RISK MANAGEMENT OPTIONS ANALYSIS

CHLOROPLATINATES

Final Report

Content

Executive summary

This report presents the results of discussions with companies that process chloroplatinates for platinum refining and catalyst manufacturing. These companies can be said to be representative of the situation of chloroplatinates processing in the EU.

The main conclusions of the assessment of both the data and the different risk management options identified are that:

- *The concern related to chloroplatinates is only occupational and limited to a few operations in Europe i.e. in precious metal refining and in chemical plants.*
- *In terms of effective risk management, an OEL appears to be the most adequate solution. The decision process on OELs is ongoing but does not prevent any initiative in the framework of REACH.*
- *Because they are possibly the most potent respiratory sensitizers encountered in industrial processes, chloroplatinates may feature high on the list of substances to consider as potential Substance of Very High Concern (SVHC). The data that need to be collected to resist inclusion of chloroplatinates on the SVHC list have been identified and these data should be able to illustrate the irrelevance of such an inclusion.*
- *As chloroplatinates are for the largest part used as intermediates (on-site isolated intermediates in the REACH terminology) the likelihood of them being prioritized for Authorisation is low.*
- *Isolated on-site intermediates do not qualify for Restriction either (article 68(1)) so that provided authorities can be convinced that chloroplatinates essentially fall under that category, the option of Restriction would be very unlikely.*

Recommendations for further work are that:

- *There is at present no technical and economic alternative to a chlorinated phase in platinum refining, and more broadly in PGM refining, but the technical-scientific argument for continued use of chloroplatinates will have to be kept up-to-date.*
- *As there might still be some possible or minor uses of chloroplatinates in the EU where the status of intermediate use is either not applicable (plating) or needs to be established (photographic films and ceramic colours), the uncertainties related to these uses, especially in the EU, may have to be addressed.*
- *The evolution of the uses and the possible emergence of new uses should be monitored so as to keep the information up-to-date, including and especially in the REACH Registration dossier, as it constitutes the reference for initiatives in the field of Risk Management Options Analysis under REACH.*
- *The evolution of both ECHA's interpretation and guidance on establishing an intermediate status of a use and process technologies especially in the field of platinum refining needs to be monitored so as to remain assured that the main arguments on which the conclusion of this assessment is based, remain valid.*

1. Introduction

Regulatory context

A process within the context of REACH, triggered autonomously from the ongoing discussions on Occupational Exposure Levels

- *The EU Roadmap 2020 for Substances of Very High Concern (SVHC Roadmap) has set the scene for the screening of thousands of substances by 2020 for a certain number of toxicological end-points from CMRs or PBT/vPvB substances to respiratory sensitizers.*
- *Chloroplatinates may feature high on the list that comes out of the screening as they appear to be potentially the most potent respiratory sensitizers encountered in industrial processes.*
- *Following this screening, regulators may decide to assess the need for additional risk management measures through a Risk Management Options Analysis (RMOA) under REACH.*
- *REACH foresees two major risk management options, i.e. Restrictions or Authorisation of SVHCs. The aim of REACH is to ban the use of SVHCs and have them substituted by industry, Authorisation being seen as a 'temporary delay' to achieving that aim.*
- *The SVHC Roadmap has however acknowledged that substance assessors may consider options outside of REACH such as workplace legislation with the setting of Occupational Exposure Levels.*

Discussions in the OEL context may influence or be influenced by the ones that may get started under the REACH framework. In terms of timing, the regulatory challenge and the interrelationship between the OEL discussions and the REACH activities may be described as such:

End 2015: IPA chloroplatinates epidemiology study results became known and accessible to the EU Scientific Committee on Occupational Exposure Limits (SCOEL)

WORST-CASE SCENARIO

⇨ **As of Q3 2016 (?):** *Due to the absence of an OEL deemed as health-protective, SCOEL expected to reconsider the issue and proceed with a* new *OEL recommendation. That process may take 2 years at the very least.*

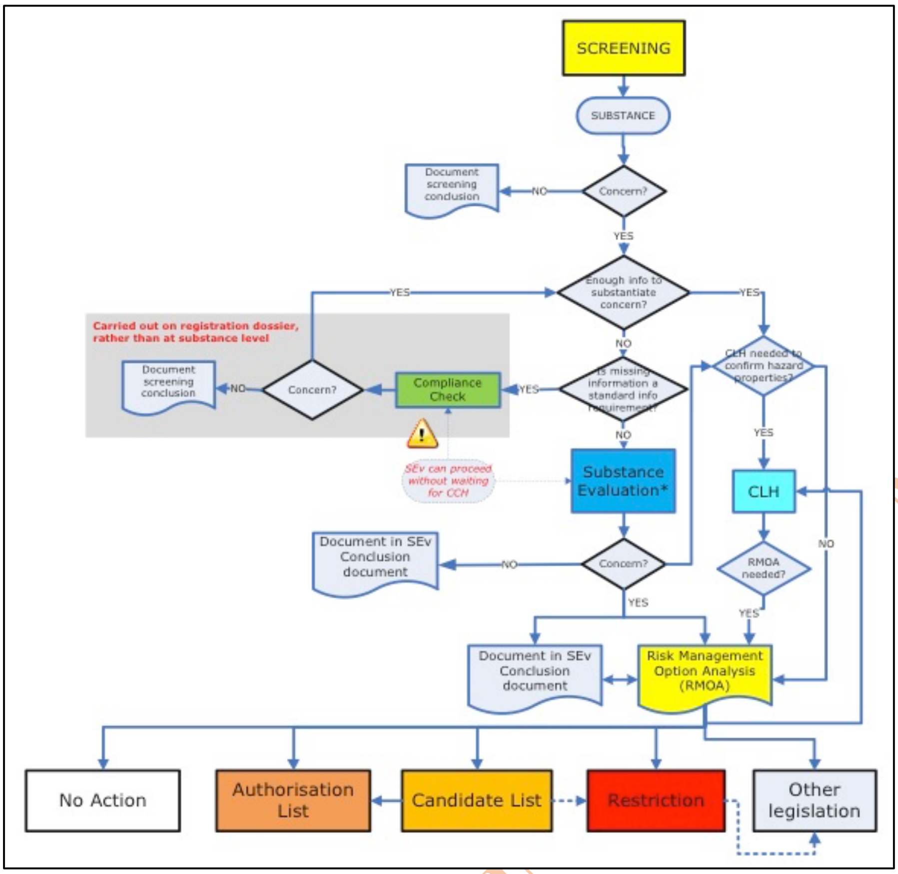
⇨ **As of 2016 onward:** *SVHC Roadmap screening process may lead to first discussions at Member State Competent Authority level (inclusion on the work plan of a Member State to identify need for risk management options or to further evaluate the substances).*[1]

⇨ **2017 (?):** *Possible proposal for inclusion of chloroplatinates on the list of Substances of Very High Concern (i.e. the Candidate list for eventual prioritisation for Authorisation), the risk will increase after the submission of the registration dossiers.*

[1] *Due to harmonised classification as respiratory sensitiser under CLP*

The SVHC Roadmap 2020, decision tree on substances being screened is illustrated in the following figure 1:

Figure 1: SVHC Roadmap RMO selection process description



Aim and process of the exercise

An anticipatory exercise to prepare industry for a challenge from the EU SVHC Roadmap

- The exercise had set itself the aim to anticipate the EU screening and possible further examination of chloroplatinates under REACH, and **not** to interfere with ongoing work and advocacy on the setting of an OEL.
- In order to prepare the industry to face a regulatory challenge under REACH, the RMOA exercise was devised in such a way that participants were invited to:
    - **Agree on remaining concerns with the use of chloroplatinates** and where these risks are as well as what type of risk reduction one would aim for (e.g. elimination of certain types of health issues)
    - **Explore all possible Risk Management Options** that may potentially apply to chloroplatinates, from both an Industry and a regulator perspective, **but with a particular effort to be invested by Industry representatives in simulating a regulator's approach and view on the matter**.

- **Identify the most adequate and proportionate Risk Management Option** applicable to chloroplatinates, through a series of selection steps and substantiating argumentations.
- **Identify the knowledge and data gaps** to be addressed by Industry to make a convincing contribution to an official RMO exercise or during public consultations in such a framework.

- Four companies have provided input and participated in the assessment of the potential Risk Management Options. These companies can be said to be representative of the situation regarding exposure to chloroplatinates at the level of platinum refining and catalyst manufacturing in Europe.
- The potentially sensitive nature of the information that might be useful for the exercise was acknowledged, such as
    1. Information on the exposure situation at company level (process and number of workers). Some data have been provided but will not be presented in this report.
    2. Data on volumes, including volumes per use categories (important i.e. in the context of intermediate uses vs. non-intermediate uses); **No data on company volumes have been collected**. If needed, one might consider different ways of collecting this type of information through a trustee or via approximations (such as e.g. rough calculation of EU Pt output multiplied by a factor (2?) to estimate the volumes of chloroplatinates).
    3. Information on uses and alternatives

    Such information, insofar as available, was collected and discussed through a conversation France Capon and Michel Vander Straeten had with the companies individually.
    In order to help participants in drawing in expertise from other departments such as R&D or Marketing, the participants were provided with a Guide for Conversation (attached to this report), that outlined the information that was looked for.

- The work consisted in a common session and individual conference calls as well as desktop research to collect material able to substantiate statements made during the meetings. Companies also sent in data.
- The exercise led to a set of recommendations for further work (Chapter 4).

2. *Scoping and information on chloroplatinates*

Platinum is a rare but vital metal in modern life, used in almost all automotive catalytic converters, and to catalyse a multitude of industrial processes from petroleum refining to creation of pharmaceuticals and agricultural fertilizer constituents.

Platinum is not classified. However, key intermediates in the platinum refining processes are the chloroplatinates, which do present significant hazards in the workplace, namely, respiratory irritation and occupational respiratory sensitisation, i.e. platinum salt sensitisation -PSS.

The analysis has put the focus on platinum salt sensitization because it is the best known health concern and the most severe one. The respiratory sensitisation classification is what brings these chloroplatinates in scope for potential selection as Substance of Very High Concern, under the Equivalent Level of Concern category. It is considered as overshadowing any other concerns that may be uncovered in the current assessment for REACH Registration. At a later stage, one may possibly have to take into consideration other hazards/risks currently under assessment: STOT RE[2]. **The decision was made not to take these hazard properties further up in the analysis** as it was considered that as the exposure concern is the same, i.e. occupational only, any risk management measure that would significantly reduce/eliminate the risk of PSS will also be protective for the other toxicological endpoints.

