Outcomes of discussion on Human Health and Environmental classification of PM Refinables as derived with MeClas by using the composition and T/D data available in the ID Cards, the reference samples and the individual company streams

PM Refiners WG mtg – Brussels, 11-12 October 2010

Version: 21 Oct 2010

General comments

a. LR IUCLID 5 files will cover all classifications relevant for each Refinable:
- Currently placed on the market as reflected by the individual company streams
- Hypothetical compositions to cover for future cases and UVCB variable/flexible nature

b. Co-registrants are invited to include exactly same information in section 1.2 of IUCLID 5 as LR to cover all streams registered by LR. Section on classification should only be completed in LR's file in order to prevent opt-out scenario (higher registration fees and requests for harmonisation)

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
- Are unlikely to be totally finalised within the remaining timeframe (see below) but should however be covered by the classification scenario added to the LR file, which is sufficiently inclusive

d. If a company stream is not properly addressed from a composition and/or classification viewpoint in the LR IUCLID 5 file submitted in 2010, the company must refer to this specific composition and associated classification in its SDS meanwhile it is added to the dossier if/when updated in 2011

e. Classifications in the LR file may be proposed as:
- Grouped classifications associated to a given composition profile → this alternative 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
    - Doré
    - Matte
    - Residues matte leaching
    - Residues speiss leaching
    - Ag electrolyte
    - Au electrolyte
    - Materials for reclaim, PM in bricks, pots, crucibles and trays, etc.
- Pick-lists including each relevant classification endpoint and category allowing registrants to "compose" the classification of their refinable (e.g.: for SDS preparation purposes) by picking those endpoints that are relevant for their specific composition → this alternative is proposed for very large and variable groups, where many combinations are possible
    - Slags
    - Slimes and sludges
    - Flue dust
    - Residues cementation and reduction
    - Materials for reclaim, PM with or without support
    - 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 cutt-offs will be done by using the elemental composition (species added in Remarks field) associated to CLP cutt-offs. Please note that the DSD classification could not always be unambiguously linked to CLP classification.

1. <u>Doré:</u>

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 Ch 1	N; R50-53	Ag (powder) > 92%
3	ENV Ch 2	N; R51-53	Ag < 92%; Cu > 69,5%
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 (10 * (2,47 * %Cu + 13 * %Pb + 40 * %Co) * surface area intermediate[#] / 0.22 > 1 and (0,12 * %Cu + 0,73 * %Pb + 27,6 * %Co) * surface area intermediate[#] / 0.22) > 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%; CoS < 1% 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 (10 * (2,47 * %Cu + 13 * %Pb + 40 * %Co) * surface area intermediate[#] / 0.22 > 1 and (0,12 * %Cu + 0,73 * %Pb + 27,6 * %Co) * surface area intermediate[#] / 0.22) > 1
3	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ch 1		To be clarified by ARCHE
4	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ch 2, Skin sens. 1, Ac. Tox. oral 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) > 20000 mg/kg (10 * (2,47 * %Cu + 13 * %Pb + 40 * %Co) * surface area intermediate[#] / 0.22 > 1 and (0,12 * %Cu + 0,73 * %Pb + 27,6 * %Co) * surface area intermediate[#] / 0.22) > 1
5	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ch 1, Skin sens. 1, Skin corr. 2, Eye dam. 2, Ac. Tox. oral 4		To be clarified by ARCHE

[#] Assume surface area of 1 mm particle size (expressed as m^2/g) unless provided otherwise by registrant

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
- Cherry-pick list of endpoints proposed: in order to compose classification (especially environmental one), following steps must be considered: 1) which flux? and 2) which composition/endpoints?

