

Human Health and Environmental classification of PM Refinables
as reviewed in light of the 2nd ATP to CLP with MeClas by using the composition and T/D data available in the ID Cards, the reference samples, the individual company streams, and any new information becoming available

Version: 22 June 2012

General comments

- a. LR IUCLID 5 files will cover all classifications relevant for each Refinable
- b. Co-registrants are invited to include exactly the same information in section 1.2 of IUCLID 5 as the one included in the LR file to cover all streams registered by the LR. Section 2 of IUCLID 5 on classification should only be completed in the LR's file in order to prevent other registrants to be regarded as opting-out from the proposed classifications (which may trigger higher registration fees and requests for harmonisation by ECHA or Member States)
- c. Company-specific classifications and refinements:
 - Can be done by using MeClas after the proper purchase of the licence (www.meclas.eu)
 - By applying in-house data on species, T/D, and particle size and/or surface area
- d. If a company stream is not properly addressed from a composition and/or classification viewpoint in the LR IUCLID 5 file (classifications in the LR's file can be more conservative and severe), the company can adopt less stringent classification in its SDS (cf. ECHA Helpdesk's answer to KGHM's question dated November 2010)
- e. Classifications in the LR file may be proposed as:
 - Grouped classifications based on composition profile → this is proposed for smaller and more uniform (yet still sufficiently variable to be considered as UVCB) groups, where a number of given composition profiles is expected to be manufactured and/or imported
 - o Doré
 - o Matte
 - o Residues matte leaching
 - o Residues speiss leaching
 - o Ag electrolyte
 - o Au electrolyte
 - o Materials for reclaim, PM in bricks, pots, crucibles and trays, etc.
 - Grouped classifications based on cluster analysis and expert judgement → this is proposed for very large and variable groups, where many combinations are possible and hence there was a need to apply cluster analysis to identify conservative classification profiles to arrive at a reasonable number of possible classifications for the individual streams belonging to each UVCB substance
 - o Slags
 - o Slimes and sludges
 - o Flue dust
 - o Residues cementation and reduction
 - o Materials for reclaim, PM with or without support
 - o Materials for reclaim, PM production by-products
- f. Compositions or triggers associated to each classification provide a non-exhaustive list of those constituents which can be present in each Refinable (compromise between referring only to major driver versus listing all classified elements)
- g. Reference to classification cut-off will be done by using the elemental composition (species added in Remarks field) associated to CLP cut-offs. Please note that the DSD classification cannot always be unambiguously linked to CLP classification.

1. Doré:

Notes:

- All constituents assumed to be in metallic form
- Alloying effects between Ag and Cu prevent Ag or Cu to leach in environmentally relevant waters; hence no environmental classification for massive as long as Ag < 92 % and Cu < 70 %
- Human health classification driven by several constituents including Ni and Pb
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Classification DSD	Composition / classification drivers
1	No classification	No classification	Ag < 92%; Cu < 69,5% (pure) or < 25% (impure); Ni < 1%; Pb comp < 0,3%; Co < 1%; Cd < 0,1%; Cu2O < 10% $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\ comp\% + Sb\%)/500) > 2000$ and any of the conditions below are not met
ENVIRONMENTAL ENDPOINTS			
2	ENV Ac 1, Env Ch 3	N; R50-53	$(\%Ag \times 0,0000044 + \%Cu \times 0,00013) * 100 > 1$
3	ENV Ac 1, Env Ch 2	N; R51-53	$(\%Ag \times 0,0000044 + \%Cu \times 0,00013) * 10 > 1$
HUMAN HEALTH ENDPOINTS			
4	Repro. 1A, STOT Rep 2	R20/22 R60/61 R48	Ni < 1%; Pb comp 0,5% - 1%; Co < 1%; Cd < 0,1%; Cu2O < 10% $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\ comp\% + Sb\%)/500) > 2000$
5	Carc. 2, Repro. 1A, STOT Rep 2	R20/22 R40 R48 R60/61	Ni < 1%; Pb comp 1-15%; Co < 1%; Cd < 0,1%; Cu2O < 10% $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\ comp\% + Sb\%)/500) > 2000$
6	Carc. 2, Repro. 1A, STOT Rep 2, Skin sens. 1	R20/22 R40 R48 R60/61 R43	Ni >= 1%; Pb comp 1-15%; Co < 1%; Cd < 0,1%; Cu2O < 10% $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\ comp\% + Sb\%)/500) > 2000$
7	Carc. 2, Repro. 1A, STOT Rep 2, Skin sens. 1, Ac. Tox. oral+inhalation 4	R20/22 R40 R48 R60/61 R43	Ni >= 1%; Pb comp >= 15%; Co < 1%; Cd < 0,1%; Cu2O < 10% $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\ comp\% + Sb\%)/500)$ between 300 - 2000

2. Matte, precious metals refining:

Notes:

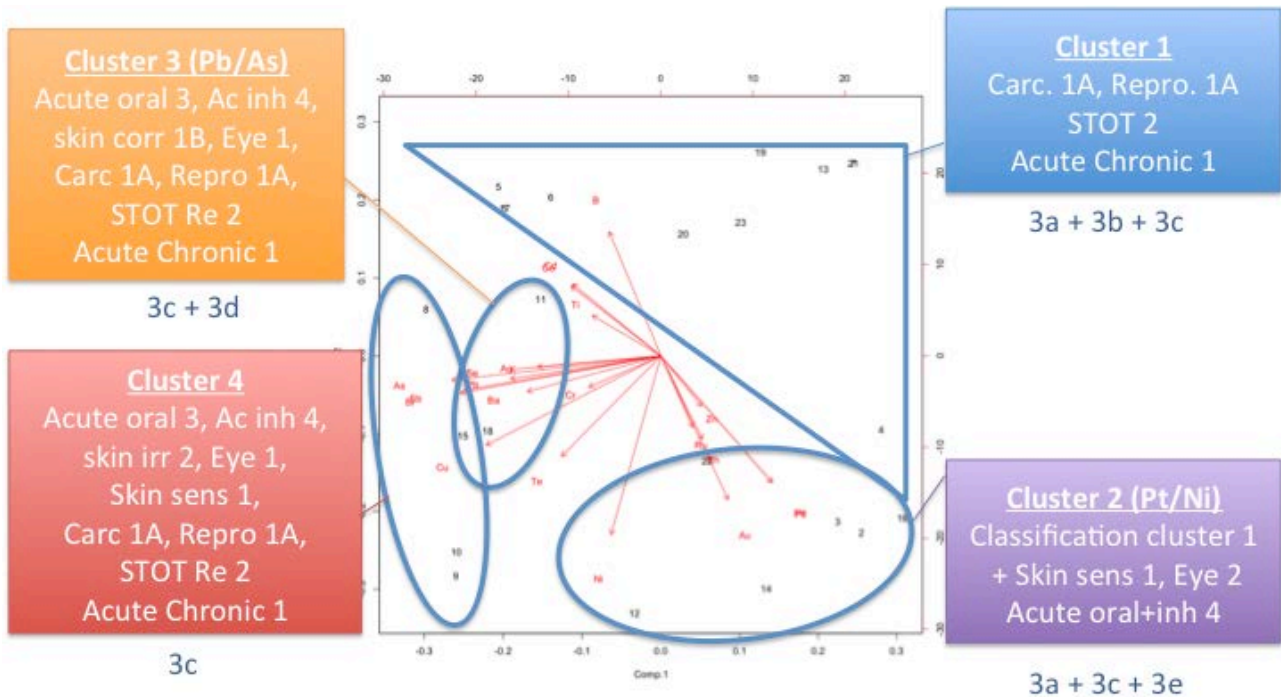
- All constituents assumed to be in metallic or sulphide form
- Grouped classifications proposed
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 1B, Repro. 1A, STOT Rep 2, ENV Ch 2	R45 R60/61 R51-53 R48	Ni powder < 1%; CoS < 1% CdS: 0,1% - 1%; Pb comp >= 0,5% $100 / ((\%As + \%Se\ comp + \%Te/Te\ comp)/100 + (\%CdS + \%Pb\ comp + \%Sb/Sb\ comp + \%Pb\ powder)/500) > 2000$ mg/kg $100 / ((\%As + \%Se\ comp)/700 + (\%Pb\ comp + Pb\ powder + \%Sb/Sb\ comp)/4500) > 20000$ mg/kg $(\%Cu \times 0,024 + \%Pb \times 0,044 + \%Co \times 0,11) < 1$ $(\%Cu \times 0,00062 + \%Pb \times 0,048 + \%Co \times 0,69) *10 > 1$
2	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ch 2, Skin sens. 1	R40 R60/61 R51-53 R43 R48	Ni powder >= 10% Pb comp >= 1%; CdS < 0,1% $100 / ((\%As + \%Se\ comp + \%Te/Te\ comp)/100 + (\%CdS + \%Pb\ comp + \%Sb/Sb\ comp + \%Pb\ powder)/500) > 2000$ $100 / ((\%As + \%Se\ comp)/700 + (\%Pb\ comp + Pb\ powder + \%Sb/Sb\ comp)/4500) > 20000$ mg/kg $(\%Cu \times 0,024 + \%Pb \times 0,044 + \%Co \times 0,11) < 1$ $(\%Cu \times 0,00062 + \%Pb \times 0,048 + \%Co \times 0,69) *10 > 1$
3	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ch 2, Skin sens. 1, Ac. Tox. oral+inh 4	R43 R48 R40 R51-53 R20-22	Ni powder >= 10% Pb comp >= 0,3%; CdS < 0,1% $100 / ((\%As + \%Se\ comp + \%Te/Te\ comp)/100 + (\%CdS + \%Pb\ comp + \%Sb/Sb\ comp + \%Pb\ powder)/500)$ between 300 - 2000 mg/kg $100 / ((\%As + \%Se\ comp)/700 + (\%Pb\ comp + Pb\ powder + \%Sb/Sb\ comp)/4500)$ between 2500 and 20000 mg/kg $(\%Cu \times 0,024 + \%Pb \times 0,044 + \%Co \times 0,11) < 1$ $(\%Cu \times 0,00062 + \%Pb \times 0,048 + \%Co \times 0,69) *10 > 1$