Compounds covered

It was agreed to concentrate the analysis on the four chloroplatinates covered by the ongoing work in view of REACH Registration.
Other compounds do not display the same human health hazard profile.

Table 1a: Physico-chemical classification and environmental classification of chloroplatinate compounds selected for the RMO Analysis exercise

	10025-99-7 Dipotassium tetrachloroplatinate	**16941-12-1 Hexachloroplatinic acid (and hydrate 26023-84-7 or 18497-13-7)**	**16921-30-5 Dipotassium hexachloroplatinate**	**16919-58-7 Diammonium hexachloroplatinate**
Physico-chemical classification	Metal corrosivity 1 (H290)	Metal corrosivity 1 (H290)	Metal corrosivity 1 (H290)	Metal corrosivity 1 (H290)
Environmental classification		Aquatic acute 1	Aquatic acute 1	Read across to be agreed by Working Group, then updated classification will be required (Aquatic acute 1, aquatic chronic 1)
		Aquatic chronic 1	Aquatic chronic 1	
		Acute M factor 10	Acute M factor 10	
		Chronic M factor 10	Chronic M factor 10	

[2] In an RMO exercise, one always has to keep in mind a major source of scrutiny in the EU-circles i.e. the **Man via Environment** criterion. However, at this stage, the ECHA Guidance Document indicates no need to conduct an indirect exposure assessment for man exposed via the environment for substances manufactured in quantities below 100 tons/year.

No environmental classification is likely to trigger an EU action in the framework of the SVHC Roadmap 2020.

Table 1B: Human health classification and environmental classification of chloroplatinate compounds selected for the RMO Analysis exercise

	10025-99-7 Dipotassium tetrachloroplatinate	**16941-12-1 Hexachloroplatinic acid (and hydrate 26023-84-7 or 18497-13-7)**	**16921-30-5 Dipotassium hexachloroplatinate**	**16919-58-7 Diammonium hexachloroplatinate**
Human Health classification	Acute toxicity 3 (H301) (oral) Skin Irritant 2 (H315) Eye Damage 1 (H318) Skin sensitisation 1B (H317) **Respiratory Sensitisation 1A (H334)** **Respiratory Sensitisation 1 (Annex VI)**	Acute toxicity 2 (H300) (oral) Skin corrosion 1B (H314) Eye damage 1 (H318) Skin sensitisation 1B (H317) **Respiratory Sensitisation 1A (H334)** **STOT RE1** **Respiratory Sensitisation 1 (Annex VI)**	Acute toxicity 3 (H301) (oral) Eye damage 1 (H318) Skin sensitisation 1B (H317) **Respiratory Sensitisation 1A (H334)** **STOT RE1** **Respiratory Sensitisation 1 (Annex VI)**	Acute toxicity 3 (H301) (oral) Eye damage 1 (H318) Skin sensitisation 1B (H317) **Respiratory Sensitisation 1A (H334)** **STOT RE1** **Respiratory Sensitisation 1 (Annex VI)**

The four compounds selected display a human health profile that is likely to draw the attention of the screening software, first, and of a Member State, in a second stage.

Notes:

- ***STOT RE1:*** *Specific Target Organ Toxicity – Repeated Exposure (category 1)*
- ***Respiratory Sensitisation 1 (Annex VI)*** *refers to ANNEX VI of the EU Regulation on Classification, Labelling and Packaging of substances and mixtures, which contains the harmonised classification and labelling for certain hazardous substances.*

Occurrence and uses of chloroplatinates

An RMOA needs to describe all the known uses and to qualify them in terms of relevance and trends. For example, the characteristics of chloroplatinates have led to their replacement in plating in jewellery and decoration (electroplating), possible exception being 'critical' uses such as in electronics that may have to be described.

- ***Refining/purification of platinum (including production of platinum sponge)***

The refining of platinum is very complex, linked to the presence of other platinum group metals (PGMs) and precious metals that are commonly found together in the ores, concentrates, base metal refining residues and material made available for recycling (processing waste, spent catalysts from the petrochemical and chemical industries and other end-of-life waste such as alloys in the glass and chemical fertiliser industries).
Before separating the individual precious metals, the starting material is dissolved in oxidized hydrochloric acid, from which platinum can be refined with selective process steps including reprecipitation and ion exchange. The pure platinum as a platinum sponge is further reduced using a wet chemical or separated with an electrolytic process. Secondary sources—such as recycling used catalysts from the petrochemical and chemical industries, and alloys from the glass and chemical fertilizer industries—are important for platinum recovery as will be shown in Table 5.

The diversity of platinum sources is shown in Table 2:

Table 2: Platinum sources

	Platinum Group Metals						Precious Metals	
	Pt	**Pd**	**Rh**	**Ir**	**Os**	**Ru**	Au	Ag
Mining concentrates and residues	X	X	X	X	X	X	X	X
Precious metal refiners (downstream process concentrates)	X	X	X	X	X	X	X	X
Base metal refining (downstream process concentrates)	X	X	X	X	X	X	X	X
Refiners, semi-refiners collectors and Use industries (processing and use residues)	X	X	X	X	X	X	X	X

Having a very similar chemical behaviour, the 6 PGMs are difficult to separate. Like the other transitional metals, PGMs form a range of complexes with different ligands of which the PGM-chloro complexes (for Pt mainly $PtCl_4^{2-}$ and $PtCl_6^{2-}$) are the most studied and important. The aqueous chloride solution is the "*only cost-effective medium in which all the PGMs can be brought into solution and concentrated*".[3]

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[3] *F.L. Bernardis et al. / Reactive and Functional Polymers 65 (2005) 205 - 217*

All PGM refining, aiming at a step-wise recovery of the individual metals, starts from such a solution containing PGM-chloro complexes.

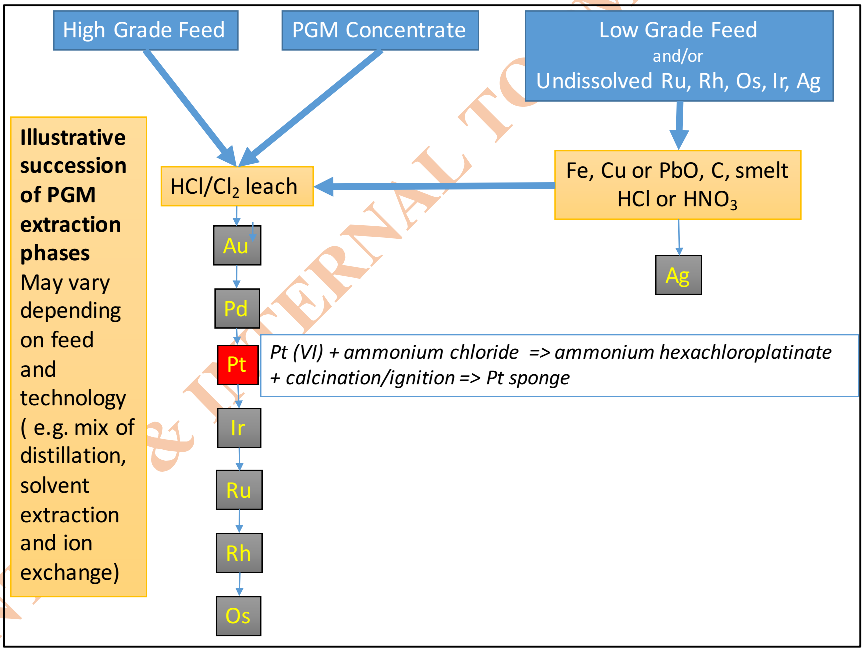
Refining methods consist of:

- ***Classical series of precipitation reactions allowing to separate the different PGMs***
- ***Solvent extraction (since the mid 1970s)***
- ***Solid-phase extraction through ligand exchange (Pd extraction) or ion-exchange ($PtCl_6^{2-}$ extraction)***

R&D is focused on improving the efficiency of the refining methods, all of them having to start with metals having been brought into an aqueous chloride solution. Given that the generation of chloroplatinate intermediate species in the refining process elevates the hazards significantly to workers, much effort has gone into developing alternative refining routes to avoid the generation of these species, but to date these research avenues have not been fruitful.

The following very simplified scheme (Figure 2) outlines how platinum is refined as part of a process where all 6 PGM and precious metals are involved (as well as some base metals).

Figure 2: Platinum production as part PGM refining



- ***Catalysis (precursor)***

Platinum is used as a catalyst in a wide variety of chemical reactions. Some of the more common catalytic uses are the oxidation of organic vapours in automobile exhaust, the oxidation of ammonia in the production of nitric acid, and the rearrangement of atoms in petroleum reforming.

- ***Exhaust catalysts***

An important application of platinum along with palladium and rhodium is the catalytic reduction of exhaust emissions (i.e. carbon monoxide CO, hydrocarbons HC, partly nitrogen oxides NOx) from automobiles. The exhaust catalysts consist mainly of cylindrical converters based on ceramic cordierite (honeycombs) or on steel foil wound and soldered (metal support).

During production, these structures are coated with platinum chemicals before calcination which converts these chemicals to platinum metal or oxides. A chloroplatinate; namely **Dihydrogen hexachloroplatinate(IV) hydrate, $H_2[PtCl_6]•nH_2O$ („CPA“)** may be one of the platinum chemicals used.

- ***Hydrosilylation***

Hydrosilylation consists of reactions that build up higher-molecular organosilicon compounds (silanes, siloxanes), and are the basis of manufacturing silicones. Silicone products are found all over the dental, automotive, building, polymer, or paper industries.

Platinum is the most effective metal for this catalytic reaction. Compounds mainly applied are **dihydrogen hexachloroplatinate(IV) hydrate ("CPA"), Sodium tetrachloroplatinate(II) hydrate, $Na_2[PtCl_4]$** or **cis-Diamminedichloroplatinum(II) ("Cisplatin"), cis-$[PtCl_2(NH_3)_2]$** and the "Karstedt's Catalyst". This means Pt(0) stabilized with, and dissolved in unsaturated organosiloxanes,.