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 2	R40	Pb comp >= 1% or Sb2O3 >= 1%; As2O3 < 0,1%, NiO < 0,1%
2	Carc. 1A	R49	As2O3 >= 0,1% or NiO >= 0,1%
3	Carc. 1B	R49	CdO >= 0,1% and As2O3 < 0,1% and NiO < 0,1%
4	Repro. 1A	R60-61	Pb >= 0,3 %
5	Repro. 1B	R60-61	(B2O3 >= 0,3% or Na2B4O7 >= 4,5%) and Pb comp < 0,3%
6	Repro. 2	R62-63	CdO >= 3%; B2O3 < 0,3%; NaB4O7 < 4,5%; Pb comp < 0,3%
7	STOT Rep 1	R48	CdO >= 10% or NiO >= 10%
8	STOT Rep 2	R48	CdO: 1% - 10% or Pb comp >= 0,5% or Se comp >= 10% or NiO: 1% - 10%
9	ENV Ch 1	R50-53	**Borosilicate + carbonate slags (Tier 1 – speciation)**: (%As2O3 + %CdO * 10 + %CoO * 10 + %Cu2O * 10 + %Pb comp * 10 + %Se comp * 10 + %ZnO + %Bi comp * 10 + %Ag comp * 1000 + %Au comp + %Pd comp * 100 + %Pt comp * 10 + %Ti comp + %Rh comp + %Ru comp) > 25% **Phosphate slags (Tier 2 – TDP)**: (0,46 * %Ag + 0,0053 * %Pb) * surface area intermediate[#] / 0.12 > 1 **Silicate slags (Tier 2 – TDP)**: (0,12 * %Cu + 0,037 * %Pb) * surface area intermediate[#] / 0.12 > 1 **Borate slags (Tier 2 – TDP)**: (0,024 * %Zn + 0,13 * %Pb) * surface area intermediate[#] / 0.12 > 1
10	ENV Ch 2	R51-53	**Borosilicate + carbonate slags (Tier 1 – speciation)**: (10 * %As2O3 + %CdO * 10 + %CoO * 10 + %Cu2O * 10 + %Pb comp * 10 + %Se comp * 10 + %ZnO + %Bi comp * 10 + %Ag comp * 1000 + %Au comp + %Pd comp * 100 + %Pt comp * 10 + %Ti comp + %Rh comp + %Ru comp) > 25% **Phosphate slags (Tier 2 – TDP)**: 10 * (0,46 * %Ag + 0,0053 * %Pb) * particle size or surface correction > 1 and (4,5 * %Ag + 0,089 * %Pb) * particle size or surface correction > 1 **Silicate slags (Tier 2 – TDP)**: 10 *(0,12 * %Cu + 0,037 * %Pb) * particle size or surface correction > 1 and (0,61 * %Cu + 0,61 * %Pb) * particle size or surface correction > 1 **Borate slags (Tier 2 – TDP)**: 10 * (0,024 * %Zn + 0,13 * %Pb) * particle size or surface correction > 1 and (0,48 * %Zn + 2,24 * %Pb) * particle size or surface correction > 1
11	ENC Ch 3	R52-53	**Borosilicate + carbonate slags (Tier 1 – speciation)**: (100 * (%As2O3 + %CdO * 10 + %CoO * 10 + %Cu2O * 10 + %Pb comp * 10 + %Se comp * 10 + %ZnO + %Bi comp * 10 + %Ag comp * 1000 + %Au comp + %Pd comp * 100 + %Pt comp * 10 + %Ti comp + %Rh comp + %Ru comp) + %BaO2) > 25% **Phosphate slags (Tier 2 – TDP)**: 100 * (0,46 * %Ag + 0,0053 * %Pb) * particle size or surface correction > 1 and (4,5 * %Ag + 0,089 * %Pb) * particle size or surface correction > 1 **Silicate slags (Tier 2 – TDP)**: 100 *(0,12 * %Cu + 0,037 * %Pb) * particle size or surface correction > 1 and (0,61 * %Cu + 0,61 * %Pb) * particle size or surface correction > 1 **Borate slags (Tier 2 – TDP)**: 100 * (0,024 * %Zn + 0,13 * %Pb) * particle size or surface correction > 1 and (0,48 * %Zn + 2,24 * %Pb) * particle size or surface correction > 1
12	Skin sens. 1	R43	CoO >= 1% or NiO >= 1%
13	Eye dam. 2		Cu2O >= 10% or As2O3: 1% - 3% or 10* %As2O3 + Cu2O >= 10%
14	Skin corr. 1B	R36,R37,R38	As2O3 >= 5%
15	Skin corr. 2		As2O3: 1% - 5%
16	Ac. Tox. oral 1	R28	100 / ((%Se + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %Pb powder + %BaO2)/500) <= 5 mg/kg
17	Ac. Tox. oral 2-3	R22/25/28	100 / ((%Se + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %Pb powder + %BaO2)/500) between 5 – 300 mg/kg