3. Slags

Notes:

- Fluxes used influence composition and hence, resulting classification
- In most slags, presence of free silica cannot be ruled out (and would have no improvement on the classification in any case)
- Refinement for silica where relevant can be done with XRD and dustiness data that would show amorphous silica instead of crystalline one, and no potential for inhalation
- B presence as sodium borate/borax in Borate/borax slag only; present as boron oxide in remaining slags
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- The two main principal components for slag samples are Ni/PM/B and Ag/Pb/As/Cu. The first cluster is characterised by relatively low metal concentrations and includes borosilicates, phosphate and borate slags. The second cluster has relatively high Ni/PM and low B concentrations, mostly silicate slags from PM rich materials, carbonate slags and borosilicates. The third and fourth cluster has relatively high Ag/Pb/As/Cu concentrations, mostly from silicate slags from Ag rich materials + borate slags



	Classification CLP	Classification DSD	Composition / classification drivers
1 (borosilicates + phosphate + borate slags)	Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R48 R49 R50-53	<p>As₂O₃ 0,1%-1% or NiO 0,1%-1% As₂O₃ < 1% and NiO < 1% CoO < 1%; Pb ≥ 0,3 %; CdO < 1% Pb comp ≥ 0,5% or Se comp ≥ 10% Cu₂O < 10% and As₂O₃ < 1% and 10x %As₂O₃ + Cu₂O < 10%</p> <p>$100 / ((%Se)/700 + (%Cu_2O + \%Pb\ comp + \%Pb\ powder + \%BaO_2)/4500) > 20000\ mg/kg$</p> <p>$100 / ((%Se + \%Te/Te\ comp)/100 + (%Cu_2O + \%Pb\ comp + \%Pb\ powder + \%BaO_2)/500) > 2000\ mg/kg$</p> <p>Borosilicate (Tier 1 - speciation): (%As₂O₃ + %CdO x 10 + %CoO x 10 + %Cu₂O + %Pb comp x 10 + %Se comp x 10 + %ZnO + %Ag comp x 1000 + %Au comp + %Pd comp x 10 + %Pt comp x 10 + %Ti comp + %Rh comp + %Ru comp) > 25% * (%As₂O₃ + %CdO x 100 + %CoO x 10 + %Cu₂O + %Pb comp + %Se comp + %ZnO + %Ag comp x 100 + %Au comp + %Pd comp x 10 + %Pt comp + %Ti comp + %Rh comp + %Ru comp) > 25%</p> <p>Phosphate slags (Tier 2 - TDP): (%Ag x 0,47 + %Pb x 0,005) > 1 (%Ag x 0,17 + %Pb x 0,003) > 1 Borate slags (Tier 2 - TDP): (%Zn * 0,024 + %Pb x 0,13) > 1 (%Zn * 0,01 + %Pb x 0,06) > 1</p>

2 (silicate slags from PM rich materials + carbonate slags + borosilicates)	Acute oral+inh 4, Skin sens 1, Eye dam 2, Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R22 R20 R43 R48 R49 R50-53	<p>As₂O₃ >= 0,1% or NiO >= 0,1% Pb >= 0,3%; As₂O₃ < 1%; CdO < 1% Pb comp >= 0,5% or Se comp >= 10% or NiO: 1% - 10% CoO >= 1% or NiO >= 1% Cu₂O >= 10% or 10 x %As₂O₃ + Cu₂O >= 10%</p> <p>$100 / ((\%Se)/700 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2)/4500)$ between 2500 and 20000 mg/kg</p> <p>$100 / ((\%Se + \%Te/Te \text{ comp})/100 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2)/500)$ between 300 and 2000 mg/kg</p> <p>Borosilicate + carbonate slags (Tier 1 - speciation): (%As₂O₃ + %CdO x 10 + %CoO x 10 + %Cu₂O + %Pb comp x 10 + %Se comp x 10 + %ZnO + %Ag comp x 1000 + %Au comp + %Pd comp x 10 + %Pt comp x 10 + %Ti comp + %Rh comp + %Ru comp) > 25% (%As₂O₃ + %CdO x 100 + %CoO x 10 + %Cu₂O + %Pb comp + %Se comp + %ZnO + %Ag comp x 100 + %Au comp + %Pd comp x 10 + %Pt comp + %Ti comp + %Rh comp + %Ru comp) > 25%</p> <p>Silicate slags (Tier 2 - TDP): (%Cu x 0,12 + %Pb x 0,04) > 1 (%Cu * 0,025 + %Pb * 0,02) > 1</p>
3 (silicate slags from Ag rich materials + borate slags)	Acute oral 3, Acute inh 4, skin corr 1B, Eye dam 1, Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R20 R22/25/28 R36,R37,R38 R48 R49 R50-53	<p>Pb >= 0,3 %; As₂O₃ >= 5%; CdO < 1%; Pb comp >= 0,5% or Se comp >= 10% CoO < 1% and NiO < 1%</p> <p>$100 / ((\%Se)/700 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2)/4500)$ between 2500 and 20000 mg/kg</p> <p>$100 / ((\%Se + \%Te/Te \text{ comp})/100 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2)/500)$ between 50 - 300 mg/kg</p> <p>Silicate slags (Tier 2 - TDP): (%Cu x 0,12 + %Pb x 0,04) > 1 (%Cu * 0,025 + %Pb * 0,02) > 1 Borate slags (Tier 2 - TDP): (%Zn * 0,024 + %Pb x 0,13) > 1 (%Zn * 0,01 + %Pb x 0,06) > 1</p>
4 (silicate slags from Ag rich materials)	Acute oral 3, Acute inh 4, skin irr 2, Eye dam 1, skin sens 1, Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R20 R22/25/28 R43 R48 R49 R50-53	<p>Pb >= 0,3 %; As₂O₃: 3% - 5%; CdO < 1% Pb comp >= 0,5% or Se comp >= 10% or NiO: 1% - 10% CoO >= 1% or NiO >= 1%</p> <p>$100 / ((\%Se)/700 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2)/4500)$ between 2500 and 20000 mg/kg</p> <p>$100 / ((\%Se + \%Te/Te \text{ comp})/100 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2)/500)$ between 50 - 300 mg/kg</p> <p>Silicate slags (Tier 2 - TDP): (%Cu x 0,12 + %Pb x 0,04) > 1 (%Cu * 0,025 + %Pb * 0,02) > 1</p>