- ***Surface treatment***

  - ***Plating***

Plating is the deposition in a micrometer range of metals from aqueous solutions ("electrolytes") of their compounds ("salts by reducing the metal ions").
These electrolytes contain the metals in oxidized states. Reduction to the elements and deposition are only practicable either with a direct current flow ("**Electroplating**") or with chemical reducers ("**Electroless Plating**").
Platinum is electroplated onto some aviation and aerospace components (cf. platinum aluminide coatings on turbine blades, electronic components (low voltage and low energy contacts), electrodes (water purification, oil refining, fertilizer manufacturing), medical equipment (catheters and connectors for surgical equipment) as well as jewellery. It offers functional and aesthetic properties.

Next to sulphate-based platinum solutions, chloroplatinic acid is still used extensively in the US for some plating applications (military equipment and repair of previously plated parts). In the EU, chloroplatinic acid is said to be used less, being viewed as a 'prior art' plating bath formulation, as there are a number of new non-chlorinated platinates on the market which are better plating agents (for example Q-salt (Tetraammineplatinum(II) hydrogenphosphate $Pt(NH_3)_4(HPO_4)$) or P-salt (diamminedinitroplatinum (II) $Pt(NH_3)_2(NO_2)_2$).

For **electroplating**, the parts to be metallized are submerged in the electrolytes as cathodes (reduction site). The anodes (oxidation site) are often made of platinized titanium or of the metal. Depending on the types of the parts, the plating units use racks or barrels for holders. The volume of plating baths, in the case of platinum plating can be as little as a few litres (jewellery) to bigger units (industrial parts, electrodes) none of which however comparable in dimension to the plating baths for nickel or chromium plating e.g.

Electroless plating is mainly suitable for parts of high complexity. The chemical reducer can be either a chemical compound (e.g. formaldehyde) or the non-noble part itself. This technology is not widely used for platinum as plating of platinum with chloroplatinic acid onto catalytically active metal substrates has not been very effective except on gold, palladium and silver.[4]

For plating with platinum, important starting materials are cis-diamminedinitritoplatinum(II) solutions, cis-$[Pt(NO_2)_2(NH_3)_2]$ **(solutions of "Pt-P Salt"), the Q-salt** $[Pt(NH_3)_4](HPO_4)$ or tetraammineplatinum(II) chloride hydrate, $[Pt(NH_3)_4]Cl_2•nH_2O$.
There is still a market for chloroplatinates such as chloroplatinic acid or Ammonium hexachloroplatinate(IV),

[4] *Electroless Autocatalytic Platinum Plating – US Patent 6,391,477 B1 (May 21, 2002)*

$(NH_4)_2[PtCl_6]$. There are also proprietary systems where the exact composition of the plating solution is not communicated. No indication of volumes or evolution of volumes (EU or export?) could be obtained. However, the trend is expected to be in line with the overall trend of chloroplatinate vs non-chloroplatinate sales indicated in Table 7.

- ***Other surface treatment techniques***

In none of the following techniques, the use of chloroplatinate compounds have been identified.

- *Thick film*

Furthermore, coatings are feasible in a silk-screen process with pastes containing precious metals. Then these deposits are fixed with heat (firing). This method is called thick-film technology and is mainly applied to electronics. In thick-film technology, platinum serves e.g. for the manufacture of lambda probes, which control the air-fuel ratio of engines.

- *Thin film*

Thin-film technology is based on physical processes (e.g. sputtering); it plays a decisive part in electronics (platinum temperature sensors in particular) and in the manufacture of biocompatible materials (coronary artery stents, pace-maker electrodes etc.)

- *Chemical Vapour Deposition*

Chemical Vapour Deposition (CVD) allows the deposition of metals from the vapour phase by applying highly volatile materials. If organometallic compounds are used, this method is called "**MOCVD**". Such processes are gaining importance in the field of precious metals. Organoplatinum compounds are conceivable for CVD.

- ***Others***

- ***Photographic films***

In spite of the digital boom which reduces the need for the classical physical-chemical processes, there is still a market for photographic materials (films) of the highest quality for commercial purposes (photocomposition, X-ray, etc.). Such photographic films are based on photosensitive layers called “emulsions” that contain silver (mainly silver bromide) to produce the “negative” image.

The formation of metallic silver on exposure to light can be affected by adding other metals to the emulsions at ***ppm*** concentration levels. Platinum is a toning agent and stabilizes the image simultaneously.
Compounds known to be used for this purpose are **chloroplatinic acid** and tetraammineplatinum(II) chloride hydrate ($[Pt(NH_4)_3]Cl_2 \cdot nH_2O$).

- ***Ceramic colours***

For decorative coating of glassware, china and pottery, **"Ceramic Colours"** are needed. Complex solutions, suspensions, or pastes are applied to the objects to be decorated. Finally, the colours are dried and then fired for permanence (metal deposition).
Compounds of precious metals, mainly of gold (Au), and of PGMs are often components of ceramic colours.
Chloroplatinic acid is used as starting material for platinum deposition.

As regards the REACH status of the use of the selected chloroplatinates in the production of platinum/platinum compounds and in the production and formulation of catalysts may be defined as intermediate.

As far as plating is concerned, the status of intermediate use has been rejected for 'surface treating agents'[5]*. The use for photographic films or as starting material for ceramic colours needs to be checked. It is however important to stress that it is the legal entities' responsibility to decide whether they designate a use as an intermediate, when faced with Authorisation for example. That view may be challenged by the national enforcing authorities. However, and pending confirmation regarding volumes, these uses are not to be considered as potentially impacting the way chloroplatinates will be considered by regulators.*

For its further analysis of the selected chloroplatinates, the panel has focused on the intermediate uses in platinum refining and catalyst manufacturing as shown in Table 3 because they represent by far the most significant volumes of use.

<u>Table 3: Status of the uses of selected chloroplatinates (current knowledge)</u>

	10025-99-7 Dipotassium tetrachloroplatinate	16941-12-1 Hexachloroplatinic acid (and hydrate 26023-84-7 or 18497-13-7)	16921-30-5 Dipotassium hexachloroplatinate	16919-58-7 Diammonium hexachloroplatinate
Intermediate Uses	Preparation of other coordination complexes of Pt such as cisplatin e.g.	Production of other Pt compounds	Production of other Pt compounds	Other Pt compounds
	Production / formulation of catalysts	Production of Catalysts (Precursor for heterogeneous catalysts)	Production of Catalysts (Precursor for heterogeneous catalysts)	
Non-Intermediate Use		Plating	Plating	Plating
Intermediate Use? status to be checked	Photographic films	Photographic films		Photographic films
		Starting material for ceramic colours		

[5] *"As long as the process does not consist in the manufacturing of another substance on its own, the main aim of the process being to provide a specific physico-chemical characteristic to a material (irrespective of whether the surface treating agent is consumed in a chemical reaction and which results in another substance), surface treating agents are not regarded as intermediates*" Example 6, page 39 ECHA Guidance on Intermediates, December 2010.

The main uses of platinum and other platinum group metals as well as precious metals are taken up in Table 4. Platinum compounds, among which chloroplatinates, represent significant uses in the list especially catalysts.

Table 4: Uses of platinum

	Platinum Group Metals						Precious metals	
	Pt	**Pd**	**Rh**	**Ir**	**Os**	**Ru**	Au	Ag
Car & stationary environmental catalysts	X	X	X					
Chemical industry (catalysts, reagents)	X	X	X	X	X	X	X	X
Nitric acid production	X	X	X					
Dental alloys	X	X				X	X	
Electronics (capacitors etc.)	X	X			X	X	X	
Pharmaceuticals and medical equipment	X	X	X	X				
Fuel cells (electrodes, membrane electrode assembly)	X					X		
Jewellery	X	X	X	X		X	X	X
Glass (production equipment)	X	X	X	X		X		
Petrochemical (reforming and isomerisation)	X	X						
Plating	X	X	X	X		X	X	X
Minting	X	X	X	X		X	X	X

Alternatives?

It is useful to set the scene from the beginning: because of their sensitizing properties chloroplatinates have seen some of their uses either being phased out, whilst other uses cannot be substituted.

In the US, the substitution to non-chlorinated substances - at the industrial use level – seems mainly motivated by technical reasons.
In Europe, chloroplatinates are less widely used than in the US and it appears that they are restricted to PGM refiners and large chemical companies.
Concerns about platinum salt sensitization have led to the setting of national OELs in countries where relevant (production sites), and to establishing mandatory worker monitoring practices controlled by the labour inspectorates.

- ***Platinum refining***

There is no alternative path to refining platinum as indicated earlier.

- ***Catalysts***

Hexachloroplatinic acid ($H_2[PtCl_6]$) is used in hydrosilylation processes The platinum requirement for hydrosilylation worldwide is in the range of several tonnes of platinum per year, putting it in the leading group of homogeneous catalytic processes with precious metals. To avoid any potential exposure to chloroplatinates, many chemical companies involved in hydrosilylation processes who previously purchased chloroplatinic acid to manufacture their own catalysts, have now switched to buying catalysts made externally (Karstedt catalysts[6]), the final catalysts not containing chloroplatinates.
Karstedt catalysts play the most important role in this field of application and contain no chloroplatinates. It has to be noted that catalysts may be bought as 'standard formulations' but also on the basis of proprietary formulas indicated by the client.

Regarding **car catalysts**, i.e. the most important use in volumes, the market offers many alternative platinum formulations to hexachloroplatinates at catalyst manufacturing level such as:

- *Platinum(II) nitrate, $Pt(NO_3)_2$*
- *cis-Diamminedinitritoplatinum(II) solution, cis-$[Pt(NO_2)_2(NH_3)_2]$*
- *Tetraammineplatinum(II) chloride hydrate, $[Pt(NH_3)_4]Cl_2 \bullet nH_2O$*
- *Tetraammineplatinum(II) hydrogencarbonate, $[Pt(NH_3)_4](HCO_3)_2$*
- *Tetraammineplatinum(II) hydroxide solution, $[Pt(NH_3)_4](OH)_2$*
- *Tetraammineplatinum(II) nitrate solution, $[Pt(NH_3)_4](NO_3)_2$*
- *Platinum sulfite solution*
- *2-Hydroxyethylammonium hexahydroxoplatinate(IV) solution „Pt EA"*

One should however keep in mind that these non-chloroplatinate substances can currently only be manufactured via a chloroplatinate intermediate species.