18	Ac. Tox. oral 4	R22	100 / ((%Se + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %Pb powder + %BaO2)/500) between 300 and 2000 mg/kg
19	Ac. Tox. inh 4	R20	100 / ((%Se)/700 + (%Cu2O + %Pb comp + %Pb powder + %BaO2)/4500) between 2500 and 20000 mg/kg

[#] Assume surface area of 1 mm particle size (expressed as m^2/g) unless provided otherwise by registrant

4. Slimes and sludges

Notes:

- PMC's largest group where the V in UVCB has its most significant meaning
- Streams from several precious metals refining processes are grouped in this group in light of their likely hazardous composition and associated classification
- Species selected for the purpose of deriving classifications are as per ID Card. When several species are provided, the worst one was selected by ARCHE
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- Still, at least one stream showed no CMR content therefore justifying a non-classified composition in the IUCLID 5 file (very pure in Au or PGM)
- Need to separate sulphate streams (e.g. anode slimes) from non-sulphate (but rather oxide, chloride or nitrate) streams as this will have consequences on the form in which metals are found (e.g.: CuSO4) and the resulting classification (e.g.: skin corrosion)
- Proposed to provide classification as cherry-pick list rather than as specific profiles: in order to compose classification, following steps must be considered: 1) which type of stream (e.g. sulphate or non-sulphate type? and 2) which composition/endpoints?