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

			%ZnSO ₄) > 25% *
2 (med Ni)	Acute inh+oral 3, Eye dam 1, Resp/skin sens 1, Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R20/23 R22/25 R41 R48 R45/49 R50-53 R60/61 R42/43	As ₂ O ₃ >= 0,1% or NiSO ₄ 0,1% - 1% or NiO >= 0,1% CdO < 0,1%; NiSO ₄ < 1%; Pb comp >= 0,3% MnSO ₄ >= 10% or Pb comp >= 0,5% or NiSO ₄ : 0,1% - 1% or Se Comp >= 10% or NiO: 1% - 10% %ZnSO ₄ + %NH ₃ + %As ₂ O ₃ + %Pt hexachloroplatinates >= 3% (%NH ₃ + %As ₂ O ₃) < 1% 10 x (%NH ₃ + %As ₂ O ₃) + %CuSO ₄ + NiSO ₄ < 10% 100 / ((%As ₂ O ₃)/5 + (%Se comp + %Te/Te comp)/100 + (%BaO ₂ + %CoO + %CuSO ₄ + %Pb comp + %NiSO ₄ + %ZnSO ₄ + %Cu ₂ O + %MnO ₂)/500) between 50 - 300 mg/kg 100 / ((%CdO)/100 + (%Se comp)/700 + (%BaO ₂ + %Pb comp + %NiSO ₄ + %MnO ₂)/4500 between 500 - 2500 mg/kg (%As ₂ O ₃ + %CdO x 10 + %CoO x 10 + %Cu ₂ O + %Pb comp x 10 + %Se comp x 10 + %ZnO + %Ag comp x 1000 + %Au comp + %Pd comp x 10 + %Pt comp x 10 + %Ti comp + %Rh comp + %Ru comp + %CuSO ₄ x 10 + %NiSO ₄ + %ZnSO ₄) > 25% * (%As ₂ O ₃ + %CdO x 100 + %CoO x 10 + %Cu ₂ O + %Pb comp + %Se comp + %ZnO + %Ag comp x 100 + %Au comp + %Pd comp x 10 + %Pt comp + %Ti comp + %Rh comp + %Ru comp + %CuSO ₄ + %NiSO ₄ + %ZnSO ₄) > 25% *
3 (high Ni/Pb)	Acute inh+oral 3, skin irr 2, Eye dam 1, Resp/skin sens 1, Carc 1A, Repro 1A, Muta 2, STOT Re 1, Env Acute 1, Env Chronic 1	R20/23 R22/25 R41 R48 R45/49 R68 R50-53 R60/61 R42/43 R36-37-38	Pb comp >= 0,3%; NiSO ₄ >= 1% %ZnSO ₄ + %NH ₃ + %As ₂ O ₃ + %Pt hexachloroplatinates >= 3% (%NH ₃ + %As ₂ O ₃) between 1% - 5% or CuSO ₄ >= 10% or NiSO ₄ >= 20% or 10 x (%NH ₃ + %As ₂ O ₃) + %CuSO ₄ + NiSO ₄ >= 10% 100 / ((%As ₂ O ₃)/5 + (%Se comp + %Te/Te comp)/100 + (%BaO ₂ + %CoO + %CuSO ₄ + %Pb comp + %NiSO ₄ + %ZnSO ₄ + %Cu ₂ O + %MnO ₂)/500) between 50 - 300 mg/kg 100 / ((%CdO)/100 + (%Se comp)/700 + (%BaO ₂ + %Pb comp + %NiSO ₄ + %MnO ₂)/4500 between 500 - 2500 mg/kg (%As ₂ O ₃ + %CdO x 10 + %CoO x 10 + %Cu ₂ O + %Pb comp x 10 + %Se comp x 10 + %ZnO + %Ag comp x 1000 + %Au comp + %Pd comp x 10 + %Pt comp x 10 + %Ti comp + %Rh comp + %Ru comp + %CuSO ₄ x 10 + %NiSO ₄ + %ZnSO ₄) > 25% * (%As ₂ O ₃ + %CdO x 100 + %CoO x 10 + %Cu ₂ O + %Pb comp + %Se comp + %ZnO + %Ag comp x 100 + %Au comp + %Pd comp x 10 + %Pt comp + %Ti comp + %Rh comp + %Ru comp + %CuSO ₄ + %NiSO ₄ + %ZnSO ₄) > 25% *
4 (high Ni/Pb/As)	Acute inh 3, Acute oral 2, skin corr 1, Eye dam 1, Resp/skin sens 1, Carc 1A, Repro 1A, Muta 2, STOT Re 1, Env Acute 1, Env Chronic 1	R20/23 R22/25 R34 R41 R48 R45/49 R68 R50-53 R60/61 R42/43	As ₂ O ₃ >= 0,1% or NiSO ₄ >= 0,1% or NiO >= 0,1% CdO >= 1% or NiSO ₄ >= 1% Pb comp >= 0,3% CdO >= 10% or NiSO ₄ >= 1% or NiO >= 10% NiSO ₄ >= 1% (%NH ₃ + %As ₂ O ₃) >= 5% 100 / ((%As ₂ O ₃)/5 + (%Se comp + %Te/Te comp)/100 + (%BaO ₂ + %CoO + %CuSO ₄ + %Pb comp + %NiSO ₄ + %ZnSO ₄ + %Cu ₂ O + %MnO ₂)/500) between 50 - 300 mg/kg 100 / ((%CdO)/100 + (%Se comp)/700 + (%BaO ₂ + %Pb comp + %NiSO ₄ + %MnO ₂)/4500 between 500 - 2500 mg/kg (%As ₂ O ₃ + %CdO x 10 + %CoO x 10 + %Cu ₂ O + %Pb comp x 10 + %Se comp x 10 + %ZnO + %Ag comp x 1000 + %Au comp + %Pd comp x 10 + %Pt comp x 10 + %Ti comp + %Rh comp + %Ru comp + %CuSO ₄ x 10 + %NiSO ₄ + %ZnSO ₄) > 25% * (%As ₂ O ₃ + %CdO x 100 + %CoO x 10 + %Cu ₂ O + %Pb comp + %Se comp + %ZnO + %Ag comp x 100 + %Au comp + %Pd comp x 10 + %Pt comp + %Ti comp + %Rh comp + %Ru comp + %CuSO ₄ + %NiSO ₄ + %ZnSO ₄) > 25% *