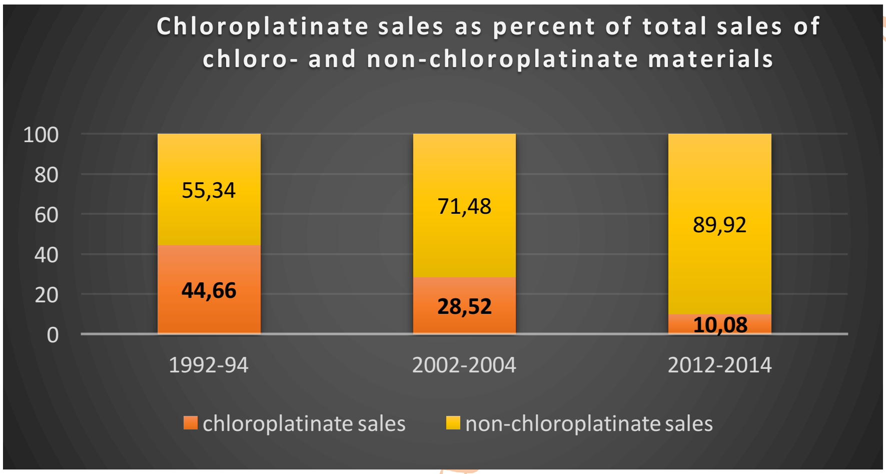
[6] CAS 68478-92-2: Platinum, 1,3-diethenyl-1,1,3,3-tetramethyldisiloxane complexes / Karstedt concentrate

- ***Plating***

Use of chloroplatinates in Europe is on the decline since decades already as "*electrolytes based on chlorides (basic salts: platinum(IV) chloride, ammonium hexachloroplatinate(IV), hexachloro- platinic(IV) acid) have no great significance today*"[7] and alternative formulations (Q and P baths) have already been developed in the late twentieth century and have been widely documented. Only an in-depth specialist analysis may allow identification of the reasons for continued use of chloroplatinates in some plating applications (economic or technological?).

Overall, the trend has been to offer downstream users non-chlorinated platinum compounds and catalysts as an alternative, when possible, to chloroplatinates or to process the chloroplatinates at the production sites rather than at the downstream user sites. Over a 20-year period, the relative share of chloroplatinates vs. non-chloroplatinate platinum compounds in sales have gone down by over 75%, as shown in Table 7.

Table 7: Evolution of chloroplatinate material sales (Global 1992 – 2012)



Source: Johnson Matthey

[7] *Birgitta Lindell, DECOS and NEG Basis for an Occupational Standard – Platinum, Nordic Council of Ministers 1997:14*

Economic considerations

Being an essential 'link' in the refining (primary production and recycling) of platinum, the economy of chloroplatinates is inseparably linked with the overall economy of platinum, platinum group metals and even precious metals.

As shown in Table 5, world gross demand for platinum is around 240 tons per annum of which approximately 40% goes into auto-catalysts. Recycling satisfies nearly 25% of gross demand.

Table 5: Supply and demand for platinum (world)

Platinum Supply and Demand (metric tons)			
SUPPLY	2013	2014	2015
South Africa	119,21	100,53	120,12
Russia	20,55	20,27	19,73
Others	24,69	24,49	24,78
Total Supply	**164,46**	**145,29**	**164,63**
DEMAND			
Auto-catalyst	89,22	95,08	104,75
Jewellery	85,84	82,21	81,14
Industrial	46,83	50,58	52,05
Investment	24,69	7,71	-2,49
Total Gross Demand	**246,58**	**235,58**	**235,44**
Recycling	**-57,52**	**-58,77**	**-62,74**
Total Net Demand	**189,06**	**176,82**	**172,71**
Movements in Stocks	-24,61	-31,52	-8,08

Source: Johnson Matthey Precious Metals Management: PGM Market Report May 2015

In 2010, PGMs recovered from recycled automobile catalytic converters, electrical products, and jewellery accounted for about 30% of the gross global supply of platinum.

In 2010, about 34 tons of platinum were recycled from automobile catalytic converters, about 310 kg of platinum were recycled from electrical components, and about 23 tons of platinum were recycled from jewellery.

During the past decade, demand for PGMs has increased with the increase in use of PGMs in automobile catalytic converters and electronic components. The growth of the fuel cell industry is expected to increase demand for

PGMs during the next decade. The amounts of mineral exploration and PGM recycling are also likely to increase during the next decade because PGM demand is expected to remain strong and existing sources of primary supply to become more expensive.

European demand for platinum is dominated by demand for auto-catalysts as shown in Table 6. Sales of platinum to EU automotive consumers were buoyant in 2014. The largest gain came from the European diesel catalyst sector, on the back of a 5% increase in diesel vehicle output and the implementation of Euro 6 and Euro VI legislation on light and heavy duty vehicles respectively.

Table 6: European demand for platinum

Europe: Gross Platinum Demand by Application										
Tonnes	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015 (forecast)**
Auto-catalyst	64,1	63,9	61,3	30,2	46,5	46,8	41,1	41,1	47,4	53,0
Chemical	3,1	3,4	3,3	2,2	3,4	3,7	3,4	3,0	3,2	3,2
Electrical	0,8	0,5	0,6	0,6	0,5	0,6	0,5	0,5	0,5	0,6
Glass	0,3	0,5	-0,8	0,2	0,3	0,9	0,1	0,3	0,3	0,3
Investment	0,0	6,1	3,3	12,0	4,4	4,8	4,2	-1,2	-2,4	-2,3
Jewellery	6,1	6,1	6,4	5,8	5,4	5,4	5,6	6,8	6,6	6,7
Medical & Biomedical	3,4	3,4	3,6	3,6	2,8	2,8	2,4	2,2	2,2	2,1
Petroleum	0,6	0,8	0,9	0,8	0,6	1,1	-0,1	-0,4	0,2	-0,2
Other	2,0	2,3	2,6	1,7	3,1	3,0	3,6	3,6	3,6	3,7
Totals	**80,4**	**87,0**	**81,2**	**56,9**	**67,0**	**69,1**	**60,8**	**55,8**	**61,6**	**67,1**

Source: Johnson Matthey Precious Metals Management

3. Identification of Risks and Discussion of all the potential Risk Management Options that may be considered

The participating companies discussed where the risks of exposure could be identified in the platinum cycle.

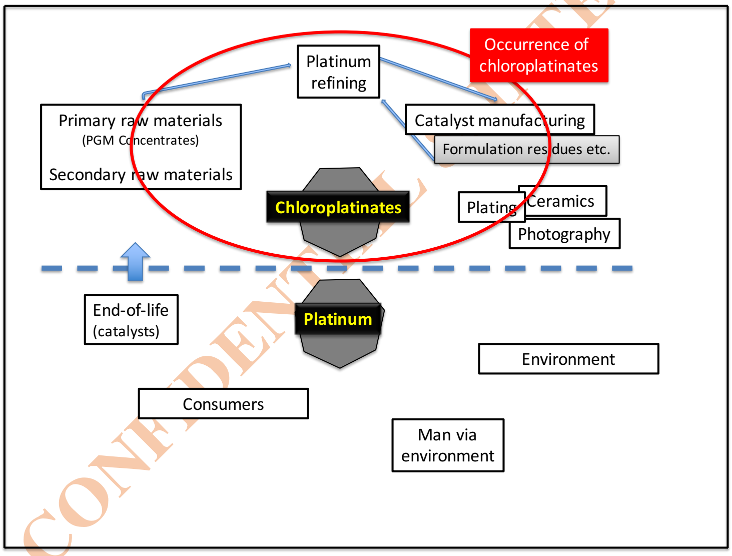
Life-cycle view of chloroplatinates

The entire life-cycle of platinum was considered to identify where there might be occurrences and potential risks to man or the environment.

As illustrated in Figure 3, the risks identified are located at the level of refining of platinum-containing primary and secondary feeds and the intermediate use in the manufacturing of catalysts (but also during research on platinum catalysts) or the manufacturing of other chloroplatinates (such as Cisplatin, an anti-cancer drug) or platinum compounds. The use of chloroplatinates be it in significantly lower quantities, in applications such as plating, photographic films and ceramic colours can not be excluded.

As stated earlier, all these uses may be considered as intermediate uses with the exception of plating. The uses in photographic films and ceramic colouring need to be better understood.

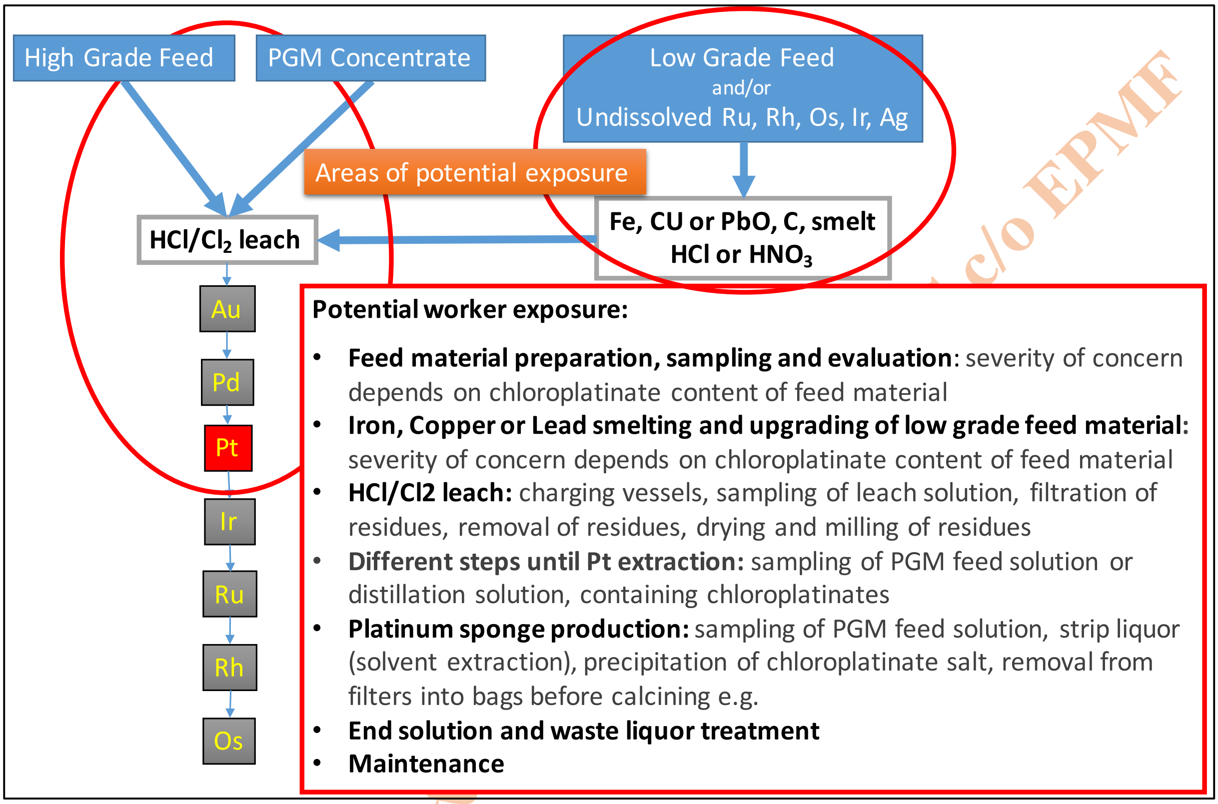
Figure 3: Chloroplatinates occurrence in the platinum life cycle



Platinum refining

The following figure indicates where there is a potential risk of worker exposure during the refining of platinum and platinum group metals (PGMs).

