smelted with a lead collector, resulting in two phases: a lead one which concentrates precious metals, and a silicate slag phase (Slags, precious metals refining).
After granulation the lead phase, or Lead Bullion, Platinum Group Metal Rich is used as a feed in the hydrometallurgical upgrading of platinum group metals; it contains predominantly lead with lower concentrations of platinum group metals, silver and gold and other non-ferrous metals in varying concentrations.

The below flowsheet identifies influx/outflux substances in the production of Lead Bullion, Platinum Group Metals Rich. Green/red arrows are used for influx from/outflux to precious metal sector.



Though the production of of a Precious Metals rich lead bullion is the result of a single process (smelting with selected fluxes), the materials that can be fed to this smelting process are typically from more than one source (copper, nickel, lead or others), and can be smelted together depending on the material available from registrant to registrant, and from day to day. Hence, the sources (because they are not necessarily pre-selected and can be smelted together) and process to produce a silver rich lead bullion or a PGM lead bullion, are the same.

The variability in composition of each constituent in this Refinable, and in particular the variability in each precious metals content, reflects the possible versions of a precious metal rich bullion that can be manufactured; if silver content is high, PGM content will be low, and vice-versa. The other constituents present will be present in lower or higher concentrations depending on the source materials' composition available for that specific smelting lot; for example, if a copper rich material was used, the concentration of copper will be high.

Production processes based on data submitted by PM Refiners in 2009

Only one registrant provided a description of their production process that fits the description above.