	Classification CLP	**Classification DSD**	**Composition / classification drivers**
1	No classification	No classification	CdO <= 0,1%; MoO3 <= 1%; (100 * (%As2O3 + %CdO * 10 + %CoO * 10 + %Cu2O * 10 + %Pb comp * 10 + %Se comp * 10 + %ZnO + %Bi comp * 10 + %Ag comp * 1000 + %Au comp + %Pd comp * 100 + %Pt comp * 10 + %Ti comp + %Rh comp + %Ru comp + %CuSO4 * 10 + %NiSO4 + %ZnSO4 + %Pt) + 10 * (%MnSO4) + %BaO2) < 25% and any of the conditions below are not met
2	ENV Ch 1	R50-53	(%As2O3 + %CdO * 10 + %CoO * 10 + %Cu2O * 10 + %Pb comp * 10 + %Se comp * 10 + %ZnO + %Bi comp * 10 + %Ag comp * 1000 + %Au comp + %Pd comp * 100 + %Pt comp * 10 + %Ti comp + %Rh comp + %Ru comp + %CuSO4 * 10 + %NiSO4 + %ZnSO4 + %Pt) > 25%
3	Carc. 1A	R45/49	As2O3 >= 0,1% or NiSO4 >= 0,1% or NiO >= 0,1%
4	Carc. 2	R40	(Pb comp >= 1% or MoO3 >= 1% or Sb2O3 >= 1%) and As2O3 < 0,1% and (NiSO4 < 0,1% or NiO < 0,1%)
5	Muta. 2	R68	CdO >= 1% or NiSO4 >= 1%
6	Repro. 1A	R60/61	Pb comp >= 0,3%
7	Repro. 1B	R60/61	(Na2B4O7 >= 4,5% or NiSO4 >= 0,3%) and Pb comp < 0,3%
8	Repro. 2	R60/61	CdO >= 3% and Na2B4O7 < 4,5% and NiSO4 < 0,3% and Pb comp < 0,3%
9	STOT Rep 1	R48	CdO >= 10% or NiSO4 >= 1% or NiO >= 10%
10	STOT Rep 2	R48	CdO: 1%-10% or MnSO4 >= 10% or Pb comp >= 0,5% or NiSO4: 0,1% - 1% or Se Comp >= 10% or NiO: 1% - 10%
11	Skin Sens. 1	R42/43	CoO >= 1% or NiO >= 1%
12	Resp./Skin Sens. 1	R42/43	NiSO4 >= 1%
13	Eye dam. 1	R41	%ZnSO4 + %NH3 + %As2O3 >= 3%
14	Eye dam. 2	R36	%ZnSO4 + %NH3 + %As2O3 between 1% - 3% or %MoO3 + %CuSO4 + %Cu2O >= 10% or 10 * (%ZnSO4 + %NH3 + %As2O3) + %CuSO4 + %Cu2O + %MoO3 >= 10%
15	Skin corr. 1B	R34	(%NH3 + %As2O3) >= 5%
16	Skin corr. 2	R36-37-38	(%NH3 + %As2O3) between 1% - 5% or CuSO4 >= 10% or NiSO4 >= 20% or 10 * (%NH3 + %As2O3) + %CuSO4 + NiSO4 >= 10%
17	Ac. Tox. oral 1	R28	100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%BaO2 + %CoO + %CuSO4 + %Pb comp + %NiSO4 + %ZnSO4 + %Cu2O + %MnO2)/500) <= 5 mg/kg
18	Ac. Tox. oral 2-3	R22/25/28	100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%BaO2 + %CoO + %CuSO4 + %Pb comp + %NiSO4 + %ZnSO4 + %Cu2O + %MnO2)/500) between 5 - 300 mg/kg
19	Ac. Tox. oral 4	R22	100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%BaO2 + %CoO + %CuSO4 + %Pb comp + %NiSO4 + %ZnSO4 + %Cu2O + %MnO2)/500) between 300 – 2000 mg/kg
20	Ac. Tox. inh 1	R26	100 / ((%CdO)/100 + (%Se comp)/700 + (%BaO2 + %Pb comp + %NiSO4 + %MnO2)/4500 <= 100 mg/kg
21	Ac. Tox. inh 2-3	R20/23/26	100 / ((%CdO)/100 + (%Se comp)/700 + (%BaO2 + %Pb comp + %NiSO4 + %MnO2)/4500 between 100 – 2500 mg/kg
22	Ac. Tox. inh 4	R20	100 / ((%CdO)/100 + (%Se comp)/700 + (%BaO2 + %Pb comp + %NiSO4 + %MnO2)/4500 between 2500 – 20000 mg/kg

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 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 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 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	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 2, 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) < 1%; 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*1000 + %As compounds*10 + %Se compounds*10 + %CuS*10 + %Pb compounds*10 + %Bi *10 + %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 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 (%AgNO3*1000 + %Pd compounds*100 + %CuSO4*10 + %Pt compounds*10 + %Pb compounds*10 + %ZnSO4) > = 25%
2	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) > 2000 mg/kg (%AgNO3*1000 + %Pd compounds*100 + %CuSO4*10 + %Pt compounds*10 + %Pb compounds*10 + %ZnSO4) > = 25%

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 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% (Pd% * 100 + Au% + CuSO4 * 10 + Ru% + Rh%) > 25% 100 / ((PtCl4%)/100 + (CuSO4%)/500) between 300 – 2000 mg/kg 100 / HCl% / 700 between 2500 – 20000 mg/kg (%Pd compounds*100 + %CuSO4*10 + %Au compounds + %PtCl4) >= 25%

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
- Proposed to provide classification as cherry-pick list rather than as specific profiles: in order to compose classification, following steps must be considered: 1) which type of stream (e.g. sulphate or oxide, silicate and chloride type? and 2) which composition/endpoints?