Figure 4: Potential worker exposure during platinum refining



Note: regarding the use of chloroplatinates in catalyst manufacturing, the concerns can be said to be similar.

The individual discussions with companies have led to the conclusion that the prevention of exposure to chloroplatinates is systematically built on three pillars, i.e. work organisation, technology and personal protection:

a) The number of workers tasked with the different operations where exposures may potentially occur is kept to the absolute minimum required for operational efficiency (organisational prevention)

b) Companies are well aware of all potential 'sources of release' in the different operations and future improvements will be mainly improvements of containment or, for example, further automation of sampling procedures (technological prevention)

c) Although recognised as the final layer of protection, the availability and use of personal protective equipment is considered important and unavoidable even with the continued focus on equipment improvement to prevent the most minute emissions.

Catalyst manufacturing

Catalyst manufacturing was represented in the panel. Basically, the same issues can be highlighted with potentially some additional process steps depending on whether or not batch processes are applied (transfer from vessel and storage).

Other downstream uses?

Plating

The nature of the material (value of platinum) or the nature of the technologies involved (high-tech, high purity requirements for electronics) imply that this is not an activity that would be outsourced.

Being mostly an in-house activity, these plating operations fall under the scrutiny of the labour inspectorates, but no data are available on the level of exposure, nor have any cases of platinum salt sensitization been identified in the publicly available literature.

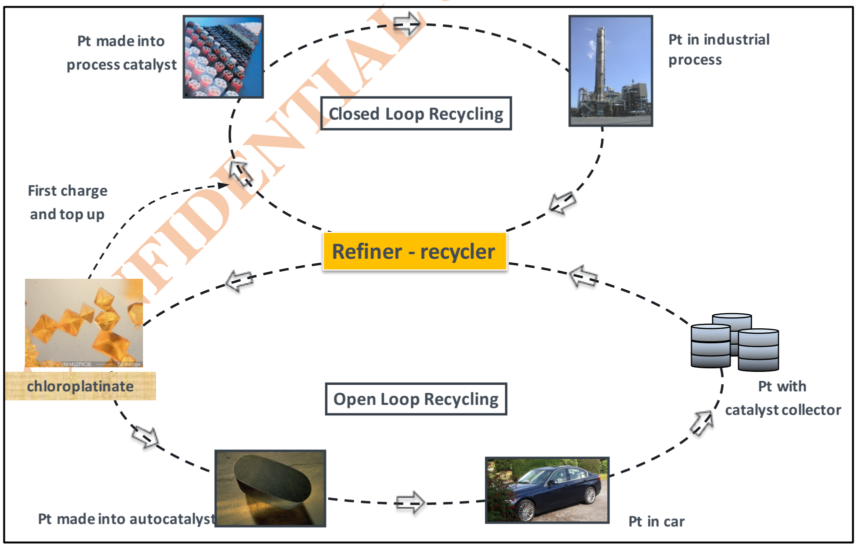
Other uses? Photography?

There is still a market for hexachloroplatinate (*at ppm range*) in emulsions for photography, be it a minor one. Companies could not confirm the existence of any other uses they were aware of, except laboratory and research.

Collection and recycling

Chloroplatinates are not encountered in the recycling loops with the exception of closed loop recycling with industrial clients (formulation residues e.g.).

Figure 5: Chloroplatinates from a recycling perspective



Based on: PGM Recycling: a Business or a Responsibility- Dr Emma Schofield (Johnson Matthey) – August 2014

All options to be considered

The panel identified and described all the potential Risk Management Options that may be considered. A first list of 8 options was developed as shown in Table 9.

Table 9: Potential Risk Management Options for chloroplatinates

Risk Management Option	Description
SUBSTITUTION (Industry initiative)	**Would consist of an industry initiative to further phase out the presence/use of chloroplatinates in its processes.**
EXISTING LEGISLATION: OEL	**A process of setting an EU-wide OEL is already ongoing.**
EXISTING LEGISLATION: BATNEEC	**Best Available Technology Not Entailing Excessive Costs may consist in the introduction and promotion (through EU BAT Reference notes as part of the instruments set up by the Industrial Emissions Directive) of a technological development that would significantly reduce or even eliminate exposure.** The relevant concern is not addressed in the existing non-ferrous metals BREF, i.e. BAT Reference Notes). The current revision does not address it.
HARMONISED CLASSIFICATION UNDER CLP	**Already harmonised for respiratory sensitization, an initiative would focus on the harmonisation of the STOT property.**
SUBSTANCE EVALUATION UNDER REACH	**Substance evaluation would be an option if it were considered that not enough data are available to define an RMO.**
RESTRICTION	**A Member State or ECHA (at the Commission's request) would have to make the case that chloroplatinates pose an unacceptable risk that needs to be addressed on a EU-wide basis through a restriction on the manufacturing, placing on the market or the use of chloroplatinates.** **A Restriction would focus on uses where chloroplatinates are substitutable/ not critical. It might however also consider imposing a ban on production that would not comply with some conditions linked to an exposure limit (cf. ongoing discussions at EU-level). However, on-site isolated intermediates (i.e. the uses in platinum refining and catalyst manufacturing) cannot be subject to a Restriction. The non-intermediate uses such as plating may be considered if it could be established that there is a concern that needs to be addressed.**
SVHC SELECTION / CANDIDATE LIST FOR AUTHORISATION	**A selection based on hazard properties only is possible (extremely potent sensitiser)**
PRIORITISATION FOR AUTHORISATION	**If considered SVHC, chloroplatinates would 'eventually' end up on the list for Authorisation.**

A prior relevance

This list was then submitted to a first analysis of relevance (Table 10) which led to the decision not to further consider the options of Harmonised Classification under CLP and Substance Evaluation under REACH.

Table 10: Relevance of potential Risk Management Options for chloroplatinates

Risk Management Option	First discussion	A priori Relevance
SUBSTITUTION (Industry initiative)	Linked to the capacity to refine Pt (and PGMs…) without a chlorinated phase. There is no sign that this could happen in the foreseeable future. This should however be taken up in the analysis because the ultimate ambition of REACH is to eliminate or substitute SVHCs. Unless quick, all-encompassing and easily verifiable, industry initiatives are only considered by the Authorities with great reluctance Illustrates the importance of a sound analysis of alternatives.	**Low**
EXISTING LEGISLATION: OEL	An update to the existing OEL may be recommended by SCOEL, on the basis of new epidemiological data. In fact, the complexity and uncertainty around the OEL setting process (what will the OEL ultimately be, and when will it be implemented?) leads some MSCAs to not favour the OEL route for risk management	**High** (ongoing process)
EXISTING LEGISLATION: BATNEEC	The relevant concern (risk of respiratory sensitisation) is not addressed specifically at this stage in the non-ferrous metals BREF, i.e. BAT Reference Notes). The current revision does not address it either. So this could not be a 'quick' solution and thus difficult to accept for authorities.	**Low**
HARMONISED CLASSIFICATION UNDER CLP	An initiative to have a harmonised classification for STOT would be a 'subordinate' initiative, not considered essential in terms of managing actual exposure risks.	**Low**
SUBSTANCE EVALUATION UNDER REACH	There is enough data on respiratory sensitisation to discuss risk management options and therefore, substance evaluation would not appear an applicable option.	**Low**
RESTRICTION	Restrictions cannot be imposed on on-site isolated intermediates, which represents the main form in which chloroplatinates are utilised in the EU. Therefore, restrictions would not appear to be appropriate to address the major uses of chloroplatinates. As there is some (minor) trade and transport of chloroplatinates and possibly some uses in plating and other minor uses, a Member State might want to look into this but it is anticipated that it would be very difficult to prove an EU-wide risk.	**Low**
SVHC SELECTION / CANDIDATE LIST FOR AUTHORISATION	The REACH Regulation states that substances on the SVHC list will "eventually" (i.e. ultimately) have to be prioritised for Authorisation (i.e. included on the Candidate List). Under the current wording of REACH, intermediates are exempted from Authorisation and most uses of chloroplatinates could therefore not be considered **relevant SVHCs** as regards eventual Authorisation. Some Member States however consider the SVHC list as a valid RMO on its own, its merit being 'stigmatisation', a discouragement to further use.	**Medium**
PRIORITISATION FOR AUTHORISATION	However, as most of the known uses (in volumes) are intermediates, and thus fall out of its scope, Authorisation would not be able to address the exposure linked to these uses.	**Low**

Discussion of identified potential Risk Management Options

The analysis had to identify the best RMO that fits with the key criteria used in the official RMOAs, in particular as regards its proportionality.
The 6 remaining different potential RMOs were tested against five key criteria. The level of expertise required at this stage was less technical (exposure mitigation-related) as more policy, legal and economic factors had to be considered.