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium

dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

5. Residues, leaching processes:

5.1. Residues, matte leaching

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1, Skin corr. 2, Ac. Tox. oral 3, Eye dam. 1,	R25 R42-43 R68 R49 R60/61 R50-53 R48	NiSO4 >= 1%; Pb >= 0,3%; Ag >= 0,15%; As2O3 3% - 5% 100 / ((As2O3%)/5 + (Se% + Te%)/100 + (Cu2O% + CuSO4% + Pb% + Sb% + NiSO4%)/500) between 50 - 300 mg/kg 100 / ((Se% + Te%)/700 + (Pb% + Sb% + NiS% + NiSO4%)/4500) > 20000 mg/kg
2	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1, Skin corr. 2, Ac. Tox. oral 3, Eye dam. 2	R25 R42-43 R68 R49 R60/61 R50-53 R48	NiSO4 >= 1%; Pb >= 0,3%; Ag >= 0,15%; As2O3 1% - 3% 100 / ((As2O3%)/5 + (Se% + Te%)/100 + (Cu2O% + CuSO4% + Pb% + Sb% + NiSO4%)/500) between 50 - 300 mg/kg 100 / ((Se% + Te%)/700 + (Pb% + Sb% + NiS% + NiSO4%)/4500) > 20000 mg/kg
3	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1, Skin corr. 2, Eye dam. 1, Ac. Tox. oral+inh 4	R23/25 R42-43 R68 R49 R60/61 R50-53 R48	NiSO4 >= 1%; Pb >= 0,3%; Ag >= 0,15%; As2O3 3% - 5%; 100 / ((As2O3%)/5 + (Se% + Te%)/100 + (Cu2O% + CuSO4% + Pb% + Sb% + NiSO4%)/500) between 300 - 2000 mg/kg 100 / ((Se% + Te%)/700 + (Pb% + Sb% + NiS% + NiSO4%)/4500) between 2500 - 20000 mg/kg

5.2. Residues, speiss leaching

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Classification DSD	Composition / classification drivers
1	Skin irr 2, Eye Dam 1, Carc. 1A, Repro. 1A, Muta 2, STOT Rep 2, ENV Ac 1, ENV Ch 1, Skin sens. 1, Ac. Tox. oral+inhalation 4	R20/22 R43 R68 R49 R60/61 R50-53 R48	NiS 1-10%; Pb > 0,5%; (As2O3 + SnCl4) > 3%; CdS < 10% 100 / ((As% + Se%)/100 + (Pb% + Sb%)/500) between 300 - 2000 mg/kg 100 / ((Se% + As%)/700 + (NiS% + Sb% + Pb%)/4500) between 2500 - 20000 mg/kg (%Ag + %As compounds + %Se compoundsx10 + %CuSx10 + %Pb compoundsx10 + %As2O3 + %NiS) >= 25% (%Agx10 + %As compounds + %Se compoundsx10 + %CuS + %Pb compounds + %As2O3 + %NiS) >= 25%

6. Electrolytes

6.1. Ag electrolyte

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Classification DSD	Composition / classification drivers
1	Repro. 1A, STOT Rep 2, ENV Ac 1, ENV Ch 1, Skin corr. 1B, Eye dam. 1	R34 R60/61 R50-53 R48	Pb 0,5 - 1%; HNO3 < 20%; H2SO4 < 15%; AgNO3% >= 5% 100 / ((ZnSO4% + Pb% + CuSO4%)/500) > 2000 mg/kg (%AgNO3x1000 + %Pd compoundsx10 + %CuSO4x10 + %Pt compoundsx10 + %Pb compoundsx10 + %ZnSO4) >= 25%
2	Ac Tox oral 4, ENV Ac 1, ENV Ch1, Skin corr. 1B, Eye dam. 1	R34 R50-53	Pb < 0,3 %; HNO3 < 20%; H2SO4 < 15%; AgNO3% >= 5% 100 / ((ZnSO4% + Pb% + CuSO4%)/500) between 300 and 2000 mg/kg (%AgNO3x1000 + %Pd compoundsx10 + %CuSO4x10 + %Pt compoundsx10 + %Pb compoundsx10 + %ZnSO4) >= 25% *

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

6.2. Au electrolyte

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)

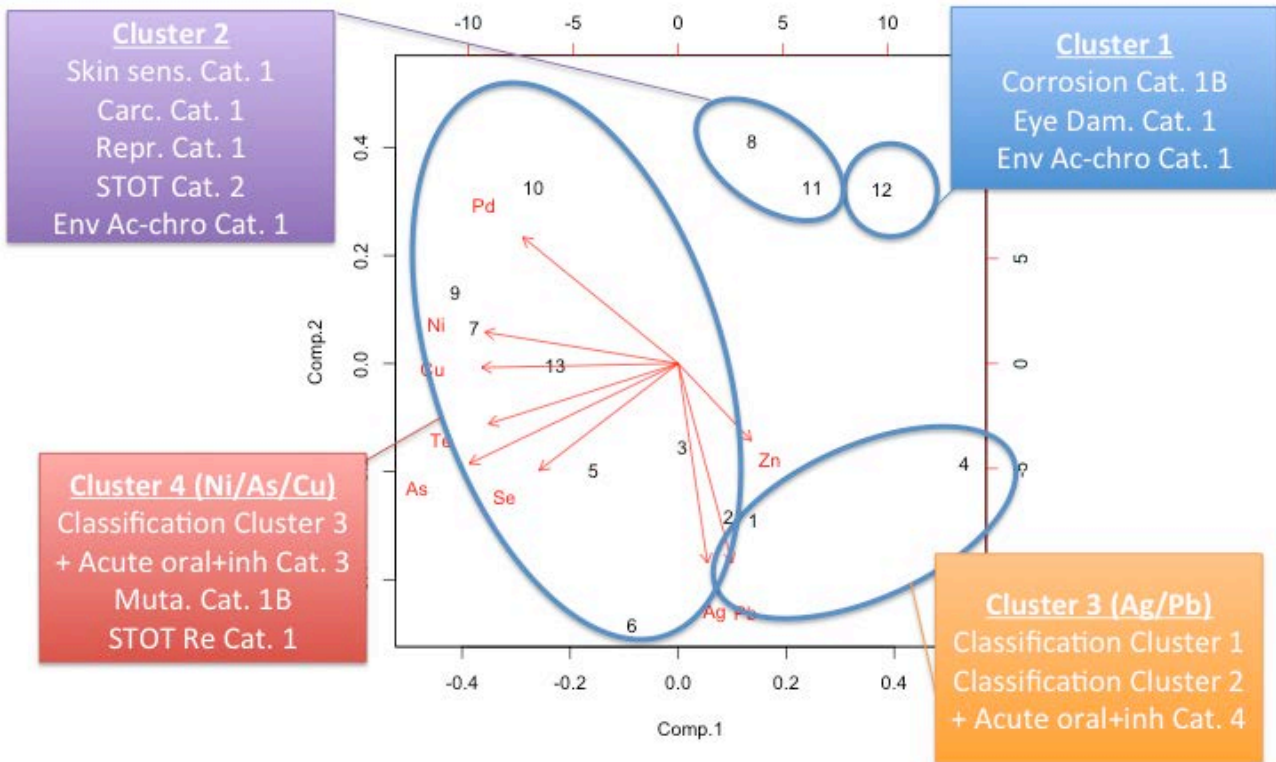
	Classification CLP	Classification DSD	Composition / classification drivers
1	ENV Ac 1, Env Ch 1, Skin corr 1A, Resp/Skin sens. 1, Eye dam. 1, Ac. Tox. oral+inh 4	R22/25 R41 R42/43 R50-53	Pb < 0,3%; HCl > 5%; PtCl4 > 1% 100 / ((PtCl4%)/100 + (CuSO4%)/500) between 300 - 2000 mg/kg 100 / HCl% / 700 between 2500 - 20000 mg/kg (%Pd compoundsx10 + %CuSO4x10 + %Au compounds + %PtCl4 + Ru% + Rh%) >= 25% *

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

7. Flue dust

Notes:

- One of PMC's largest group
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- Two main principal components for flue dust samples are Pb/Ag and Ni/As/Cu. The first two clusters are characterised by relatively low metal concentrations. The third cluster has relatively high Ag/Pb concentrations, mostly from PM smelting process/pyrometallurgical refinement. The fourth cluster has relatively high Cu/As/Ni concentrations, mostly from metal dore smelting, refining in TBRC Converter and decopperised slime from copper electrolysis