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 1A	R45/49	As2O3 >= 0,1% or NiO >= 0,1% or NiSO4 >= 0,1%
2	Carc. 2	R40	(Pb comp >= 1% or Sb2O3 >= 1%) and As2O3 < 0,1%; NiO < 0,1%; NiSO4 < 0,1%
3	Muta. 2	R68	NiSO4 >= 1%
4	Repro. 1A	R60/61	Pb comp >= 0,3%
5	Repro 1B	R60/61	(Na2B4O7 >= 4,5% or NiSO4 >= 0,3%) and Pb comp < 0,3%
6	STOT Rep 1	R48	NiO >= 10% or NiSO4 >= 1%
7	STOT Rep 2	R48	NiO: 1% - 10% or Se comp >= 10% or Pb comp >= 0,5% or MnSO4 >= 10% or NiSO4: 0,1% - 1%
8	ENV Ch 1	R50/53	(%As2O3 + %Pb comp * 10 + %Se comp *10 + %ZnO + %NiSO4 + %Bi/Bi comp * 10 + %AgNO3 * 1000 + %Au comp + % Pd/Pd comp * 100 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp * 10 + %Ti/Ti comp + %Cu2O * 10 + %MnO2 + %Se comp * 10 + %Ag comp * 1000 + %CuSO4) > 25%
9	Skin sens. 1	R42/43	NiO >= 1% or NiSO4 < 0,01%
10	Resp./Skin sens. 1	R42/43	NiSO4 >= 1%
11	Eye dam. 1	R41	(%As2O3 + %SnCl4) >= 3%
12	Eye dam. 2	R36	(%As2O3 + %SnCl4): 1% - 3% or (%Cu2O + %CuSO4) >= 10%
13	Skin corr. 1B	R34-36-37-38	(%As2O3 + %SnCl4) >= 5%
14	Skin corr. 2	Not classified	(%As2O3 + %SnCl4): 1% - 5% or CuSO4 >= 10% or NiSO4 >= 20% or 10* (%As2O3 + %SnCl4) + %CuSO4 + %NiSO4 >= 10%
15	Ac. Tox. oral 1	R28	100/ ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %CuSO4 + %NiSO4)/500) <= 5 mg/kg
16	Ac. Tox. oral 2-3	R22/25/28	100/ ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %CuSO4 + %NiSO4)/500) between 5 and 300 mg/kg
17	Ac. Tox. oral 4	R22	100/ ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%Cu2O + %Pb comp + %CuSO4 + %NiSO4)/500) between 300 and 2000 mg/kg
18	Ac. Tox. inh 1	R26	100/ ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) <= 100 mg/kg
19	Ac. Tox. inh 2-3	R20/23/26	100/ ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 100 – 2500 mg/kg
20	Ac. Tox. inh 4	R20	100/ ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 2500 – 20000 mg/kg

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
- Proposed to provide classification as cherry-pick list rather than as specific profiles

	Classification CLP	**Classification DSD**	**Composition / classification drivers**
1	No classification	No classification	SnCl4 < 1% and any of the conditions below are not met
2	Carc. 1A	R45/49	As2O3 >= 0,1% or NiSO4 >= 0,1% or NiO >= 0,1%
3	Carc. 2	R40	Pb comp >= 1% or Sb2O3 >= 1% and As2O3 < 0,1% and NiSO4 < 0,1% and NiO < 0,1%
4	Muta. 2	R68	NiSO4 >= 1%
5	Repro. 1A	R60/61	Pb comp >= 0,3%
6	Repro. 1B	R60	NiSO4 >= 0,3% and Pb comp < 0,3%
7	STOT Rep 1	R48	NiSO4 >=1% or NiO >= 10%
8	STOT Rep 2	R48	Se comp >= 10% or Pb comp >= 0,5% or MnSO4 >= 10% or NiO: 1% - 10% or NiSO4: 0,1% - 1%
9	ENV Ch 1	R50-53	(%As2O3 + %Pb comp * 10 + %Se comp *10 + %ZnO + %NiSO4 + %Bi/Bi comp * 10 + %AgNO3 * 1000 + %Au comp + % Pd/Pd comp * 100 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp * 10 + %Ti/Ti comp) > 25%
10	Resp/Skin sens. 1	R42/43	NiSO4 >= 1%
11	Eye dam. 1	R36-37-38	%SnCl4 + %AgNO3 + %As2O3 >= 3%
12	Eye dam. 2	R36-37-38	{(%SnCl4 + %AgNO3 + %As2O3): 1% - 3%} or {10 * (%SnCl4 + %AgNO3 + %As2O3) + %CuSO4 >= 10%)
13	Skin corr. 1B	R34-36-37-38	%SnCl4 + %AgNO3 + %As2O3 >= 5%
14	Skin corr. 2	Not classified	(%SnCl4 + %AgNO3 + %As2O3): 1-5% or CuSO4 >= 10% or NiSO4 >= 20% or 10*(%SnCl4 + %AgNO3 + % As2O3) + %CuSO4 + NiSO4 >= 10%
15	Ac. Tox. oral 1	R28	100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%CuSO4 + %Pb com + %NiSO4)/500) <= 5 mg/kg
16	Ac. Tox. oral 2-3	R22/25/28	100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%CuSO4 + %Pb com + %NiSO4)/500) between 5 – 300 mg/kg
17	Ac. Tox. oral 4	R22	100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%CuSO4 + %Pb com + %NiSO4)/500) between 300 – 2000 mg/kg
18	Ac. Tox. inh 4	R20	100 / ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 2500 – 20000 mg/kg