The following criteria were considered in order, each of them covering different dimensions:

1. Effectiveness
2. Practicality
3. Regulatory Consistency
4. Economic impact
5. Human health and environmental impact

The synthesis, i.e. the bringing together of the outcome of the assessment (including the scoring and ranking) leading to **an overall conclusion on proportionality**.
The panel was asked to score the criteria and their parameters. Some of the parameters were considered more important and their scoring was given a heavier weight.

Effectiveness evaluation

Is the RMO able to reduce possible risks and will its effects be measurable?

- *What is the availability of proven and affordable technology?*
- *What is known about alternatives?*

Any **data and expertise on alternatives** will be a valuable input into the discussion.
Table 11 provides the aggregation of the individual companies' assessment and scoring of the different potential RMOs.

Table 11: Effectiveness scoring and ranking of potential Risk Management Options for chloroplatinates

EFFECTIVENESS		Ability to reduce risks	weight	Measurability / Monitorability	weight	Proven technology available	weight	OVERALL EFFECTIVENESS SCORE	RANKING
Substitution (Industry)		**7,5**	1	**27,5**	1	**5**	1	**40**	**3**
Existing legislation (e.g. OEL, BATNEEC, etc.)	**OEL**	**30,5**	1,5	**31,5**	1	**17,5**	1	**94,75**	**1**
	New BAT	**30,5**	1,5	**31,5**	1	**12,5**	1	**89,75**	**2**
Restriction under REACH		**10**	1	**22,5**	1	**6**	1	**38,5**	**4**
SVHC selection / Candidate Listing		**4,5**	1	**16,5**	1	**1,5**	0,5	**21,75**	**6**
Authorisation under REACH		**4,5**	1	**26,5**	1	**4**	0,5	**33**	**5**

Ability to reduce risks: Considering that the risks are only encountered at the workplace, it is felt that the existing legislative paradigm designed to address occupation exposures, i.e. via establishing regulatory OELs, is most able to control risks associated with chloroplatinates.
New technology (under the form of a BAT) is given the same weight as the risk reduction optimum will be technology-based.
Substitution by Industry is given a very low score as downstream uses (beyond the production of platinum) of chloroplatinates have already been reduced and the remaining margin is very limited. The bulk of chloroplatinates remain in the platinum/PGM refining and will not be substituted.
The other Risk Management Options are considered very weak as they will not address the majority of the volumes concerned, because they are intermediates (Authorisation or Restriction) or have no practical implication in operational terms (SVHC selection).

Measurability / monitorability: All options are perceived as being easily monitorable.

Proven technology available: The scoring on the criterion of availability of proven technology is overall very low (OEL scores highest but with nearly half its previous score). Companies indicate that no turn-key technology is available and that the process is more one of step-wise improvements that will take time.

Practicability evaluation

Practicability may be considered from a variety of angles: clarity on actions to be undertaken to implement the RMO, clarity on obligations and responsibilities (Industry and regulators), availability of RMO tools, enforceability and 'implementability' for the regulators. Another aspect that may prove to be quite important is the timeline of implementation or time to result: is there a political urgency to act or not? This may weigh a lot on the decision on the RMO… Table 12 shows how the panel scored the different options.

Table 12: Practicability scoring and ranking of potential Risk Management Options for chloroplatinates

PRACTICABILITY		Ease of implementation by Industry	weight	Ease of implementation for regulators	weight	Time to result	weight	OVERALL PRACTICABILITY SCORE	Ranking
Substitution (Industry)		5	1	7,5	0,5	2,5	1	**11,25**	**6**
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	8	1,5	28	1	11	1,5	**56,5**	**2**
	New BAT	8	1,5	18	1	8,5	1,5	**42,75**	**4**
Restriction under REACH		15	1	27,5	1	22,5	1,5	**76,25**	**1**
SVHC selection / Candidate Listing		10	0,5	22,5	1	13	1	**40,5**	**5**
Authorisation under REACH		12,5	1	27,5	1	9,5	1,5	**54,25**	**3**

Ease of implementation by Industry: Restrictions and SVHC selection/Authorisation being a clear framework appear as being easier to implement by Industry than an OEL. The reason for this is that the scope of Restriction and Authorisation would be limited to only small numbers of uses and would not impact the main industrial intermediate uses.

Ease of implementation for regulators: Overall, all regulatory options score high. The panel recognized the difficulty for a regulator to deal with an industry (self-regulatory) initiative.

Time to result: With the exception of Restriction, as defined in this exercise, all options score low in terms of time to result, integrating regulatory timelines as well as the uncertainty related to the required technological optimization.

Regulatory consistency

The question to answer here is whether the RMO is consistent with a fair level playing field across the EU? Is there a risk of significant differences between national implementations? Are there any potential regulatory overlaps with existing regulations and/or policies?

Table 13: Regulatory effectiveness scoring and ranking of potential Risk Management Options for chloroplatinates

REGULATORY CONSISTENCY		Regulatory consistency across the EU	weight	Consistency with existing EU regulations and policies	weight	OVERALL REGULATORY CONSISTENCY SCORE	Ranking
Substitution (Industry)		0	1	8	0,5	**4**	**6**
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	29,5	1,5	35,5	1,5	**97,5**	**1**
	New BAT	34,5	1,5	25,5	1,5	**90**	**2**
Restriction under REACH		37,5	1	19,5	1	**57**	**3**
SVHC selection and Candidate Listing		15	1	2	1	**17**	**5**
Authorisation under REACH		30	1	9,5	1	**39,5**	**4**

Regulatory consistency across the EU: All regulatory options, with the exception of SVHC selection, are perceived to be able to yield the same result in terms of level playing field across the EU. SVHC selection, because it has no 'practical teeth' has a lower impact whilst an Industry initiative has no impact on regulatory consistency.

Consistency with existing EU regulations and policies: The Risk Management Options with the highest potential for offering business planning security score the highest. Authorisation, in particular, is perceived as contradictory with the EU policy regarding **critical raw materials** where PGMs are featuring high on the list.

Economic impact

It was felt interesting to enrich the proportionality assessment of the different RMOs with a consideration of some criteria seen from both a manufacturer and a downstream user point of view (Table 14).

Table 14: Economic impact scoring and ranking of potential Risk Management Options for chloroplatinates – manufacturers' perspective

IMPACT ON MANUFACTURERS		Supply disruptions	weight	SME-specific impacts	weight	Costs	weight	Investments (production and R&D)	weight	Overall economic impact on manufacturers
Substitution (Industry)		22,5	0,5	20	0,5	15	0,5	22,5	0,5	40
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	27,5	0,5	20	0,5	10,5	0,5	20	0,5	39
	New BAT	27,5	0,5	20	0,5	10,5	0,5	20	0,5	39
Restriction under REACH		17,5	0,5	20	0,5	22	0,5	15	0,5	37,25
SVHC selection and Candidate Listing		20	0,5	25	0,5	27,5	0,5	20	0,5	46,25
Authorisation under REACH		17,5	0,5	20	0,5	23	0,5	18	0,5	39,25

Supply disruption: Because of business planning security, OEL and BAT score high as a preferred option whilst the uncertainty around Authorisation and Restriction leads to a low score for these options.

SME-specific impacts: The panel was unanimously neutral on that aspect as none of them could be considered an SME or could identify an SME-specific impact.

Costs: The options with the least expected impact in industrial operation terms score the highest.

Investments (production/R&D): The different options are scored similarly which is an indication of the uncertainty about their impact on future investments

Table 15: Economic impact scoring and ranking of potential Risk Management Options for chloroplatinates – downstream user perspective

IMPACT ON DOWNSTREAM USERS		Supply disruptions	weight	SME-specific impacts	weight	Costs	weight	Investments (Production and R&D)	weight	Overall economic impact on downstream users
Substitution (Industry)		15	0,5	12,5	0,5	12,5	0,5	12,5	0,5	26,25
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	10	0,5	7,5	0,5	7,5	0,5	7,5	0,5	16,25
	New BAT	10	0,5	7,5	0,5	5	0,5	5	0,5	13,75
Restriction under REACH		15	0,5	12,5	0,5	12,5	0,5	17,5	0,5	28,75
SVHC selection and Candidate Listing		30	0,5	30	0,5	27,5	0,5	27,5	0,5	57,5
Authorisation under REACH		15	0,5	12,5	0,5	7,5	0,5	15	0,5	25

Supply disruption: With the exception of SVHC selection, none of the options is seen as more favourable than the other, from a downstream user point of view.

SME-specific impacts: It was felt that downstream users might prefer instruments such as Restriction or Authorisation.

Costs: The options with the least expected impact in industrial operation terms score the highest (i.e. Restriction and SVHC selection.

Investments (production/R&D): The impact on future investments is felt to be most negative for OELs and BAT.

Table 16: Overall economic impact scoring and ranking of potential Risk Management Options for chloroplatinates

OVERALL ECONOMIC IMPACT		Overall economic impact on manufacturers	Overall economic impact on downstream users	Overall economic impact	Ranking (highest score, thus lowest negative impact ranks first!)
Substitution (Industry)		40	26,25	66,25	**2**
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	39	16,25	55,25	**5**
	New BAT	39	13,75	52,75	**6**
Restriction under REACH		37,25	28,75	66	**3**
SVHC selection and Candidate Listing		46,25	57,5	103,75	**1**
Authorisation under REACH		39,25	25	64,25	**4**

Ranked first is SVHC selection because it is expected that it will have no economic impact on operations and trade.

All other options are ranked closely because the panel had difficulty estimating the various economic impacts for the different RMOs. A clearer view of the economic impact would be possible in case a more concrete proposal for RMO would be submitted by a regulator.

The panel was also invited to consider the potential human health and environmental impacts (seen as benefits) of the different potential RMOs.

Table 17: Human health impact scoring and ranking of potential Risk Management Options for chloroplatinates

HUMAN HEALTH IMPACT		Improvement of affected population (workers, etc.)	weight	Other health impacts (benefits)	weight	Overall human health impact
Substitution (Industry)		20	1	9,5	1	**29,5**
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	27,5	1,5	35,5	1	**76,75**
	new BAT	25	1,5	33	1	**70,5**
Restriction under REACH		17,5	1,5	9,5	1	**35,75**
SVHC selection / Candidate Listing		0	1,5	0	1	**0**
Authorisation under REACH		12,5	1,5	2,5	1	**21,25**

Improvement of affected population: Because it would be the only instrument to cover all exposures, an OEL gets the highest score.