	Classification CLP	Classification DSD	Composition / classification drivers
1 (low Ni/Pb)	Skin corr/irr 1B, Eye Dam. 1, Env Acute 1, Env Chronic 1	R41 R42/43 R50/53	$(\%As_2O_3 + \%SnCl_4 + \%AgNO_3) \geq 3\%$ $NiO < 0,1\%$, $NiSO_4 < 0,01\%$; $As_2O_3 < 0,1\%$; $Pb\ comp < 0,3\%$; $Na_2B_4O_7 < 4,5\%$; $Se\ comp < 10\%$; $MnSO_4 < 10\%$; $Sb_2O_3 < 1\%$; $Pt\ hexachloroplatinates < 1\%$ $100 / ((\%As_2O_3)/5 + (\%Se\ comp + \%Te/Te\ comp)/100 + (\%Cu_2O + \%Pb\ comp + \%CuSO_4 + \%NiSO_4)/500) > 2000\ mg/kg$ $100 / ((\%Se\ comp)/700 + (\%Pb\ comp + \%NiSO_4)/4500) > 20000\ mg/kg$ $(\%As_2O_3 + \%Pb\ comp + \%Se\ comp \times 10 + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 1000 + \%Au\ comp + \%Pd\ comp \times 10 + \%Rh/Rh\ comp + \%Ru/Ru\ comp + \%Pt/Pt\ comp \times 10 + \%Cu_2O \times 10 + \%Ag\ comp \times 1000 + \%CuSO_4 \times 10) > 25\% \ast$ $(\%As_2O_3 + \%Pb\ comp \times 10 + \%Se\ comp + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 100 + \%Au\ comp + \%Pd\ comp \times 10 + \%Rh/Rh\ comp + \%Ru/Ru\ comp + \%Pt/Pt\ comp + \%Cu_2O + \%Ag\ comp \times 100 + \%CuSO_4) > 25\% \ast$
2	Skin sens 1, Carc. 1A, Repr. 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R42/43 R60/61 R50/53	$(\%As_2O_3 + \%SnCl_4 + \%AgNO_3) < 1\%$ $10 \times (\%As_2O_3 + \%SnCl_4 + \%AgNO_3 + \%CuSO_4) + \%NiSO_4 < 10\%$ $CuSO_4 < 10\%$; $NiO: 0,1\% - 10\%$; $NiSO_4: 0,01\% - 1\%$; $Pb\ comp: 0,3\% - 0,5\%$ $Se\ comp < 10\%$; $MnSO_4 < 10\%$; $Pt\ hexachloroplatinates < 1\%$ $100 / ((\%As_2O_3)/5 + (\%Se\ comp + \%Te/Te\ comp)/100 + (\%Cu_2O + \%Pb\ comp + \%CuSO_4 + \%NiSO_4)/500) > 2000\ mg/kg$

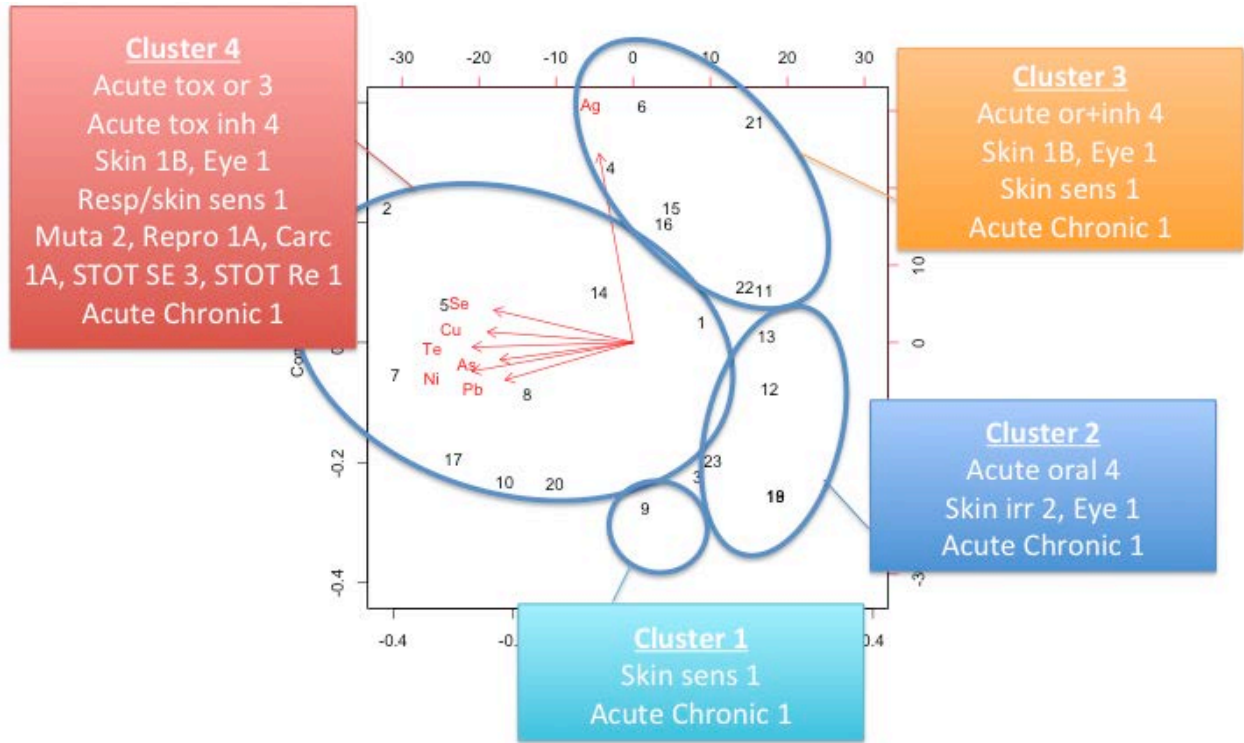
			<p>100/ ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between > 20000 mg/kg</p> <p>(%As2O3 + %Pb comp + %Se comp x10 + %ZnO + %NiSO4 + %AgNO3 x 1000 + %Au comp + % Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp x 10 + %Cu2O x 10 + %Ag comp x 1000 + %CuSO4 x 10) > 25% *</p> <p>(%As2O3 + %Pb comp x 10 + %Se comp + %ZnO + %NiSO4 + %AgNO3 x 100 + %Au comp + % Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp + %Cu2O + %Ag comp x 100 + %CuSO4) > 25% *</p>
3 (high Ag/Pb)	Acute oral 4, Acute inh 4, Skin corr/irr 1B, Eye Dam. 1, Skin sens 1, Carc. 1A, Repr. 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R41 R42/43 R45/49 R60/61 R48 R20/22 R50/53	<p>(%As2O3 + %SnCl4 + %AgNO3) >= 3%</p> <p>NiO >= 0,1% or As2O3 >= 0,1%</p> <p>NiSO4 < 0,01%; Pb comp >= 0,3%; Pt hexachloroplatinates < 1%</p> <p>NiO: 1% - 10% or Se comp >= 10% or MnSO4 >= 10%</p> <p>100/ ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %CuSO4 + %NiSO4)/500) between 300 and 2000 mg/kg</p> <p>100/ ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 2500 - 20000 mg/kg</p> <p>(%As2O3 + %Pb comp + %Se comp x10 + %ZnO + %NiSO4 + %AgNO3 x 1000 + %Au comp + % Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp x 10 + %Cu2O x 10 + %Ag comp x 1000 + %CuSO4 x 10) > 25% *</p> <p>(%As2O3 + %Pb comp x 10 + %Se comp + %ZnO + %NiSO4 + %AgNO3 x 100 + %Au comp + % Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp + %Cu2O + %Ag comp x 100 + %CuSO4) > 25% *</p>
4 (high Ni/As/Cu)	Acute oral 3, Acute inh 3, Skin corr/irr 1B, Eye Dam. 1, Resp/Skin sens 1, Carc. 1A, Muta 1B, Repr. 1A, STOT Re 1, Env Acute 1, Env Chronic 1	R41 R42/43 R68 R45/49 R48 R60/61 R25/22 R20 R50/53	<p>(%As2O3 + %SnCl4 + %AgNO3) >= 3%</p> <p>NiSO4 >= 0,01% or As2O3 >= 0,1%</p> <p>NiO >= 10% or NiSO4 >= 1% or Pt hexachloroplatinates >= 1%</p> <p>Pb comp >= 0,3%</p> <p>100/ ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %CuSO4 + %NiSO4)/500) between 50 and 300 mg/kg</p> <p>100/ ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 500 - 2500 mg/kg</p> <p>(%As2O3 + %Pb comp + %Se comp x10 + %ZnO + %NiSO4 + %AgNO3 x 1000 + %Au comp + %Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp x 10 + %Cu2O x 10 + %Ag comp x 1000 + %CuSO4 x 10) > 25% *</p> <p>(%As2O3 + %Pb comp x 10 + %Se comp + %ZnO + %NiSO4 + %AgNO3 x 100 + %Au comp + %Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp + %Cu2O + %Ag comp x 100 + %CuSO4) > 25% *</p>