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
- Proposed to provide classification as cherry-pick list rather than as specific profiles

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 1A	R49	NiO >= 0,1%
2	Carc. 1B	R45	Cd >= 0,1%
3	Muta. 2	R68	Cd >= 1%
4	Repro. 1A	R60/61	Pb powder >= 0,3%
5	STOT Rep 1	R48	Cd >= 10% or NiO >= 10%
6	STOT Rep 2	R48	Cd: 1% -10% or Se >= 10% or NiO: 1% - 10% or Pb powder >= 10%
7	ENV Ch 1	R50/53	(0,11 * %Co + 45 * %Ag + 0,0072 * %Ni) > 1
8	ENV Ch 2	R51/53	10 * (0,11 * %Co + 45 * %Ag + 0,0072 * %Ni) > 1 and (27 * %Co + 444 * %Ag + 0,17 * %Ni) > 1
9	Resp/Skin sens. 1	R42/43	Co >= 1%
10	Skin sens. 1	R43	NiO >= 1%; Co < 1%
11	Ac. Tox. oral 4	R22	100 / ((%As + %Se + %Te/Te comp)/100 + (%BaO2 + %Sb/Sb comp + %Pb powder)/500) between 300 and 2000 mg/kg
12	Ac. Tox. inh 1	R26	100 / ((%Cd)/100 + (%As + %Se)/700 + (%BaO2 + %Sb/Sb comp + %Pb powder)/4500) <= 100 mg/kg
13	Ac. Tox. inh 2-3	R20/23/26	100 / ((%Cd)/100 + (%As + %Se)/700 + (%BaO2 + %Sb/Sb comp + %Pb powder)/4500) between 100 – 2500 mg/kg
14	Ac. Tox. inh 4	R20	100 / ((%Cd)/100 + (%As + %Se)/700 + (%BaO2 + %Sb/Sb comp + %Pb powder)/4500) between 2500 – 20000 mg/kg

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

	Classification CLP	Classification DSD	Composition / classification drivers
1	Carc. 1A	R49	NiO >= 0,1%
2	Repro. 1A	R60/61	Pb comp >= 0,3%
3	STOT Rep 1	R48	NiO >= 10%
4	STOT Rep 2	R48	Pb comp >= 0,5% or Se >= 10% or NiO: 1% - 10%
5	ENV Ch 1	R50/53	(0,08 * %Cu + 5,16 * %Ag) > 1
6	ENV Ch 2	R51/53	10 * (0,08 * %Cu + 5,16 * %Ag) > 1 and (0,41 * %Cu + 50 * %Ag) > 1
7	ENV Ch 3	R52/53	100 * (0,08 * %Cu + 5,16 * %Ag) > 1 and (0,41 * %Cu + 50 * %Ag) > 1
8	Skin sens. 1	R43	NiO >= 1% and Co < 1%
9	Ac. Tox. oral+inh 4	R20/22	100 / ((%As + %Se + %Te comp)/100 + (%Pb comp + %Sb/Sb comp)/500) between 300 – 2000 mg/kg 100 / ((%As + %Se)/700 + (%Pb comp + %Sb/Sb comp)/4500) between 2500 – 20000 mg/kg