Other health benefits: Being the most efficient measure (and potentially the most drastic in operational terms) an OEL is considered to potentially offer the most health benefits. It would provide a working environment that would be 'over-protective' for all other health risks related to chloroplatinates (and most likely, other substances present).

Table 18: Environmental impact scoring and ranking of potential Risk Management Options for chloroplatinates

ENVIRONMENTAL IMPACT		Specific benefits	weight	Other environmental benefits	weight	Overall environmental impact
Substitution (Industry)		0	1	0	0,5	**0**
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	0	1	0	0,5	**0**
	new BAT	0	1	0	0,5	**0**
Restriction under REACH		0	1	0	0,5	**0**
SVHC selection / Candidate Listing		0	1	0	0,5	**0**
Authorisation under REACH		0	1	0	0,5	**0**

There being no environmental issues, there would also be no environmental benefits to register.

Table 19: Overall human health and environmental impact scoring and ranking of potential Risk Management Options for chloroplatinates

OVERALL HUMAN HEALTH AND ENVIRONMENTAL IMPACT		Overall human health impact	Overall environmental impact	Overall huamn health and environmental impact	Ranking (highest score, thus lowest negative impact ranks first!)
Substitution (Industry)		29,5	0	29,5	**4**
Existing legislation (e.g. OEL, BATNEEC, etc.)	OEL	76,75	0	76,75	**1**
	new BAT	70,5	0	70,5	**2**
Restriction under REACH		35,75	0	35,75	**3**
SVHC selection and Candidate Listing		0	0	0	**6**
Authorisation under REACH		21,25	0	21,25	**5**

The conclusion is that OELs are the most favourable option in terms of human health improvement, whilst logically SVHC selection offers no (immediate) benefit.

Synthesis of discussion of identified potential Risk Management Options

The following two tables present the final ranking of the potential Risk Management Options based on the sum of their scores (Table 20) or the sum of the rankings (Table 21).

Table 20: Synthesis as ranking based on sum of scores, of the potential Risk Management Options

SUM OF SCORES		Overall effectiveness	Overall practicability	Overall regulatory consistency	Overall economic impact	Overall Human Health and Environmental Benefit	Overall proportionality scoring	Final score ranking
Substitution (Industry)		40	11,25	4	66,25	29,5	151	**6**
Existing legislation (e.g. OEL, BATNEEC, etc.)	**OEL**	94,75	56,5	97,5	55,25	76,75	380,75	**1**
	New BAT	89,75	42,75	90	52,75	70,5	345,75	**2**
Restriction under REACH		38,5	76,25	57	66	35,75	273,5	**3**
SVHC selection / Candidate Listing		21,75	40,5	17	103,75	0	183	**5**
Authorisation under REACH		33	54,25	39,5	64,25	21,25	212,25	**4**

Table 21: Synthesis as ranking based on the sum of individual rankings of the potential Risk Management Options based on ranking

RANKINGS		Overall effectiveness	Overall practicability	Overall regulatory consistency	Overall economic impact	Overall Human Health and Environmental Benefit	Overall proportionality ranking	Final ranking
Substitution (Industry)		3	6	6	2	4	21	**4**
Existing legislation (e.g. OEL, BATNEEC, etc.)	**OEL**	1	2	1	5	1	10	**1**
	New BAT	2	4	2	6	2	16	**3**
Restriction under REACH		4	1	2	3	3	13	**2**
SVHC selection / Candidate Listing		6	5	3	1	6	21	**4**
Authorisation under REACH		5	3	5	4	5	22	**6**

This discussion leads to the following main conclusion:

OEL: The preferred option
The OEL is the preferred option in terms of effectiveness, practicability, regulatory consistency and human health benefit to address the concern at the occupational level in the plants.
Companies are aware that it is not the easiest solution to implement and certainly not the cheapest one.

Two other options were considered as of potential interest:

BAT: An option considered in parallel with an OEL, but difficult to implement on its own

The panel has considered that if a BAT could be effective in addressing the challenge, i.e. the risk of exposure to chloroplatinates, the practicability of that option was questionable in terms of time of implementation. It would require a lot of discussions within the Industry and then take benefit of a revision of the Non-Ferrous Metals BREF notes.

An additional challenge seemed to be that such an initiative would not be able to influence an RMO discussion under REACH initiated by a Member State or ECHA.

Restriction: Might be effective where it could apply, i.e. in a very limited number of uses (if any)

The panel felt that a Restriction, focused on specific uses that could be substituted, might be a practicable risk management option. However, there is no easy-to-imagine scope for a Restriction on chloroplatinates or uses of it, so that this assessment would need to be revisited in the event a Restriction were to be considered.

In any case, it was felt that no Restriction would be able to yield the human health benefits of an OEL.

Finally, three options come out low in ranking:

SVHC Selection: A political decision based on a hazard profile?

As such the selection as a Substance of Very High Concern was felt as not entailing immediate costs to any significant degree. There would be no obligations that would influence the operational conditions in the plants.

On the other hand, an SVHC selection would have no positive impact in terms of risk reduction.

Authorisation: No human health benefit and contradicts EU concerns on critical raw materials

The bulk of chloroplatinates are intermediates and would thus not fall under the scope of Authorisation. This has led the panel to give it a low score on effectiveness and human health impact.

Substitution (Industry initiative): Limited in scope and credibility

An Industry initiative was considered with some doubt and not only because the panellists did try to adopt a regulators' perspective. The question of what could be substituted remained open as well as the uncertainty on the usefulness of such a measure for the Industry if it, per se, would not be able to avert any regulatory challenges.

4. Conclusions and recommendations

This study has brought together member companies of the Precious Metals Consortium for an anticipative Risk Management Options Analysis on chloroplatinates. It allowed the participating companies to:

1. Discuss the **possible regulatory challenges** that may:
    a. follow the publication of the IPA chloroplatinates epidemiology study results and their communication to the EU Scientific Committee on Occupational Exposure Limits (SCOEL)
    b. result from the screening for likely Substances of Very High Concern under REACH within the framework of the EU SVHC Roadmap 2020

    In this context, a scenario might be the following:
    i. **As of Q3 2016 (?):** *Due to the absence of an OEL deemed as health-protective, SCOEL expected to reconsider the issue and proceed with a new OEL recommendation. That process may take 2 years at the very least.*
    ii. **As of 2016 onward:** *SVHC Roadmap screening process may lead to first discussions at Member State Competent Authority level (inclusion on the work plan of a Member State to identify need for risk management options or to further evaluate the substances).*
    iii. **2017 (?):** *Possible proposal for inclusion of chloroplatinates on the list of Substances of Very High Concern (i.e. the Candidate list for eventual prioritisation for Authorisation), the risk will increase after the submission of the registration dossiers.*
2. Discuss the main **remaining concerns with the use of chloroplatinates.** This has included the listing of uses and identification of uses not well-known and that might need to be documented better.
3. **Explore six possible Risk Management Options** for chloroplatinates, from both an Industry and a regulator perspective.
4. **Identify what might be the most proportionate Risk Management Measure** applicable to chloroplatinates, through a series of selection steps and substantiating argumentations.
5. **Assessthe knowledge and data gaps** to be addressed by Industry to make a convincing contribution to an official RMO exercise or during public consultations.

Six Risk Management Options were considered

The following six possible Risk Management Options have been identified and discussed by the panel of companies. They are presented here with the main conclusions one can draw.

Substitution (Industry initiative): Limited in scope and credibility

Substitution is a difficult concept for industry, not least for chloroplatinates. The majority of chloroplatinates arise during the PGM refining process and, to date, alternative refining processes that do not generate chloroplatinates are not technologically or economically feasible, and as such chloroplatinates are unavoidable in PGM refining. The replacement of chloroplatinates by a non-chlorinated platinum compound in catalysts or plating is ongoing as shown by figures over the last 20 years. Going beyond that would touch the very essence of PGM refining and would get into contradiction with EU policies (critical raw materials and other policies to encourage an industrial revival). No further recommendations will be made regarding this option.

OEL: The preferred option

An OEL comes out of the discussion as being the preferred option in terms of effectiveness, practicability, regulatory consistency and human health benefit to address the concern where it is, i.e. at occupational level, in a limited number of plants.

This option referring to an ongoing regulatory process, no specific recommendation will be made in terms of data to collect or arguments to develop.

BAT: Difficult to implement and unable to avert RMOA discussions under REACH

Such an initiative would not be able to influence an RMO analysis initiated by a Member State or ECHA and is to be considered as a theoretical option only and thus no recommendations will be made for further analysis or data collection.

Restriction: Might be effective where it could apply, i.e. in a very limited number of uses (if any)

No Restriction would be able to yield the human health benefits of an OEL. The fact that chloroplatinates are likely to be considered (for most if not all of them) as on-site isolated intermediates should prevent authorities from choosing the restriction route although authorities may challenge industry conclusions that uses meet the intermediate definition.
Furthermore, there are ongoing debates between ECHA Committees and the EU Commission about the possibility to suggest a Restriction that would focus on some operating conditions (imposing a recalculated DNEL) and interpretations may change.
Industry has to expect, however, questions from authorities about the uses of chloroplatinates and the conditions of these uses so as to be sure that no use where unacceptable risks *may* occur are overlooked.

SVHC Selection: A political decision based on a hazard profile?

The hazard profile of chloroplatinates make them a good candidate for consideration as SVHC, thus to be put on the Candidate List for Authorisation.
The recommendations in terms of data that are made in this report focus on the development of an argument against considering chloroplatinates as **relevant** SVHCs. If authorities conclude that the intermediate status of the majority of the uses of chloroplatinates mean that only very limited uses will be impacted by eventual prioritising for authorisation, the limited relevance of this RMO approach may be appreciated. The chloroplatinates' irrelevancy in this context will have to be proven by data on intermediate status, tonnages and conditions of use (wide-dispersive or no).
One has however to consider that some Member States are of the view that SVHC selection can be a valid RMO, as it stigmatizes the substance and therefore discourages its future uses.
SVHC selection being the first step toward Authorisation, it has to be considered as a serious risk.