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

8. Residues, cementation and reduction

Notes:

- One of PMC's largest group
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- The two main principal components are a Pb/Ni/As/Cu component and an Ag component. The first three clusters have relatively low metal concentrations. Cluster 4 is characterised by relatively high metal concentrations.



	Classification CLP	Classification DSD	Composition / classification drivers
1	Skin sens 1, Env acute 1, Env chronic 1	R43 R50-53	<p>NiSO₄ 0,01% - 0,1%, NiO < 0,1%</p> <p>Sb₂O₃ < 1%; As₂O₃ < 0,1%; Pb comp < 0,3%; Se comp < 10%</p> <p>MnSO₄ < 10%; (%SnCl₄ + %AgNO₃ + %As₂O₃) < 1%</p> <p>10x(%SnCl₄ + %AgNO₃ + %As₂O₃ + %CaO + %CuSO₄) + NiSO₄ < 10%</p> <p>$100 / ((\%As_2O_3)/5 + (\%Se\ comp + \%Te/Te\ comp)/100 + (\%CuSO_4 + \%Pb\ com + \%NiSO_4)/500) > 2000\ mg/kg$</p> <p>$100 / ((\%Se\ comp)/700 + (\%Pb\ comp + \%NiSO_4)/4500) > 20000\ mg/kg$</p> <p>$(\%As_2O_3 + \%Pb\ comp \times 10 + \%Se\ comp \times 10 + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 1000 + \%Au\ comp + \%Pd\ comp \times 10 + \%Rh/Rh\ comp + \%Ru/Ru\ comp + \%Pt/Pt\ comp \times 10 + \%Ti/Ti\ comp) > 25\% *$</p> <p>$(\%As_2O_3 + \%Pb\ comp + \%Se\ comp + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 100 + \%Au\ comp + \%Pd\ comp \times 10 + \%Rh/Rh\ comp + \%Ru/Ru\ comp + \%Pt/Pt\ comp + \%Ti/Ti\ comp) > 25\% *$</p>
2	Acute oral 4, skin irr 2, Eye dam 1, Env acute 1, Env chronic 1	R22 R36-37-38 R50-53	<p>Sb₂O₃ < 1%; As₂O₃ < 0,1%; Pb comp < 0,3%; Se comp < 10%; MnSO₄ < 10%</p> <p>NiSO₄ < 0,1% and NiO < 0,1%</p> <p>%SnCl₄ + %AgNO₃ + %As₂O₃ >= 3%</p> <p>(%SnCl₄ + %AgNO₃ + %As₂O₃): 1-5% or CuSO₄ >= 10% or NiSO₄ >= 20% or 10x(%SnCl₄ + %AgNO₃ + %As₂O₃) + %CaO + %CuSO₄ + NiSO₄ >= 10%</p> <p>CaO < 20%</p> <p>$100 / ((\%As_2O_3)/5 + (\%Se\ comp + \%Te/Te\ comp)/100 + (\%CuSO_4 + \%Pb\ com + \%NiSO_4)/500) \text{ between } 300 - 2000\ mg/kg$</p> <p>$100 / ((\%Se\ comp)/700 + (\%Pb\ comp + \%NiSO_4)/4500) > 20000\ mg/kg$</p> <p>$(\%As_2O_3 + \%Pb\ comp \times 10 + \%Se\ comp \times 10 + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 1000 + \%Au\ comp + \%Pd\ comp \times 10 + \%Rh/Rh\ comp + \%Ru/Ru\ comp + \%Pt/Pt\ comp$</p>

			$x 10 + \%Ti/Ti \text{ comp}) > 25\% *$ $(\%As_2O_3 + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} + \%Ti/Ti \text{ comp}) > 25\% *$
3	Acute oral+inh 4, Skin sens 1, Env acute 1, Env chronic 1	R20 R22 R36-37-38 R43 R50-53	$Sb_2O_3 < 1\%$; $As_2O_3 < 0,1\%$; $NiSO_4: 0,01\% - 0,1\%$ and $NiO < 0,1\%$ $Pb \text{ comp} < 0,3\%$; $Se \text{ comp} < 10\%$; $MnSO_4 < 10\%$; $CaO < 1\%$ $\%SnCl_4 + \%AgNO_3 + \%As_2O_3 < 1\%$ $10x(\%SnCl_4 + \%AgNO_3 + \%As_2O_3 + \%CaO + \%CuSO_4) + \%NiSO_4 < 10\%$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%CuSO_4 + \%Pb \text{ com} + \%NiSO_4)/500)$ between 300 - 2000 mg/kg $100 / ((\%Se \text{ comp})/700 + (\%Pb \text{ comp} + \%NiSO_4)/4500)$ between 2500 - 20000 mg/kg $(\%As_2O_3 + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} \times 10 + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} \times 10 + \%Ti/Ti \text{ comp}) > 25\% *$ $(\%As_2O_3 + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} + \%Ti/Ti \text{ comp}) > 25\% *$
4	Acute oral 3, Acute inh 4, Skin 1B, Eye 1, Resp/skin sens 1, Muta 2, Repro 1A, Carc 1A, STOT SE 3, STOT Re 1, Env acute 1, Env chronic 1	R20 R22/25 R34-36-37-38 R42/43 R45/49 R48 R50-53 R60/61 R68	$NiSO_4 \geq 1\%$; $As_2O_3 \geq 0,1\%$ or $NiSO_4 \geq 0,1\%$ or $NiO \geq 0,1\%$ $Pb \text{ comp} \geq 0,3\%$; $NiSO_4 \geq 1\%$ or $NiO \geq 10\%$; $\%SnCl_4 + \%AgNO_3 + \%As_2O_3 \geq 3\%$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%CuSO_4 + \%Pb \text{ com} + \%NiSO_4)/500)$ between 50 - 300 mg/kg $100 / ((\%Se \text{ comp})/700 + (\%Pb \text{ comp} + \%NiSO_4)/4500)$ between 2500 - 20000 mg/kg $(\%As_2O_3 + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} \times 10 + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} \times 10 + \%Ti/Ti \text{ comp}) > 25\% *$ $(\%As_2O_3 + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} + \%Ti/Ti \text{ comp}) > 25\% *$