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	Carc. 2, Repro. 1A, STOT Rep 1, ENV Ch 1, Skin sens. 1	R43 R40 R50-53 R60/61 R48	Co < 1%; Ni >= 10%; Pb powder >= 0,3% 100 / ((%As + %Se + %Te/Te comp)/100 + (%Sb/Sb comp + %Pb powder)/500) > 2000 mg/kg 100 / ((%As + %Se)/700 + (%Sb/Sb comp + %Pb powder)/4500) > 20000 mg/kg (%As * 10 + %Cu powder * 10 + %Pb powder * 10 + %Ag * 1000 + %Pd * 100 + %Pt * 10 + %Cr *10 + %Rh + %Ru + %Ti + %Zn powder)> 25%
2	Carc. 2, Repro. 1A, STOT Rep 2, 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 comp)/100 + (%Sb/Sb comp + %Pb powder)/500) > 2000 mg/kg 100 / ((%As + %Se)/700 + (%Sb/Sb comp + %Pb powder)/4500) > 20000 mg/kg (%As * 10 + %Cu powder * 10 + %Pb powder * 10 + %Ag * 1000 + %Pd * 100 + %Pt * 10 + %Cr *10 + %Rh + %Ru + %Ti + %Zn powder) > 25%
3	Carc. 2, Repro. 1A, STOT Rep 1, 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 comp)/100 + (%Sb/Sb comp + %Pb powder)/500) between 300 – 2000 mg/kg 100 / ((%As + %Se)/700 + (%Sb/Sb comp + %Pb powder)/4500) between 2500 – 20000 mg/kg (%As * 10 + %Cu powder * 10 + %Pb powder * 10 + %Ag * 1000 + %Pd * 100 + %Pt * 10 + %Cr *10 + %Rh + %Ru + %Ti + %Zn powder) > 25%
4	Repro. 1A, STOT Rep 2, 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 comp)/100 + (%Sb/Sb comp + %Pb powder)/500) > 2000 mg/kg 100 / ((%As + %Se)/700 + (%Sb/Sb comp + %Pb powder)/4500) between 2500 – 20000 mg/kg (%As * 10 + %Cu powder * 10 + %Pb powder * 10 + %Ag * 1000 + %Pd * 100 + %Pt * 10 + %Cr *10 + %Rh + %Ru + %Ti + %Zn powder) > 25%
5	Carc. 2, STOT Rep 2, 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 comp)/100 + (%Sb/Sb comp + %Pb powder)/500) > 2000 mg/kg 100 / ((%As + %Se)/700 + (%Sb/Sb comp + %Pb powder)/4500) > 20000 mg/kg (%As * 10 + %Cu powder * 10 + %Pb powder * 10 + %Ag * 1000 + %Pd * 100 + %Pt * 10 + %Cr *10 + %Rh + %Ru + %Ti + %Zn 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 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 (0,4 * %Cu + 0,13 * %Pb) * surface area intermediate[#] / 0.19 > 1
2	Carc. 2, Repro. 1A, STOT Rep 2, 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 (0,4 * %Cu + 0,13 * %Pb) * surface area intermediate[#] / 0.19 > 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 10 * (0,4 * %Cu + 0,13 * %Pb) * surface area intermediate[#] / 0.19 > 1 and (2 * %Cu + 2,25 * %Pb) * surface area intermediate[#] / 0.19 > 1
4	Carc. 2, Repro. 1A, STOT Rep 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 100 * (0,4 * %Cu + 0,13 * %Pb) * surface area intermediate[#] / 0.19 < 1 or (2 * %Cu + 2,25 * %Pb) * surface area intermediate[#] / 0.19 < 1

[#] Assume surface area of 1 mm particle size (expressed as m^2/g) unless provided otherwise by registrant