Authorisation: No human health benefit and contradicts EU concerns on critical raw materials

The bulk of chloroplatinates may be considered intermediates and would thus not fall under the scope of Authorisation. Even if, under the current wording of REACH (which may be revised after 2018), there is quasi no risk of chloroplatinates being prioritised for Authorisation, the sector- and substance-related data (not the individual company data) that would be needed in such an eventuality still have to be collected and processed.
These data would be most useful to show the real contribution of chloroplatinates to the EU economy and the limits in terms of alternatives.

Recommendations

This exercise has allowed the collection of useful arguments for future advocacy and has allowed the identification of some data gaps that might need to be filled as a Member State or ECHA might be asking for more information, so as to be able to assess a need for further assessment or action.

Address data and knowledge gaps on volumes and minor or upcoming uses

These gaps relate to the total volumes and volumes per use of chloroplatinates. Such data, valuable for the preparation and update of the REACH Registration dossiers, will allow substantiating the Industry claims about the intermediate uses of chloroplatinates.

The collection of these data should help identify or confirm non-existence or irrelevance of uses beyond the production of platinum and platinum compounds in platinum refineries and catalyst manufacturing plants. Plating is one of these uses that merits a special attention as is the use in photographic films and ceramic colouring.

Keep key arguments for choice of Risk Management Option up-to-date

The intermediate status of most of the uses constitutes a decisive factor in an RMO choice. The evolution of ECHA's interpretation and guidance on establishing an intermediate status of a use needs thus to be followed closely.

The other decisive factor is that there is no technical and economic alternative to a chlorinated phase in platinum refining, and more broadly in PGM refining. Therefore, it is highly advisable that the technical-scientific argument and economic corollary be kept up-to-date.

The check list of items to consider taken up in Table 22 illustrates that not much information needed will be collected in the framework of the REACH Registration so that a parallel collection and processing should be considered to be prepared for a first challenge, from a REACH perspective, as early as end-2016.

Table 22: Recommended information to collect and process

		Info in Registration dossier?	OEL ongoing	Restriction Depends on proposal	SVHC selection	Authorisation
Substance-related data	Human Health hazard profile	**Yes**				
	Related human health regulations	**No**		**X**	**X**	**X**
	Environmental hazard profile	**Yes**				
	Related environmental regulations	**No**		**X**	**X**	**X**
Process- and use-related data	Volumes produced and used in EU (overall)	**Production and import only**		**X**	**X**	**X**
	Exposure (generic – REACH exposure scenarios)	**Yes**		**Check /update**	**Check /update**	**Check /update**
	Process and product regulations	**No**		**X**	**X**	**X**
	Volumes per use /process & historic overview as well as future trends	**No**		**X**	**X**	**X**
	Functionality per use/process	**No**		**X**	**X**	**X**
	Alternatives per use/process and if alternatives available, their hazard profile	**No**		**X**	**X**	**X**
Value chain-related data	# of legal entities	**Not downstream**		**X**	**X**	**X**
	# of workers exposed	**No**		**X**	**X**	**X**
	#of workers dependant on substance availability	**No**		**X**	**X**	**X**
	Markets in the value chain (main characteristics)	**No**		**X**	**X**	**X**
	Cross-value chain links and interrelationships/vulnerabilities	**No**		**X**	**X**	**X**
	Impact scenarios (incl. Non-use scenario)	**No**		**X**	**X**	**X**
	Life-cycle and sustainability dimensions (recycling, availability of materials, criticality of the substance or products made of it)	**No**		**X**	**X**	**X**
	Costing of the impact scenarios vs. current situation	**No**		**X**	**X**	**X**
	Costs to implement new technology	**No**		**X**	**X**	**X**
	Costs to not have the substance available (non-use – alternative)	**No**		**X**	**X**	**X**

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Precious Metals Consortium

ATTACHMENT

RISK MANAGEMENT OPTIONS ANALYSIS ON CHLOROPLATINATES

Guide to a Data Gathering Conversation

I. Substances of Very High Concern to the EU: EU SVHC Roadmap 2020

By 2020, the EU – i.e. the European Chemicals Agency, the Member State Competent Authorities and the European Commission - will screen thousands of substances with a specific toxicological profile such as carcinogen, mutagen or toxic for reproduction (CMR), persistent, bio-accumulative and toxic (PBT) or, under the heading of Equivalent Concern, substances that are dermal or respiratory sensitizers or display a specific target organ toxicity (STOT).

The purpose of this screening is to identify substances for which the current risk management measures may be considered insufficient. Member States or ECHA may then initiate a Risk Management Options Analysis (RMOA) to determine the risk management measure they consider most suited. Such measures may be:

- *The inclusion on the list of Substances of Very High Concern (SVHC) from which the substances are selected that need to go through a process of Authorisation of their different uses*
- *The setting of a Restriction on production or uses*
- *Other risk management measures such as Occupational Exposure Limits (OEL).*

Considering that chloroplatinates are among the most potent respiratory sensitizers encountered in industrial settings (cf. Platinum Salt Sensitization –PSS), it is considered very likely that they will be selected for further analysis. This may happen as early as the end of 2016.

The substances identified as being 'at risk' of such an RMOA are **Dipotassium tetrachloroplatinate**, **Hexachloroplatinic acid (and hydrate)**, **Dipotassium hexachloroplatinate** and **Diammonium hexachloroplatinate.**

II. Anticipative Industry Risk Management Options Analysis

The Precious Metals Consortium c/o European Precious Metals Federation has initiated its own RMOA, an exercise in which participants are invited to perform a 'mock-up' exercise during which they need to adopt the point of view of an authority.

The aim of such an RMOA exercise is to

a. *Agree on the remaining concerns with the use of chloroplatinates*
b. *Explore all possible risk management options that may potentially apply to chloroplatinates*
c. *Discover the most adequate and proportionate risk management measure (from a regulatory but also technical and economical point of view)*
d. *Identify the knowledge and data gaps that are to be addressed by Industry so that it can contribute credibly and convincingly to an official RMO exercise.*

III. Why we need contributions from EHS, R&D, Marketing and Finances.

To perform a solid RMO Analysis requires the input from a diversity of expertise.

In the REACH context the Precious Metals Consortium has access to:

- *Occupational hygienists able address the questions related to exposure at the workplace*
- *Environmental specialists able to identify potential risks to or via the environment*

But, we need a broader input from:

- ***R&D specialists** able to provide technical (chemical) arguments justifying continued use (i.e. difficulty or impossibility to substitute) and indicate the general tendency in R&D regarding these substances.*

- ***Marketing specialists*** *able to indicate the uses they are aware of through their client base as well as the past and expected trends in usage of the chloroplatinates they are aware of*
- ***Financial specialists*** *able to provide an indication on the overall economic importance of chloroplatinates as such or through their use in platinum refining*

IV. Data gathering Conversation: Elements that are relevant for a Risk Management Options Analysis

Fully aware of the potentially sensitive nature of some of this information from a competitive point of view, the Precious Metals Consortium c/o European Precious Metals Federation has agreed with the participants to the Industry RMOA exercise to prepare a Guide for a Data Gathering Conversation to be held in September/October 2015 with the different companies having a stake producing/using chloroplatinates.

A Risk management Options Analysis may be very demanding in terms of data, as authorities want to be able to assess the solidity of exposure data, the real substitution possibilities and their technical and economic feasibility as well as broader socio-economic factors potentially of significance such as potential downstream value chain impacts. First exchanges between Precious Metals Consortium c/o European Precious Metals Federation and its members as well as the International Platinum Association have allowed identifying a first series of knowledge and data gaps that are relevant to an EU RMOA on chloroplatinates. These will have to be addressed by Industry in advance of the first likely 'time slot' for an official RMO initiative, i.e. before end-2016.

A. *In the context of the European REACH regulation, the main focus is to encourage or force* ***substitution*** *of substances with the toxicological profile mentioned in* ***point I*** *in* ***their different uses.***

- ***USES: Identification***
  Main uses known are
  - *Intermediate use in platinum production and in the production and formulation of catalysts*
  - *Downstream use of catalysts*

  Question: Would you have an idea of relative volumes between the use as intermediate and the use as such of chloroplatinates? This distinction is important for regulators because the REACH Regulation currently exempts intermediates from Authorisation.
  Question: Would you be able to describe the use in catalyst production/formulation and the downstream catalyst use? Which are the downstream use sectors and for what specific purpose are these catalysts used?
  Question: Do you know other uses? What would their relevance be in terms of absolute or relative volumes?
- ***USES: Trends***
  Due to their well-known sensitization potential, chloroplatinates have been replaced in some processes by less-hazardous substances (other platinum compounds e.g.)
  Question: Would it be possible to sketch the evolution of the uses of chloroplatinates in the last +/- 20 years? Which applications have been modified or substituted? Are there any indications on the volumes this may represent?
  Question: Are there any indications on future substitutions or uses that are expected to remain stable, to grow or to come up?
- ***USES: Substitution***
  It is important to gather information and arguments to counter the pressure to substitute.
  Questions:
  - *What is the justification of the need to go through a chloride phase in platinum refining? Is there literature available on alternative approaches that have been tried?*

- *What is the justification of the continued use of chloroplatinates in catalyst manufacturing and use?*
- *What is the justification of continued use or future use in other applications you are aware of?*

The justifications might be technical/chemical or economic, or a combination of both. Could one elaborate on that?

- ***USES: Specificities in catalyst use***
  Chloroplatinates are said to be used in both homogeneous and heterogeneous catalysts.
  Question: Would you be able to confirm this and describe these different uses? Is there a difference in worker exposure and in end-of-life management (recycling?) between the use in a homogeneous catalyst and in a homogeneous catalyst?

B. *A Risk Management Options Analysis considers the **socio-economic and financial dimension** of the uses of a substance under review.*

- ***ECONOMICS: Economic significance of chloroplatinates in the platinum value chain***
  Question: Would you be able to provide an indication of the economic significance of chloroplatinates in the platinum value chain?
  One might look at this from different perspectives:
  - *Importance of platinum refining and usage in the EU, as it relies on the chlorinated phase (hence an intermediate production phase with chloroplatinates).*
  - *Importance of chloroplatinates trading (including imports) in the platinum value chain.*
- ***ECONOMICS: Economic significance of chloroplatinates used in catalysts***
  Question: Would you be able to provide an indication of the economic significance of chloroplatinates in catalyst production as well as in catalyst use?