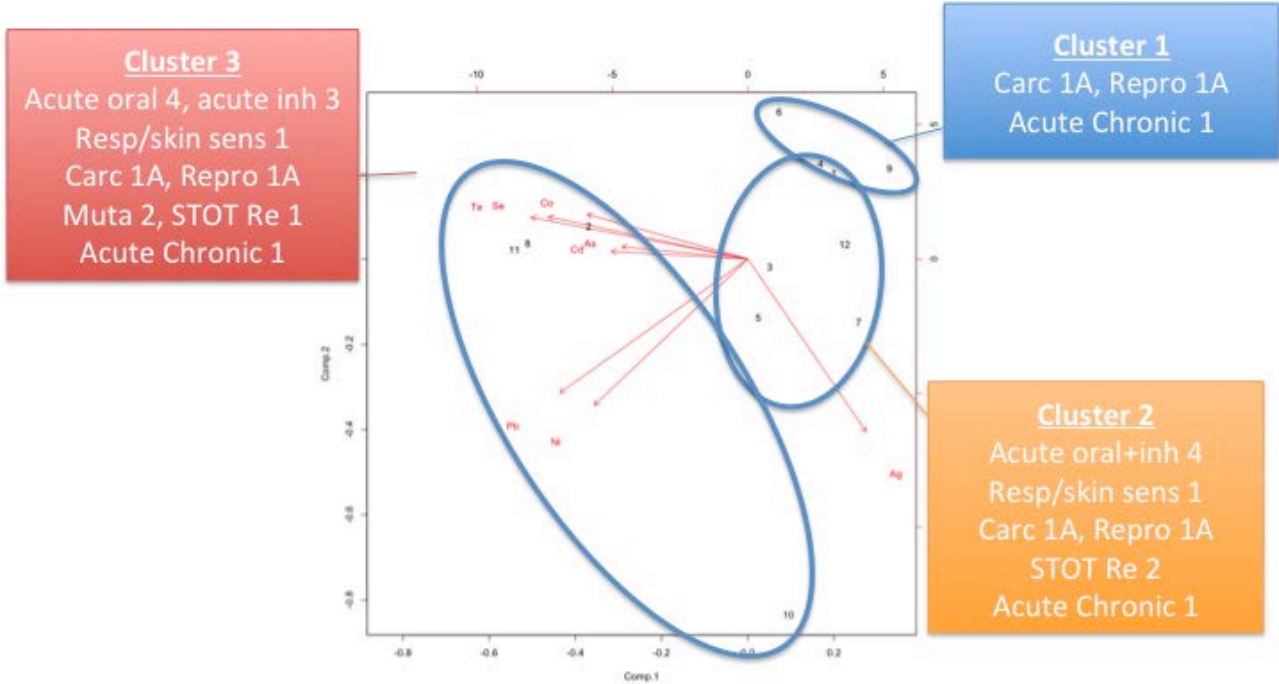
* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

9. Materials for reclaim

9.1. Materials for reclaim, PM with or without support

Notes:

- One of PMC's largest group
- All constituents assumed in metallic and oxide form
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- The main principal component driving classification is the Pb/Ni component. The first, second and third cluster have respectively relatively low, medium and high Pb/Ni concentrations



	Classification CLP	Classification DSD	Composition / classification drivers
1 (low Pb/Ni)	Carc 1A, Repro 1A, Env Acute 1, Env Chronic 1	R49 R60/61 R50/53	NiO 0,1% - 1%; Cd < 1%; Pb powder 0,3% - 10%; Se < 10%; Co < 1% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%BaO2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%Cd)/100 + (\%As + \%Se)/700 + (\%BaO2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%Co \times 0,11 + \%Ag \times 45 + \%Ni \times 0,007) > 1$ $(\%Co \times 0,69 + \%Ag \times 11 + \%Ni \times 0,007) > 1$
2 (med Pb/Ni)	Acute oral+inh 4, Resp/skin sens 1, Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R22 R20 R42/43 R48 R49 R60/61 R50/53	NiO \geq 0,1%; Cd < 1%; Pb powder \geq 0,3%; Co \geq 1% Se \geq 10% or NiO: 1% - 10% or Pb powder \geq 10%; $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%BaO2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) \text{ between } 300 \text{ and } 2000 \text{ mg/kg}$ $100 / ((\%Cd)/100 + (\%As + \%Se)/700 + (\%BaO2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) \text{ between } 2500 - 20000 \text{ mg/kg}$ $(\%Co \times 0,11 + \%Ag \times 45 + \%Ni \times 0,007) > 1$ $(\%Co \times 0,69 + \%Ag \times 11 + \%Ni \times 0,007) > 1$
3 (high Pb/Ni)	Acute oral 4, Acute inh 3, Resp/skin sens 1, Carc 1A, Repro 1A, Muta 2, STOT Re 1, Env Acute 1, Env Chronic 1	R22 R20/23 R42/43 R68 R48 R49 R60/61 R50/53	NiO \geq 0,1%; Cd \geq 1%; Pb powder \geq 0,3%; Co \geq 1% Cd \geq 10% or NiO \geq 10% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%BaO2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) \text{ between } 300 \text{ and } 2000 \text{ mg/kg}$ $100 / ((\%Cd)/100 + (\%As + \%Se)/700 + (\%BaO2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) \text{ between } 500 - 2500 \text{ mg/kg}$

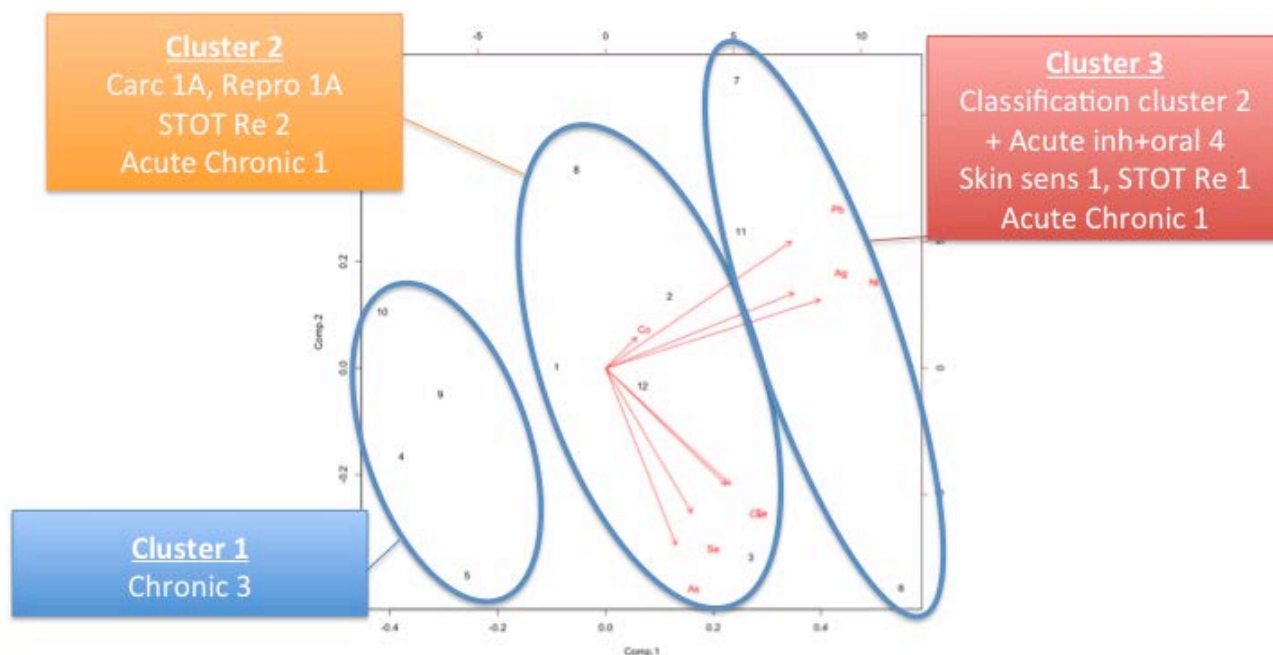
$$(\%Co \times 0,11 + \%Ag \times 45 + \%Ni \times 0,007) > 1$$

$$(\%Co \times 0,69 + \%Ag \times 11 + \%Ni \times 0,007) > 1$$

9.2. Materials for reclaim, PM in bricks, pots, crucibles and trays

Notes:

- One of PMC's largest group
- All constituents in oxide, silicate and metallic form
- Grouped classification proposed, the main principal component driving classification is the Pb/Ni component. The first, second and third cluster have respectively relatively low, medium and high Pb/Ni concentrations



	Classification CLP	Classification DSD	Composition / classification drivers
1 (low Ni/Pb)	Env Chronic 3	R52/53	$NiO < 0,1\%$; $Pb \text{ comp} < 0,3\%$; $Se < 10\%$; $Co < 1\%$ $100 / ((\%As + \%Se + \%Te \text{ comp})/100 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/4500) > 20000 \text{ mg/kg}$ $(\%Ag \times 5,15 + \%Cu \times 0,08) < 1$ $(\%Ag \times 1,05 + \%Cu \times 0,031) * 10 < 1$
2 (low Ni/high Pb)	Carc 1A, Repro 1A, STOT Re 2, Env Acute 1, Env Chronic 1	R48 R49 R60/61 R50/53	$NiO 0,1\% - 1\%$; $Pb \text{ comp} \geq 0,3\%$; $Pb \text{ comp} \geq 0,5\%$ or $Se \geq 10\%$; $Co < 1\%$ $100 / ((\%As + \%Se + \%Te \text{ comp})/100 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/4500) > 20000 \text{ mg/kg}$ $(\%Ag \times 5,15 + \%Cu \times 0,08) > 1$ $(\%Ag \times 1,05 + \%Cu \times 0,031) > 1$
3 (high Ni/Pb)	Acute inh+oral 4, Skin sens 1, Carc 1A, Repro 1A, STOT Re 1, Env Acute 1, Env Chronic 1	R20/22 R43 R48 R49 R60/61 R50/53	$Pb \text{ comp} \geq 0,3\%$ $NiO \geq 10\%$ $NiO \geq 1\%$ and $Co < 1\%$ $100 / ((\%As + \%Se + \%Te \text{ comp})/100 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/500)$ between 300 - 2000 mg/kg

			$100 / ((\%As + \%Se)/700 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/4500)$ between 2500 - 20000 mg/kg $(\%Ag \times 5,15 + \%Cu \times 0,08) > 1$ $(\%Ag \times 1,05 + \%Cu \times 0,031) > 1$
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9.3. Materials for reclaim, PM production by-products

Notes:

- All constituents assumed in metal or metal oxide form
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- Grouped classification proposed

	Classification CLP	Classification DSD	Composition / classification drivers
1	No classification	No classification	Co <1%; Ni <1%; Pb powder <0.3%; Se < 10% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$ $100 \times (\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) + 10 \times (\%Sb/Sb \text{ comp}) + (\%Ni \text{ powder} + \%Ba) < 25\%$
2	ENV Ch 2	R51-53	Co <1%; Ni <1%; Pb powder <0.3%; Se < 10% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$ $10 \times (\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) + \%Sb/Sb \text{ comp} > 25\%$
	ENV Ac 1, Env Ch 1	R50-53	Co <1%; Ni <1%; Pb powder <0.3%; Se < 10% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$
3	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ac 1, ENV Ch 1, Skin sens. 1	R43 R40 R50-53 R60/61 R48	Co < 1%; Ni $\geq 10\%$; Pb powder $\geq 0,3\%$ $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$

			%Ti + %Zn powder) > 25%
4	Carc. 2, Repro. 1A, STOT Rep 2, ENV Ac 1, ENV Ch 1, Skin sens. 1	R43 R40 R50-53 R60/61 R48	Co < 1%; Ni: 1%-10%; Pb powder >= 0,3% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$
5	Carc. 2, Repro. 1A, STOT Rep 1, Ac 1, ENV ENV Ch 1, Skin sens. 1, Ac. Tox. or+inh 4	R43 R40 R50-53 R60/61 R48 R20/22	Co < 1%; Ni >= 10%; Pb powder >= 0,3% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) \text{ between } 2500 - 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$
6	Repro. 1A, STOT Rep 2, Ac 1, ENV ENV Ch 1, Ac. Tox. inh 4	R60/61 R50-53 R48 R20/22	Co < 1%; Ni < 1%; Pb powder >= 0,3%; Se >= 10% or Pb powder >=10% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) \text{ between } 2500 - 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$
7	Carc. 2, STOT Rep 2, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1	R43 R40 R50-53 R48 R20/22	Co >= 1%; Ni: 1%-10%; Pb powder < 0,3% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 20000 \text{ mg/kg}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$

10. Pb bullion, PGM rich

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Mainly metallic
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 1B, Repro. 1A, STOT Rep 1, ENV Aq 1, ENV Ch 1, Skin sens. 1, Ac. Tox. or 4 +inh 4	R20 R43 R45 R60/61 R50-53 R48	Ni powder >= 10%; Pb powder >= 7%; Cd 0,1% - 1% $100 / ((Te\% + Se\% + Sb\% + As\%)/100 + (Pb\ powder\%)/500)$ between 300 - 2000 mg/kg $100 / ((Se\% + Sb\% + As\%)/700 + Pb\ powder\%/4500)$ between 2500 - 20000 mg/kg $(\%Cu \times 0,4 + \%Pb \times 0,14) > 1$ $(\%Cu \times 0,05 + \%Pb \times 0,056) > 1$
2	Carc. 2, Repro. 1A, STOT Rep 2, ENV Aq 1, ENV Ch 1, Skin sens. 1, Ac. Tox. or 4 +inh 4	R20/22 R43 R40 R60/61 R50-53 R48	Ni powder 1% - 10%; Pb powder >= 7%; Cd < 0,1% $100 / ((Te\% + Se\% + Sb\% + As\%)/100 + (Pb\ powder\%)/500)$ between 300 - 2000 mg/kg $100 / ((Se\% + Sb\% + As\%)/700 + Pb\ powder\%/4500)$ between 2500 - 20000 mg/kg $(\%Cu \times 0,4 + \%Pb \times 0,14) > 1$ $(\%Cu \times 0,05 + \%Pb \times 0,056) > 1$
3	Carc. 2, Repro. 1A, STOT Rep 2, ENV Ch 2, Skin sens. 1, Ac. Tox. or 4 +inh 4	R20/22 R43 R40 R60/61 R51-53 R48	Ni powder 1% - 10%; Pb powder >= 7%; Cd < 0,1% $100 / ((Te\% + Se\% + Sb\% + As\%)/100 + (Pb\ powder\%)/500)$ between 300 - 2000 mg/kg $100 / ((Se\% + Sb\% + As\%)/700 + Pb\ powder\%/4500)$ between 2500 - 20000 mg/kg $(\%Cu \times 0,4 + \%Pb \times 0,14) < 1$ $(\%Cu \times 0,05 + \%Pb \times 0,056) *10$ between 1-10
4	Carc. 2, Repro. 1A, STOT Rep 2, Skin sens. 1, Ac. Tox. or 4 +inh 4	R20/22 R43 R40 R60/61 R48	Ni powder 1% - 10%; Pb powder >= 7%; Cd < 0,1% $100 / ((Te\% + Se\% + Sb\% + As\%)/100 + (Pb\ powder\%)/500)$ between 300 - 2000 mg/kg $100 / ((Se\% + Sb\% + As\%)/700 + Pb\ powder\%/4500)$ between 2500 - 20000 mg/kg $(\%Cu \times 0,4 + \%Pb \times 0,14) < 1$ $(\%Cu \times 0,05 + \%Pb \times 0,056) *10$ between 1-10

Assume surface area of 1 mm particle size (expressed as m²/g) unless provided otherwise by registrant